TOWARDS IMPROVED LAND ADMINISTRATION SERVICES: A MODEL TO SUPPORT SPATIAL DATA INTEROPERABILITY AMONG LAND AGENCIES IN ACCRA, GHANA

ROY JOANNIDES
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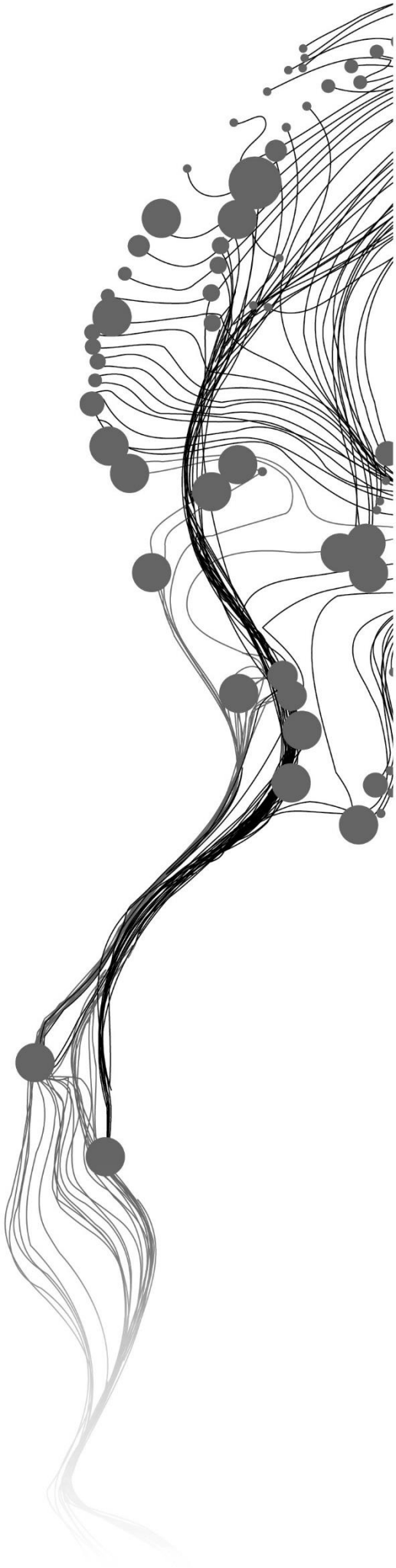

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ABSTRACT

Land is life. Nevertheless, this finite natural resource contends with an increasing population with growing economic, social, and environmental demands. What can be considered a sweeping generalisation is that people are direct beneficiaries of land, and a form of government typically oversees this people-to-land relationship through land administration services. 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. In pursuing improved land services in Accra, this research explored the critical need for spatial data interoperability among land agencies at the heart of land service provision. Taking a scientific approach, land administration services were comprehensively assessed, the factors hindering spatial data interoperability were identified, and a model to support spatial data interoperability was developed and evaluated.

Mixed methods were employed to assess land services, including data collection methods like semi-structured interviews of senior agency staff, client surveys, and observation of existing models within selected land agencies. Supplementing the above, extensive literature reviews were conducted to explore global frameworks, standards and guidelines suitable to identify the technical and organisational challenges within selected agencies and design a framework for land service assessment suited to the context of Accra. Two themes, ten dimensions and twenty-two indicators formed the designed framework. The model design approach was then employed to develop a model to support spatial data interoperability and evaluate it.

The "as-is" Use Cases of three selected services (land title registration, the acquisition of building permits, and registration of customary interests) were presented to assess the state of land service provision. The results of the land service assessment show that on both the operational and beneficiary levels, land services provided by the in-focus agencies were not optimal considering selected indicators. A thorough exploration of the in-focus agencies' operations (workflows and processes) revealed semantic heterogeneities of data; a lack of metadata; inconsistent use of data standards models and formats; the lack of an Integrated Web-based Platform; and a culture of resistance to data sharing. Having established a baseline from the assessment, the model to support spatial data interoperability consisting of five components inspired by global standards and principles was developed. Further, evaluation of the model against the selected service *Requirements* and national legislation revealed that the model's components were sufficient. To seamlessly adopt the proposed model into the modus operandi of land agencies, the study suggested building consensus for change, technical training, soliciting financial support, incremental implementation of each component and continuous monitoring and evaluation as critical mechanisms to prioritise.

The study concludes that the proposed model offers a promising framework for enhanced coordination among land agencies, facilitating spatial data interoperability and should be tabled for discussion among all land service providers. Further research should explore sustainable ways to ensure the proposed model components can be iteratively enhanced and adopted beyond Accra to all land service agencies in Ghana.

KEYWORDS: *Land Service Provision, Spatial Data Interoperability, Land Administration Domain Model (ISO 19152), Data Heterogeneities, Unified Mark-up Language, Modelling, Standards.*

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"The future belongs to those who believe in the beauty of their dreams".

- Eleanor Roosevelt-

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

APIs ..... Application Programmable Interfaces
BSN ..... BurgerServicenummer
CLS ..... Customary Lands Secretariat
CSAU ..... Client Service Access Unit
EIF ..... European Interoperability Framework
ELIS..... Enterprise Land Information System
ETL ..... Extract, Transform, and Load
FIG ..... International Federation of Chartered Surveyors
GELIS ..... Ghana Enterprise Land Information System
GIS..... Geographic Information Systems
GLPIN ..... Ghana Land Parcel Identification Number
GoG ..... Government of Ghana
GRA ..... Ghana Revenue Authority
ICT ..... Information and Communication Technology
INSPIRE..... Infrastructure for Spatial Planning in Europe
ISO ..... International Standardization Organisation
KPIs ..... Key Performance Indicators
LADM ..... Land Administration Domain Model
LAP ..... Land Administration Project
LAS ..... Land Administration System
LC ..... Lands Commission
LGAF ..... Land Governance Assessment Framework
LGI ..... Land Governance Indicators
LIS..... Land Information Systems
LTRD ..... Land Title Registration Division
LUSPA ..... Land Use and Spatial Planning Authority
LVD ..... Land Valuation Division
MDA ..... Model-Driven Architecture
MESTI ..... Ministry of Environment, Science, Technology and Innovation
MLGRD ..... Ministry of Local Government and Rural Development
MLNR ..... Ministry of Lands and Natural Resources
OGC..... Open Geospatial Consortium
OMG ..... Object Management Group
PPD ..... Physical Planning Department
PVLMD..... Public and Vested Lands Management Division
RCC..... Regional Coordinating Council
RRRs ..... Rights, Responsibilities, and Restrictions
SDG ..... Sustainable Development Goal
SDI ..... Spatial Data Infrastructure
SMD ..... Survey and Mapping Division
SPC ..... Statutory Planning Committee
SSPC ..... Secretariat of Spatial Planning Committee
TCPD ..... Town and Country Planning Department
TIN ..... Tax Identification Number
TSC ..... Technical Sub-committee
UML ..... Unified Modelling Language
UN-IGIF ..... Integrated Geospatial Information Framework
WCAG ..... Web Content Accessibility Guidelines
WPD ..... Works and Planning Department

1. INTRODUCTION

This chapter comprises seven sub-chapters; the research background, problem statement, research aim and objectives, research questions, conceptual framework, research structure and a chapter summary.

1.1. Research Background

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. According to the UN/ECE (1996), *"land administration is concerned with determining, recording, and disseminating information about land ownership, value, and use when implementing land management policies"*. While in a broader context, land management refers to all activities associated with managing land and other natural resources essential for achieving political goals and sustainable development (Williamson et al., 2010).

An overarching assertion is that people are direct beneficiaries of land, and a form of government typically oversees this people-to-land relationship through land administration services or, succinctly, land services. Services are defined differently in various fields. However, one earmark about services is that they are intangible commodities with economic value. This thesis lays its foundation on Ponsignon et al. (2012) service definition, a "business process" derived from coordinated activities and available resources consumed at production. Within the domain of Land Administration, and more so in this thesis, services are defined as how the operational aspect of land administration, primarily land information, is provided to beneficiaries within a land market. One of the tenets of a healthy land market is the efficient provision of land services such as land title registration; deed registration; land conflict resolution; property assessment, and valuation, to name a few.

Land services are strongly considered a catalyst for socioeconomic development and a plank for poverty reduction (Besley & Ghatak, 2005). Geospatial information, arguably central to stakeholders' demand for services, is an essential foundation for informed decision-making and sustainable land management, justifying the earlier statement by Besley and Ghatak (2005). Similarly, according to the United Nations (2018), this is a nation's 'digital currency' and a critical component of national infrastructure that provides a blueprint for addressing complex societal challenges. Given this, managing and delivering geospatial information cost-effectively, timely and transparently to stakeholders is imperative; hence, retelling Williamson et al.'s notion of land management "*….achieving political goals and sustainable development*" as the broad goal for which land services are provided.

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). Also, in the parlance of land administration experts and researchers, recent improvements to the provision of land

information are being driven by technological developments, with Land Information Systems (LIS[1]) being at the forefront (Chigbu et al., 2021; Imre, 2017; McLaren & Stanley, 2017; Steudler et al., 2004).

According to GLTN (2021), providing land administration services is conventionally the government's responsibility at both central and local levels, where sharing geospatial data among land-related agencies is imperious. Thus, superficially, such services are facilitated when land institutions function as integrated bodies and have interoperability. The UN-Habitat (2016) states that while clear descriptions of work processes, business objectives and responsibilities are essential for improving land organisations' performances, collaboration across the institutional front is necessary to deliver services to the customer, and a shared information infrastructure sustains this. With this understanding comes the foundation of this thesis, centring on the interoperability of spatial data, which land agencies synthesise into information through land service for stakeholders. This ability of two or more agencies to share information and to use this information that has been exchanged is referred to as interoperability (IEEE, 1990) in this thesis. Thus, the capacity of land-related agencies to exchange data via standard formats or protocols and to use this information shared among their management partners.

The ideal case of data sharing to support the provision of services has been portrayed in the earlier paragraphs; however, this is not always the reality. In the wake of globalisation, a vast amount of data is collected, digitised and managed by various spatial information systems within different land agencies for diverse purposes. This trend is in an optimistic bid to facilitate timely and high-quality services while reducing management costs, but unfortunately, these different data formats, structures, databases and platforms make sharing spatial data a daunting task (Tang et al., 2011). It has become apparent that creating isolated (fragmented) digital environments (subsystems) is a threat or barrier preventing public management organisations from connecting.

Relating to practical instances, Bandeira (2010) states that most countries, such as Ghana, with a civil law system, have land agencies exhibiting varying degrees of decentralisation and hence introduce more information inconsistencies on legal ownership and parcel demarcation. In most cases, this has been the reason for duplicating efforts and monetary resources needed to acquire and use spatial data. To settle the so-called "*Information Island*", Todorovski (2009) recommends that data sharing by government bodies at all levels is a solution to counter the adverse effects of multiple data collection, storage and dissemination. Though the emergence of web services, geo-portals, and other standards have been developed and employed worldwide to facilitate spatial data interoperability, the call for further research exists.

1.2. Problem Statement

Besley & Ghatak (2007) state that providing land services in developing countries such as Ghana is existential, particularly considering the pressing needs of the less privileged and needy. 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 in 2017, the World Bank Doing Business: Equal Opportunities For All report declared an approximately 46-day turnaround time for land registration in Ghana. While these reports go a long way to substantiate Ghana's flawed land administration system and ineffective land service provision, beneficiaries' perception over the years proves the same. According to Abubakari et al. (2018), Ghana's land administration system is indeed unsatisfactory, and this is tied to the inconsistencies deriving from legal pluralism, data redundancies (due to the disintegration of information systems and agencies) and out-of-date information. This is further

[1] Although there is no universal definition of LIS, Rakhmonov et al. (2021), in their recent study, expressed that they are technologies that facilitate the acquisition entry, processing, storage, and dissemination of geospatial or land information.

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. Consequently, the leading land administration service agencies in Ghana, including the Lands Commission (LC), Land Use and Spatial Planning Authority (LUSPA), and Customary Lands Secretariat (CLS), continue to be beckoned by beneficiaries to improve the provision of land services. These challenges explain why public investment in the Ghanaian land market has been undermined recently. While the direction for improvement has been purported through various interventions later discussed in a comprehensive literature review of Chapter 2, some critical challenges still exist. Ehwi & Asante (2016); World Bank (2018) state that making spatial data interoperable among land agencies to support business processes in Ghana has been challenging. This country-specific challenge confirms evidence from Brynjolfsson (1993); Mu et al. (2015), indicating that improving institutions' business processes goes beyond hardware and software deployment but should consider an extensive adaptation of the technology and organisation in a broader societal network to realise all intended benefits. Although the later discussed interventions in Ghana have attempted to bolster land administration processes, little effort has been made to ensure the interoperability of spatial data between land agencies, which according to Agostinho et al.(2012), is considered essential for meeting competitive rising service demands and taking advantage of market opportunities.

In Ghana's decentralised land management system, a considerable amount of valuable geospatial data has been gathered in various forms 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. These predicaments are partly owing to the absence of a data interoperability model, which would include features such as a meta-data standardisation for data storage and dissemination.

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. For example, in the case where clients, through the services of a licenced surveyor, need to visit the LUSPA to detect any land-use restrictions on land parcels before visiting the SMD; to validate site plans during the request of the land title registration service in the Lands Commission.

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. 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. The value of not being limited by existing systems would allow the implementation of strategic solutions and agile approaches from the get-go. In light of this, immediate action should be taken by all stakeholders. Ensuing these challenges and potential areas for improvement in Ghana's land service provision, the aim and objectives of this research are derived.

1.3. Aim of Research

The research aims to: Develop a spatial data interoperability model that would improve the provision of land administration services in Ghana.

1.3.1. Objectives of Research

The following objectives are considered to achieve the aim of the research.

1. To assess the state of land administration services in Accra, Ghana.
2. To identify the factors hindering data interoperability among land agencies in Accra, Ghana.
3. To develop a model to support data interoperability among land agencies in Accra, Ghana.
4. To evaluate this model against service *Requirements* and international standards and provide possible recommendations for its adoption.

1.4. Research Questions

Objective 1: To assess the state of land administration services in Accra, Ghana.

a. What global land frameworks or principles can be adopted to assess land administration services in Ghana?
b. What are the *Requirements* to provide selected land services of the in-focus [2]land agencies?
c. When considering the selected indicators from global land frameworks or principles, what is the state of land administration service in Accra, Ghana?

Objective 2: To identify the factors hindering spatial data interoperability among land agencies in Accra, Ghana.

a. What are the national data standards and policies regulating spatial data interoperability?
b. What gaps hinder spatial data interoperability among land agencies in Accra, Ghana?

Objective 3: To develop a model to support data interoperability among land agencies in Accra, Ghana.

a. How can the identified gaps be incorporated into a model to support spatial data interoperability?

Objective 4: To evaluate this model against country Requirements and provide possible recommendations for its adoption.

a. Does the proposed model satisfy the selected land service *Requirements*?
b. What are some mechanisms to support the adoption of this developed model in land agencies?

1.5. Conceptual Framework

The conceptual framework of the research depicts the improved case of a land administration system in Ghana where land administration service providers, through the implementation of a spatial data interoperability model, collaboratively provide improved land administration services to beneficiaries, including clients, district assemblies, investors or the government. The research focus is highlighted with thicker black outlines with other elements in thinner ones. Interactions are illustrated with arrows, and the abbreviations of in-focus agencies and references are stated in full beneath the diagram (See Figure 1.1).

[2] In subsequent Chapters of the research, "in-focus" agencies are three selected agencies who provide land services.

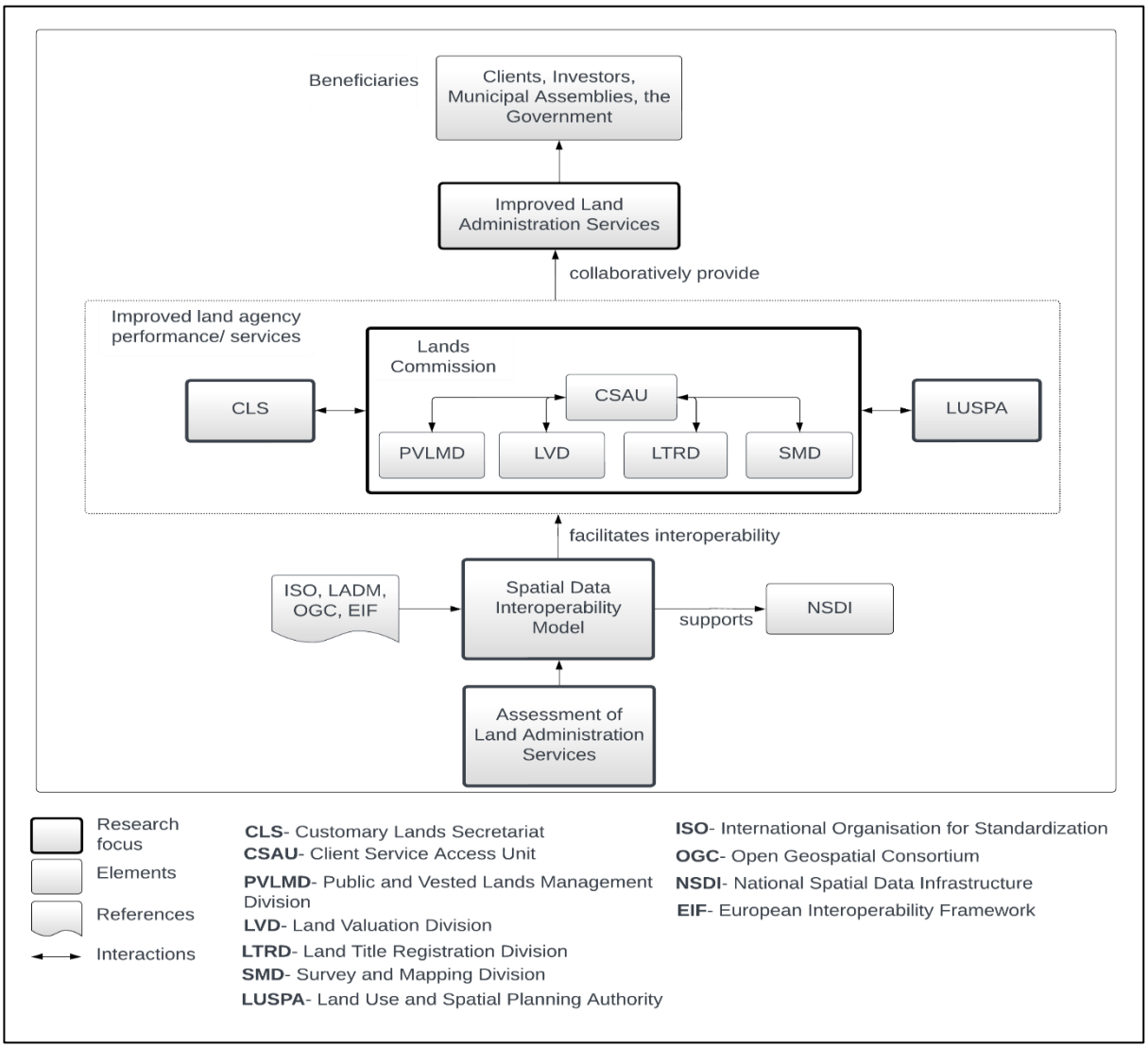

Figure 1.1. Conceptual framework of the research

1.6. Thesis Structure

This thesis is split into six chapters: introduction, literature review, methodology, land service assessment results, model to support spatial data interoperability, and conclusion and recommendations. Chapter One introduces the research by presenting the background, problem statement, aim and objectives, and conceptual framework. Chapter two presents the theoretical framework underpinning the research. Chapter Three describes the research approach, study area and justification, research design, fieldwork activities and data collected and analysed for the research. Chapter Four presents the land service assessment results and its assessment. Chapter Five is where the model to support spatial data interoperability among land agencies is developed. Chapter Six presents conclusions in line with the aim and objectives and recommends areas for further research.

1.7. Chapter Summary

This chapter introduces the research topic, elucidating how the research problem in Ghana's Land Administration was discovered. The research objectives and the study's conceptual framework are established, setting the scene for the ensuing chapters of the research. This chapter concludes by presenting an overview of the research's structure.

2. LITERATURE REVIEW

This research is founded on a juncture between geospatial science, business service improvement, and land administration literature. Commensurate with the interdisciplinary nature of the study, relevant concepts within these fields are reviewed, following a comprehensive state-of-the-art. Finally, this chapter ends with a framework for assessing land administration services in Accra, Ghana, used in successive chapters of the research.

2.1. Land Services and the Land Market

Land administration operates within a broad land governance and management setting, specific to different country contexts. Researchers, including Adjekophori (2020); Dawidowicz & Źróbek (2017); and Wallace (2009), have conducted studies on land administration systems (which lead to the provision of services) and land markets and substantiated a positive relationship between the two. Siniak (2014) identified that a flawed land administration system (LAS) hinders effective land market operation and economic development and added that all nations concerned with sustainable land markets should consider maintaining the LAS as a core focus. Dawidowicz & Renigerbilozor (2014) also state that LAS and land market function in a loop connection. Thus, while the LAS facilitates data collection, storage, and management of data in databases and cadastres, the land market provides the overview of the transactions and state of activities on land.

These researchers concur that a symbiotic relationship exists between land administration services and the land market. Thus, while the land market relies on effective land services to safeguard security and transparency in land transactions, land services such as land titling rely on a functioning land market to provide the basis for their operations. Notwithstanding, the impact of land administration service is unequivocal in providing security of tenure, levying a land tax, planning and control of land use, and land development, all of which comprise a land market (FIG, 2008).

2.1.1. Land Administration "as-a-service" Concept

In a recent publication by Bennett et al. (2023), the concept of "as-a-Service" was explored with the challenge of land administration system maintenance, focusing on examining its relevance, application, and potential adaptation. It proposes a shift from organisational structures based on delivering products at regular, although ad hoc, intervals toward a service-oriented subscriber model. The 4-tier framework from Enterprise Architecture, including business, application, information and technology, was used in the initial stages of the research of Bennette et al. (2023) to describe a potential adoption of this approach into the core of land administration. Generally, the aaS approach minimises one-time and rolling costs, enables easier scaling, and facilitates system upgrades (Chou & Chou, 2007). Although some researchers, including Bennet et al. (2021), believe land administration challenges are macro and extend beyond the gambit of land practitioners, others emphasise that alternative administrative approaches like this should be explored.

2.2. Information and Communications Technology (ICT) and Land Service Provision

Providing land services is contingent on several factors, and ICTs are one such. According to Indrajit et al. (2021), the rapid spread of technology (including hardware and software) with the support of the Internet is providing customised solutions to improve the relations between beneficiaries and suppliers of information. Oukes et al. (2019) state that, for instance, with the availability of Application Programmable Interfaces (APIs), exchanging information electronically among organisations like the planning authorities, notaries, banks, and registries is seamless. They note that Web Feature Service (WFS) allows platform-independent queries for geographical features on the web, much as Web Mapping Service (WMS) is used to produce

georeferenced map images via the Internet. According to Zeng & Cleon (2018); Karikari et al. (2016), modern technologies such as LIS directly bear on the efficient and cost-effective provision of land services. LIS are computerised systems facilitating land information access, retrieval, update, and dissemination. While LIS and technology have been developed to support service provision, limitations have restrained them. The core of such limitations is the complexity of their design, implementation, and adoption (McLaren & Stanley 2017). As succinctly captured by Irani & Love (2008), "*Each innovation in technology and its field of application poses new challenges in measurement of outcome and evaluation*."

2.3. Spatial Data, Spatial Data Infrastructure (SDI)

While spatial data can be described as elements or features that possess geographic information about the earth (space) and time, Souza & Delgado (2012) define Spatial Data Infrastructure to enable access to spatial data and its associated services using protocols and standard specifications. Briefly described, SDIs are considered contemporary internet-based mechanisms to manage geospatial data and information in the digital environment. The word "infrastructure" denotes a reliable and enabling digital environment analogous to networking that facilitates the management of geographically related information. Hence, these data infrastructures, according to Indradjit et al. (2020), are typically operationalised by formal organisations (producers and suppliers of geo-information) and usually function at a country's local (organisational), sub-national and national levels.

The UN-GGIM (2019) report added that on the national level, the SDI could be generally defined as a framework of policies, common standards, technology, and institutional arrangements that enable agencies to integrate and publish while users access distributed heterogeneous geospatial information. The UN-GGIM (2019) also adds that two factors which limit an NSDI are the availability of data in vast data types (big data, structured and unstructured, referenced and unreferenced data) and the need for data integration and analysis (bridging silos or repositories).

2.4. Interoperability and Integration

According to Venadat (2010), for management sciences, interoperability and integration are directed towards business process alignment. The IEEE (1990) define interoperability as "*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*". Agostinho et al. (2012) also define interoperability as the capability of different systems or entities to exchange information via standard formats or protocols and to maximise this shared information. Integration, on the other hand, according to Li and Williams (2005), is described as the coordination of various elements, including processes, technology, and people of organisations, to achieve the optimal fulfilment of one business mission.

Chen et al. (2008) consider that interoperability denotes coexistence, autonomy and a federated environment, while integration speaks more to the notions of coordination, coherence and uniformity. Thus, in simple terms, interoperability concerns' loosely coupled' components connected by a communication network and can interact to exchange services while maintaining their inherent operation logic. Conversely, integration refers to "tightly coupled" interdependent components that cannot be disconnected. Knitting both notions, it is correct to infer that two integrated systems are most likely interoperable, while two interoperable systems may not necessarily be integrated.

2.5. European Interoperability Framework (EIF)

According to the European Commission (2017), the European Integration Framework (EIF) is an encompassing framework for defining, creating, developing, and supplying European public services. The EU believes there are five layers of interoperability which are semantic, technical, organisational, and legal, with a cross-cutting layer of all four layers being integrated public service governance. Semantic interoperability involves maintaining the precise format and meaning of exchanged data or information. This is enabled through vocabularies and schemata, taxonomy reference data agreements, controlled vocabulary, thesauri, code lists, and reusable data structures/models. Technical interoperability refers to applications and infrastructures that determine interface specifications, interconnection services, data, and exchange protocols. On the other hand, organisational interoperability refers to "how public administrations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals" European Commission (2017). While legal interoperability ensures that entities operating under various legal guidelines, policies, and rules can work in tandem when sharing data. Figure 2.1 presents the EIF.

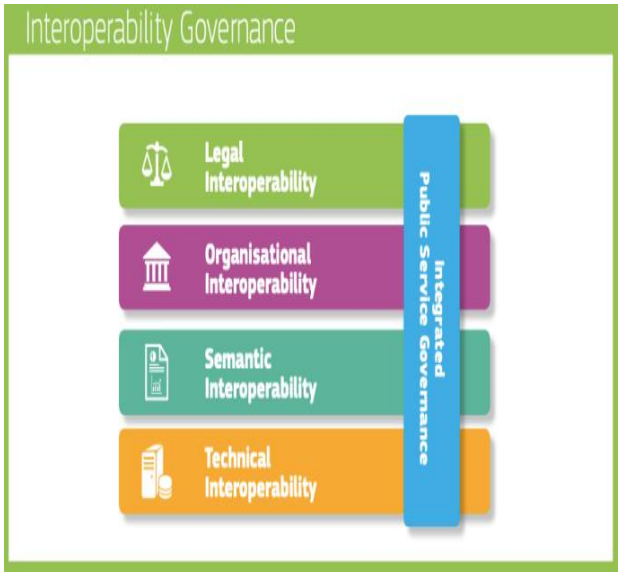

Figure 2.1: European Interoperability Framework

2.6. The ISO ATHENA Interoperability Framework (AIF)- CEN/ISO Standard 11354-1:2011

According to Berre et al. (2007), the AIF gives an interdisciplinary and model-driven approach to analysing and understanding organisations' business demands and technological *Requirements*. The AIF also provides a methodological framework that defines the interoperability approach, from exploring cooperation through solution maintenance to reference guidelines for implementing the reference architecture. This model is based on the FP5 network IDEAS (Interoperability Development for Enterprise Applications and Software, IST-2001-37368), and it identifies and captures related information from several viewpoints. The IDEAS framework also emphasises the need for interoperability at many levels and systems. Berre et al. (2007) also mention a model-driven interoperability approach for Business, Processes, Services, and Information/Data levels to overcome the semantic walls emerging from diverse interpretations of syntactic descriptions. Figure 2.2 presents the AIF.

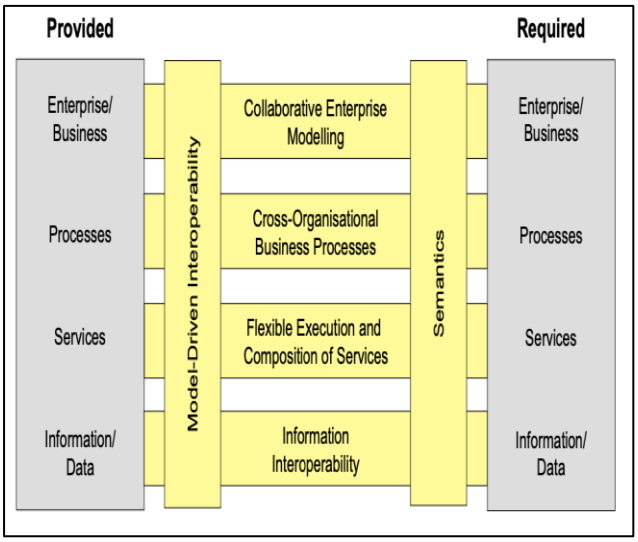

Figure 2.2: The ISO Athena Interoperability Framework

2.7. Unified Modelling Language (UML) in Modelling for Interoperability

One significant development in recent years within information technology is the wide acceptance of UML as a standard way for modelling solutions and visual representation of complex systems. Since being

standardised by the Object Management Group (OMG) in 1997, this language has seen widespread adaptation into business analysis, finance (OMG, 2017), and even for modelling in fields like land administration. According to the OGC (2003), UML as a language is designed for diagramming concepts and relationships to implement information exchange effectively and can be seen as the lingua franca for modelling purposes. UML diagrams such as class diagrams, activity diagrams, and sequence diagrams prove valuable modelling aspects of a system such as land administration, including land registration, parcel identification, acquisition of building/development permits and other transactional processes. On a lower level, they support depicting relationships between components such as the stakeholders, data and workflows/processes comprising a land administration system.

2.8. Model Driven Architecture (MDA)

MDA, according to OMG (2014), is a methodology for software design, development, and implementation. This method gives guidance for developing software descriptions represented as models. MDA decouples business and application logic from core platform technology; thus, platform-independent models (PIM) of an application's or integrated system's business functionality built with Uniform Mark-up Language (UML) and other modelling standards can be realised on nearly any platform, open or proprietary, including Web Services, using MDA. These PIM approaches isolate an application's core from the technology-specific code that implements it, insulating its core from technology and its never-ending churn cycle while facilitating interoperability inside and beyond platform boundaries. According to Oukes et al. (2019), the MDA development life cycle begins by defining the user requirements, after which the models which can be understood by technology and humans are created. This model is relevant for land administration domain modelling to support interoperability.

2.9. Metadata and Data Standards

The prefix "Meta" in the domain of information technology means "an underlying characterisation or description". Relating this to data, Roy & Das (2015) state that metadata composes a set of descriptions defined as the metadata record attached to a resource to be useful for intended purposes. In other words, the term summarises basic information about data (who, when, what, why, where, and how data was generated), making it easier to trace its origin and quality and facilitate its use and reuse. Many academics contend that metadata is required for a computer system to accurately analyse this data and its context with other pertinent data. (Gartner, 2016; Warren, 2015). Metadata for spatial data includes the data source, date, format, projection, scale, resolution, and accuracy (ESRI, 2003). These descriptions are recorded, saved and published in electronic directories or repositories. Depending on the Use Case, compatibility *Requirements* and the systems used for metadata processing, metadata can be written in a variety of forms, including Extensible Markable Language (XML), Comma-Separated Values (CSV), JavaScript Object Notation (JSON), Resource Description Framework (RDF), and Hypertext Mark-up Language (HTML.

Additionally, Aydinoglu & Bovkir (2017) state that the Open Geospatial Consortium (OGC), the International Organisation for Standardisation, and the U.S. Federal Geographic Data Committee began pushing data sharing through spatial data standards. According to ESRI (2013), they are used to "store geospatial data in a common format or transfer data from system to system via Extract, Transform, and Load (ETL) operations". Data standards are also defined by the World Bank (2023) as criteria for organising information acquired by a system to allow semantic interoperability. As a result, they are a set of agreed-upon rules that ensure data placed into a system can be sorted, indexed, retrieved, and transmitted across systems. Typically, data standards specify within a digital system: the length of a field, format (e.g., numeric or strings of letters), permissible values (e.g., male, female, other), and order of entry (e.g., year, month, and date). The ISO (19115/19139) is a widely considered international standard regarding geographic metadata.

It specifies a comprehensive set of structured elements and guidelines for documenting various aspects of spatial data (ISO, 2019), written in XML, supporting machine readability and data exchange.

2.10. Land Administration Domain Model (LADM)

The ISO 19152:2012 LADM is a conceptual and descriptive standard that defines fundamental information-related components of land administration (including elements above water and land, thus below and above the earth's surface) (Lemmen et al., 2013, 2015). This standard presents a foundation to establish spatial data interoperability in land management. It is essential for modelling the relationship between documented Rights, Responsibilities, and Restrictions (RRRs), people-to-land relations, and the geometrical or topological components of spatial information. According to Lemmen et al. (2015), it provides the semantics of the land administration domain essentially based on shared ontology and Model-driven Architecture (MDA). Because this model is generic (built with standard land administration terminology), it is adaptable to local contexts (different levels of land governance) and serves as the foundation for developing national and regional profiles with formal and informal practices. In this regard, profiles have been developed for many countries, including Kenya, Portugal, Russia, and the Netherlands (Aditya et al., 2021). The Unified Modelling Language (UML) is used to define the LADM. The three major packages comprise the LADM: Party, Administrative and Spatial Unit packages. Figure 2.3 presents the UML of the LADM, showing its main classes.

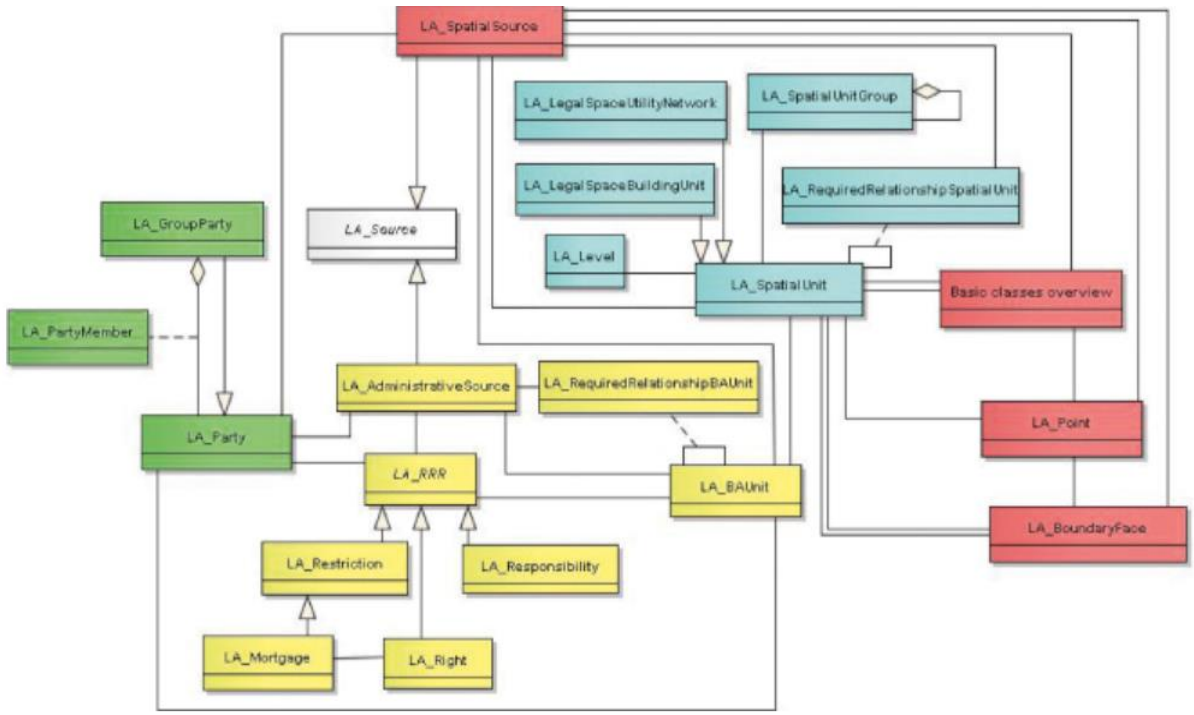

Figure 2.3: UML of the LADM, showing its main classes. Source: (Lemmen et al., 2013)

2.10.1. Land Administration Service Institutions and Agencies in Ghana

Historically, land administration in Ghana has undergone a series of changes through colonial and post-colonial regimes resulting in the current institutional structure. According to Jones-Casey et al. (2019), these interventions have been done in frantic efforts to mainly streamline and bolster land institutions and their activities, which had been regarded as counterproductive.

Tracing these developments to 1999, the National Land Policy was passed as the impetus for land legislative reform in Ghana (Ministry of Lands And Forestry, 1999). The Land Administration Projects 1 and 2 of 2003-2019 ensued as part of the implementation of institutional reforms which spearheaded the Lands

Commission Act, 2008 (Act 767), which consolidated four of the then-independent Lands Commission divisions and the setting up of Customary Land Secretariats (CLSs) across the country (Kuusaana & Gerber, 2015). According to the fact sheet of LANDac (2021), the institutions involved in land administration include the Ministry of Lands and Natural Resources (MLNR), Lands Commission (which comprises: Survey and Mapping, Land Title Registration, Land Valuation and Public and Vested Lands Management divisions); Office of the Administrator of Stool Lands (OASL); Land Use and Spatial Planning Authority (LUSPA) and various Customary Lands Secretariats (CLS).

In the context of Ghana, the institutional framework is decentralised and consists of various bodies responsible for land administration functions or processes. Nonetheless, there are leading providers of land administration services whose beneficiaries are clients, the government, district assemblies and investors. By this, supervisory bodies, primarily ministries, private entities such as Meridia, and the courts which provide conflict resolution in this thesis's purview are excluded. Therefore, the leading land administration agencies, referred to as "in-focus agencies", are the Lands Commission, Land Use and Spatial Planning Authority, and Customary Lands Secretariats. The core functions of these agencies are stated in Appendix 1. Figure 2.4 presents an actor map of institutions and agencies involved in land administration in Accra, Ghana.

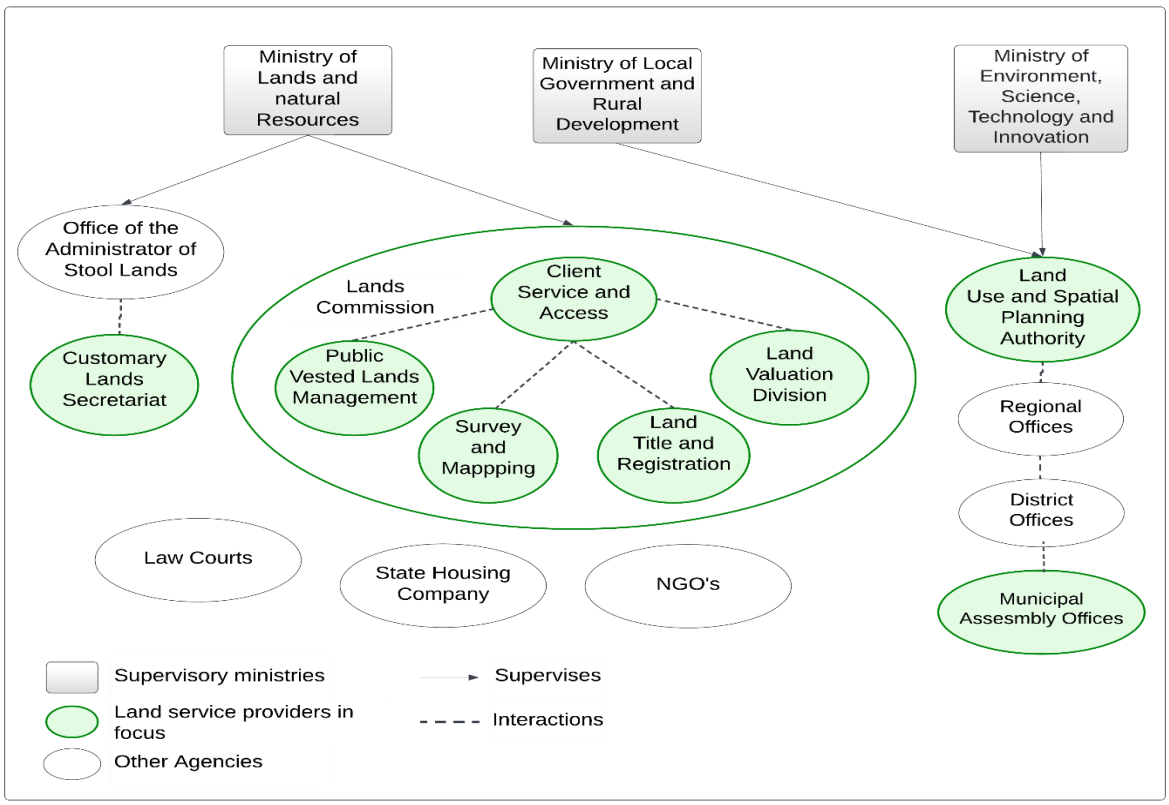

Figure 2.4. Actor map of institutions and agencies involved in land administration in Accra, Ghana.
Source: Authors Construct

2.10.2. Spatial Data Interoperability and its Legislations in Ghana

The relatively slow pace of the NSDI development accounts for why spatial data interoperability in Ghana lags. However, Deane et al. (2017) state that the pace has been set for progress through LAP 2 directives and objectives. On the organisational front, agencies such as the National Information Technology Agency (NITA [3]) are implementing infrastructure and policies such as Ghana Electronic Records and Data Management Standard to encourage interoperability (Deane et al., 2017). At the very mint of technological

3 Responsible for designing and maintaining ICT infrastructure, standards, and geospatial service delivery in Ghana.

interventions, the ELIS software system has relevant but limited service-oriented architecture and has been deployed in 6 out of 16 regions of the county's Lands Commission.

Recently, developments like blockchain, which relies on interoperability principles, have been explored for digitalising land administration in Ghana. However, according to Eder (2019), despite the many years of partnership with the Ministry of Lands and Natural Resources of Ghana and the American technology and consulting company IBM for Ghana's blockchain-based land registry initiative, few concrete developments have been chalked thus far. On a basic level, Yaga et al. (2019) describe blockchain as tamper-resistant ledgers that enable a community of users to record transactions, such that, under regular network operation, no transaction can be changed once published. According to Rodima-Taylor (2021), it has contributed to the formalisation or legalising of property rights in the Global South, where numerous unrecorded informal landholdings should be given more attention.

Several legislations shape data interoperability among land agencies in Ghana. Important ones include the Data Protection Act 2012, the Ghana Electronic Records and Data Management Standard (ERDMS), and the National Data Sharing Policy of the Government of Ghana. The Data Protection Act of 2012 encompasses various provisions, principles, and standards to safeguard personal data and its responsible processing. Specifically, it emphasises the need for obtaining consent, data accuracy, and limitations on data use in line with individuals' information (GOG, 2012). It also obliges data controllers or users to implement measures against unauthorised access, exposure, amendment, or personal data loss. Overall, the Act plays a crucial role in data sharing, and land agencies, like other public stakeholders, are mandated to follow its *Requirements* in their service provision activities to foster the privacy and safety of their beneficiaries. The ERDMS is a framework that establishes guidelines and *Requirements* for creating, storing, retrieving and disseminating electronic records in Ghana's data management ecosystem (NITA, 2021). Its standards are focused on integrity, authenticity, and accessibility of data and emphasise the need for organisations to strive for interoperability and standardisation. It also underscores the need for open data, access controls, audit trailing, data encryption and authentication for better security of electronic data records (NITA, 2021). Other legislation, like the Land Act 1036 and Land Use and Spatial Planning Act 2016 (Act 925), have elements that speak to spatial data interoperability in land agencies.

2.11. Overview of Frameworks for Assessing Land Administration Services

Assessing or measuring the performance of a system is a prerequisite for improving its effectiveness and performance: "You cannot improve what you cannot measure" or "If you cannot measure it, you cannot manage it" (Kaplan & Norton, 1997). Assessment frameworks are pivotal in increasing land agencies' operational performance while improving land administration services by describing what is to be assessed and how to assess it. Frequent assessments are critical due to the rapid changes in every local context and the complexities inherent to the technology employed for land administration services.

While no universally accepted frameworks or models for assessing land administration services due to country variations, be it social, economic, political or cultural, specific globally recognised indicators or elements fit this purpose. In identifying relevant indicators for assessing land services, Dr Steudler's assessment framework, the Capacity Assessment Framework by the International Federation of Chartered Surveyors (FIG), the Land Governance Assessment Framework (LGAF) by the World Bank, and The Integrated Geospatial Information Framework (UN-IGIF) were reviewed (Steudler, 2004; FIG, 2008; World Bank, 2011; UN & World Bank, 2019).

These were selected based on their elements' conceptual and thematic conformity with the assessment of land administration services. Via the assessment of the land administration system, land administration services can be assessed. While other frameworks encompass different components of the land

administration system, these capture essential aspects of land administration services, including beneficiaries, agencies, technology and the mechanisms through which services should be provided. Additionally, their scope can be applied to the sub-national level, which suits the Accra region in the case of this research. These frameworks are discussed briefly, after which indicators for assessing land administration services in Accra, Ghana, are presented by referencing these indicators.

2.11.1. Dr Steudler's Assessment Framework

Steudler (2004) provides a framework that identifies essential indicators for assessing the efficiency of the whole LAS. He evaluates five areas: policy, management, operations, external variables, and the review process. These are divided into indicators, with the operational theme capturing factors such as user definition, products and services, aspects impacting users, and aspects affecting products and services. He defines the operational level as stakeholder units that carry out daily duties and whose choices have a short-term impact on goods, services, and consumers. Appendix 2 shows the operational level, evaluation aspects and selected criteria relevant to this research.

2.11.2. Framework for Capacity Assessment in Land Administration by the (FIG)

FIG (2008) suggested general principles that evaluate the capacity of a country's LAS, distinguishing between the societal, organisational/entity and individual levels. Its organisational/entity level narrows in on formal organisations, agencies, and departments by examining all capacity dimensions, including interactions with other entities, stakeholders, and clients. The framework presents general principles, including security, clarity and simplicity, timeliness, fairness, accessibility, cost, and sustainability (FIG, 2008). Under the "Business Objectives" element, customer orientation is the focus, where electronic access to land information, standards, complaint procedures and transparency are indicators of an efficient service delivery system.

2.11.3. The World Bank's LGAF

According to Deininger et al. (2011), the LGAF is "*a diagnostic instrument to assess the state of land governance at the national or sub-national leve*l". This tool spans five broader themes: legal and institutional framework, land use planning, management and taxation, public land management, public provision of information, and dispute resolution and conflict management. For the scope of this thesis, the theme: the public provision of information where Land Governance Indicators (LGI) 18(1, 2, 5 and 7), LGI 19(1 and 2), LG 20 and LG121 namely, accessibility, affordability and sustainability of land administration services, are in focus. These indicators are considered from the perspective of beneficiaries of a land administration system and the registries or cadastres responsible for providing land tenure or planning information. Appendix 3 shows panel 6: Public provision of land information from the registry and cadastre.

2.11.4. Integrated Geospatial Information Framework (UN-IGIF)

The Integrated Geospatial Information Framework is a forward-thinking strategy and implementation guide established by the United Nations and the World Bank in partnership. This model is for developing scalable and relevant national and sub-national geospatial information management and coordination systems for nations transitioning to digital economies, e-services, and e-commerce (UN & World Bank, 2018). Per the 2030 Agenda for Sustainable Development, this was created to improve citizen services and overcome the geographical digital gap. This framework emphasises the nexus between provider and user communities, stating that they are essential to achieving tangible benefits. It contains underpinning principles, goals and strategic pathways relevant to assessing land administration services in Ghana, highlighted in red in Appendix 4.

2.12. Framework for Assessing Land Administration Services in Ghana.

Land administration services can be assessed from different perspectives considering different objectives. Bearing in mind the definition of land services in Chapter 1, "*how the operational aspect of land administration,*

primarily land information, is provided to beneficiaries within a land market", the assessment will be based on two levels: the organisational and beneficiary levels. Under the organisational level, assessment indicators are in tandem with the structure of the agency as well as its processes or workflows. Under the beneficiary level, the focus of indicators is in tandem with the services received by beneficiaries of the in-focus agencies. For a comprehensive but concise assessment in line with the scope and objectives of this research, specific elements inspired by the above global land management frameworks are identified and fine-tuned. The elements' conceptual, thematic and scalable similarities under the above-reviewed frameworks allow for their adoption to the study area of this research. Figure 2.5 shows the levels, themes and indicators for assessing the provision of land services in Accra, Ghana.

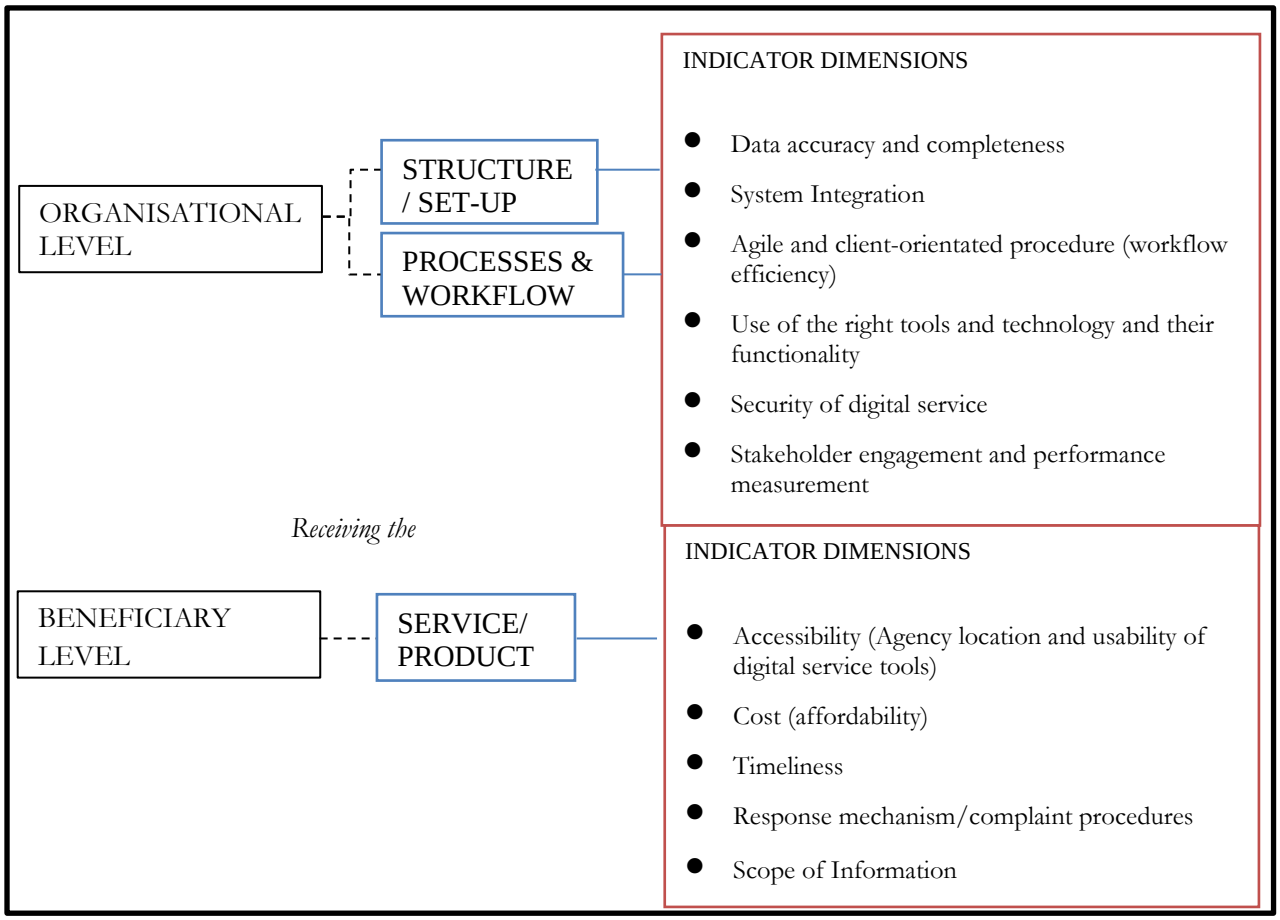

Figure 2.6: Themes and indicators for the assessment of land administration service in Accra. Source: Authors Construct

The land administration assessment for this thesis's scope is not done granularly with respect to each selected service. Instead, a more aggregated approach measures all services' results against identified indicators and dimensions. The land service selection method considers the following, 1—services in high demand; 2.—services with bottlenecks (complex workflows), which can be improved through interoperability. The selected services based on this are Acquisition of building/development permits; Certification of plans; Conflict resolution; Consolidated search report; Land title registration; Parcel plan preparation (survey); and registration of deeds and instruments.

The methodology employed to assess these indicators leverages semi-structured interviews and questionnaires. The service process operation theme is centred on the agency structure and is directed towards experts in the field (selected land service agencies). The client orientation theme leverages a questionnaire designed and answered by clients patronising services from the in-focus land service agencies in Accra, Ghana. Assessment of the service process operation theme combined open-ended responses from

experts and observation of data models used by these agencies. The client questionnaire was analysed quantitatively using IBM SPSS and Microsoft Excel pivot tables. Table 2.3 shows the Land administration services assessment framework for land agencies in Ghana.

Thematic areas	Dimensions	Indicators (I)
Service process operation/ Internal workflow (Operational theme)	Data accuracy and completeness	I1. How completely and accurately does the land agency manage the data in its information systems?
	System Integration	I2. How well-integrated are the various information systems the land agency uses if there are various divisions? I3. How often is client information maintained in different divisions synchronised to ensure the integrity of information?
	Agile and client-orientated procedure (workflow efficiency)	I4. How efficient is the land agency's organisational structure (internal workflow), from data collection to service provision? For example, the number of steps for task completion and frequency/number of client data input during the request of services. I5. Is there an approach of incremental development, prototyping and continuous learning to improve service provision?
	Use of the right technology in the provision of services and their functionality	I6. Does the land information system employ the most suitable technology to ensure the efficient use of resources in providing a service? I7. Are electronic services used to simplify manual processes and reduce duplication of effort? I8. How well are the land agency's information systems fully functional and able to meet the needs of its stakeholders? This can include performing searches, tracking transactions and generating reports.
	Security of digital service	I9. Is all information (spatial and non-spatial) clients provide confidential and stored appropriately? I10. Does the service agency actively identify security, privacy threats and fraud risks associated with clients' information when they request services?
	Performance measurement and stakeholder engagement	I11. How well does the land agency engage with its stakeholders, such as property owners, developers, and other land-related agencies? This includes user satisfaction surveys, feedback mechanisms, and stakeholder participation in decision-making processes. I12. Does the agency identify metrics or standards (key performance indicators) to improve services with the agency? I13. Does the agency frequently measure and monitor performance in line with service provision against (KPIs)
Client Satisfaction (service/product)	Accessibility (usability of digital service)	I14. Web service platforms are available and cater to different devices and browsers. I15. There are digital services that make use of web content accessibility guidelines. I16. Output documents (both digital and hardcopy) are presented in plain and understandable languages
	Cost (affordability)	I17. The cost of services is reduced by agency collaboration (data sharing) and is affordable to clients
	Timeliness	I18. The service(s) are delivered within the stipulated time frame of the agency. I19. There is a timely response to requests for accessing client records.

	Response mechanism/complaint procedures	I20. There are available complaint procedures to clients in correspondence with requested services. I21. Responses are accurate and concise during the processing of documents.
	Scope of Information	I22. The service(s) is scoped according to the information the client needs and expects/ The service satisfies the client's entire request by providing adequate information in output documents.

Table 2.1: Framework for Assessing Land administration services in Accra, Ghana Source: Authors Construct

2.13. Chapter Summary

This chapter reviewed the interdisciplinary concepts that make up the study's theoretical framework. The state-of-the-art, including available frameworks to assess land administration services, was then reviewed to design the framework for Accra's land service assessment. In this Chapter, research questions (a) of Objective One (*What global land frameworks or principles can be adopted to assess land administration services in Ghana?)* and (a) of Objective Two *(What are the national data standards and policies regulating spatial data interoperability?*) was achieved. The next chapter presents the methodology for undertaking this study.

3. METHODOLOGY

This section includes the research approach, methods, design, study area, and data to achieve the study's objectives.

3.1. Research Approach

This research sits within the pragmatist research paradigm. The aim of the research informs this. This research attempts to develop a spatial data interoperability model after assessing land administration services in Accra, Ghana. Taking this premise, a design research method was employed, backed by a case study. A case study was used in this research due to its ability to depict a holistic approach to understanding social phenomena, as Pettigrew (1990) succinctly put it. This methodology helped to explore phenomena within a precise context utilising various data sources while considering a variety of lenses to reveal several facets of the study's focus (Baxter et al., 2008). For the analysis phase, quantitative and qualitative methods were employed using tools such as IBM SPSS, Microsoft Excel and Atlas.Ti.

On the premise of the research, it is also imperative to allude to the study's research philosophy since it shaped how the research elements were studied. In this regard, interpretivism, which assumes a subjective interpretation of findings after data collection and analysis, was preferred (Fossey et al., 2002). The research strategy was also deductive, where arguments were established considering existing theories and literature. Figure 3.1 shows the general research workflow[4].

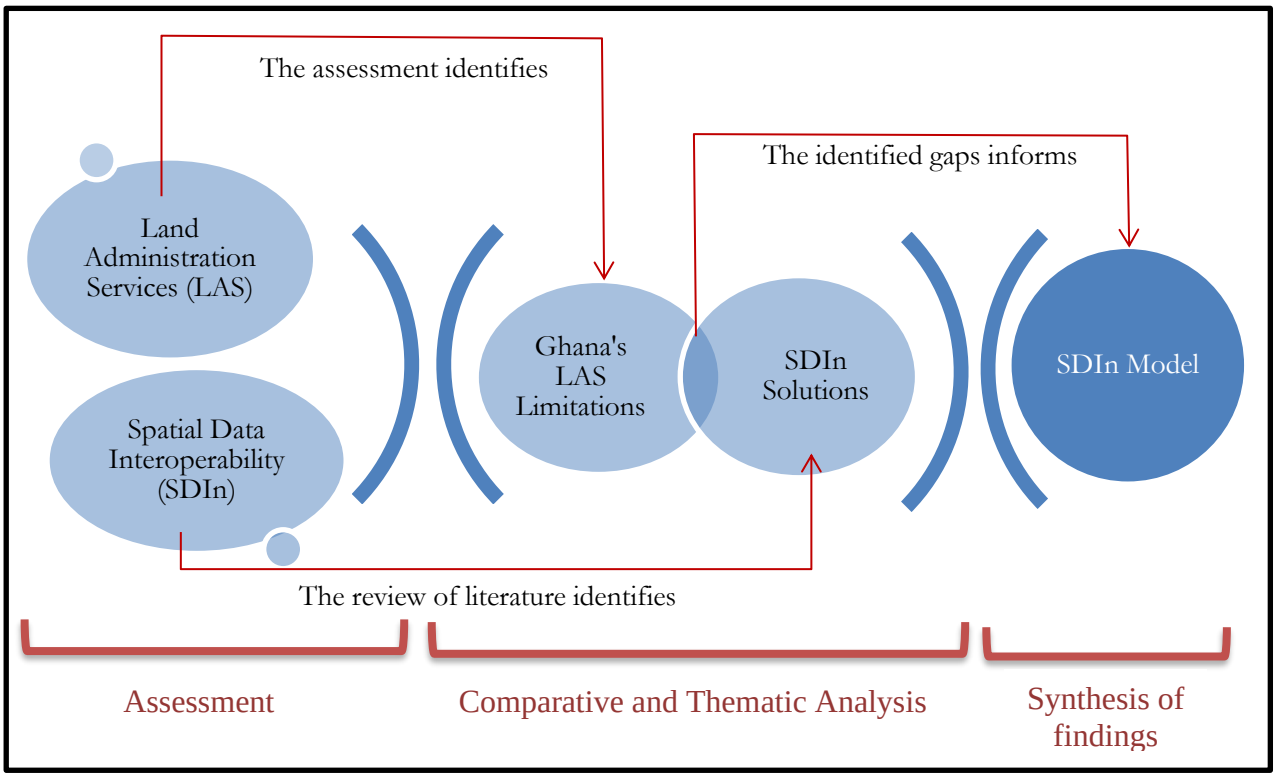

Figure 3.1: General research workflow *Source: Authors Construct*

[4] SDIn- Spatial Data Interoperability

3.2. Study Area and Justification

Yin (2008) suggests placing scope boundaries on research to reduce the tendency to answer far-reaching objectives and questions. To do this, Baxter et al. (2008) suggested bounding, which is limited to "*time and place; time and activity; or definition and context*".

The research focused on accessing land services provided after implementing LAP 2 in Accra (time and place). This is because the advent of LAP 2 has spearheaded major institutional reforms, including the consolidation of the Lands Commission 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 and 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 done by determining whether or not 1) they are 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 (MLNR, MLGRD, MESTI), 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-spatial 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 spatial 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. Spatial data interoperability was thus limited to the agencies mentioned above, leaving the model's success to extend to other agencies performing land administration functions. Figure 3.2 presents the study area map.

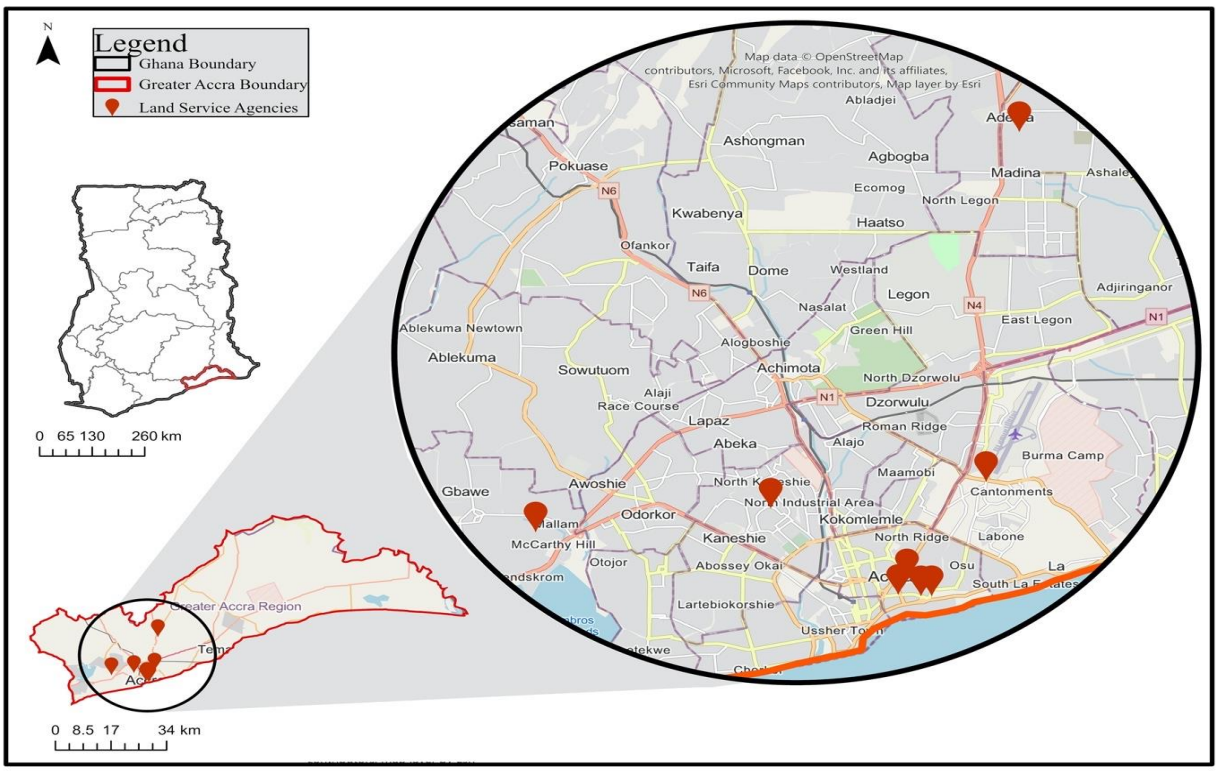

Figure 3.2: Study area map *Source: Authors Construct*

3.3. Research Design

The research design consists of activities methodically categorised under pre-fieldwork, fieldwork and post-fieldwork, captured in Figure 3.3.

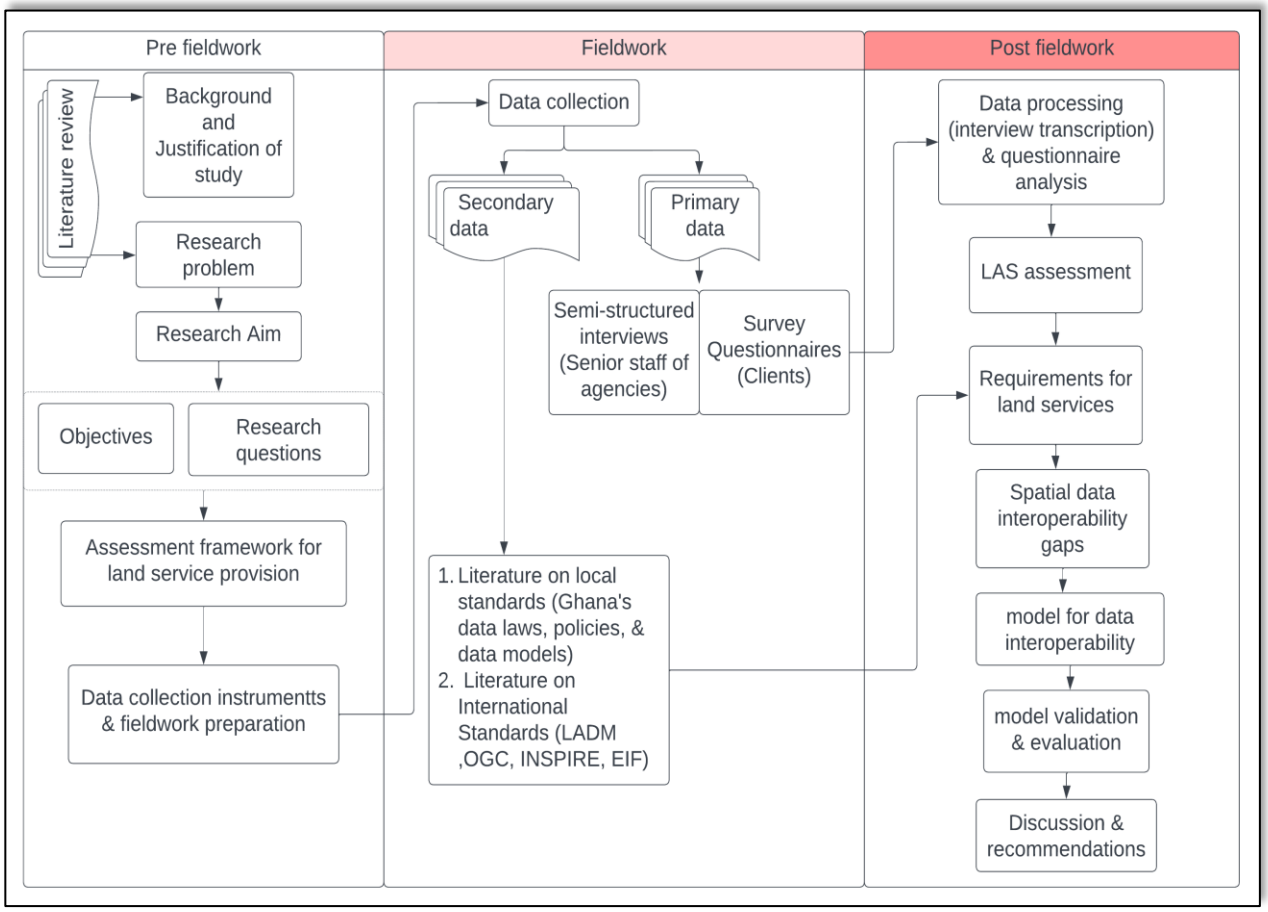

Figure 3.3: Flow chart of study

3.3.1. Pre-fieldwork

A literature review established the study's background and problem. Subsequently, the research aim, objectives and questions were derived during the pre-field work. An overview of the framework for assessing land services was presented at this stage. Subsequently, data collection instruments were prepared, and all other fieldwork strategies and approaches were decided at this stage in anticipation of the fieldwork.

3.3.2. Fieldwork

At this stage, primary data collection was done. To understand the state of land service provision in Ghana, secondary data from the literature review was supplemented with primary data from clients through questionnaires and semi-structured interviews with senior staff within the in-focus agencies. According to Galletta (2013), semi-structured interviews facilitate exchange between the interviewer and participant, thus allowing the interviewer to improvise follow-up questions founded on the interviewee's replies. The sampling strategy employed for the survey questionnaire was convenience sampling. According to Taherdoost (2016), this strategy selects participants based on their availability and willingness to participate. Since many clients frequent these high-transaction agencies, this proved to be an inexpensive and adequate option to capture the views of the beneficiaries requesting the selected land services. Questionnaires were administered with the help of the Jotform tool (see Appendix 5 for the survey questionnaire). This was a means to realise objective one.

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. According to Maxwell (1996), purposive sampling is a strategy in which specific sample participants are selected consciously to provide principal information that is otherwise unobtainable from other sources, thus selection based on knowledge within a particular field. 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. This was the means to realise objective two. All but two interviews were audio recorded (see Appendix 6 for the semi-structured interview guide).

The services provided by the in-focus agencies are extensive. The assessment was limited to core services most requested in these agencies. These 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. In the subsequent Chapters, three of these services, which are acquiring building/development permits, land title registration and the registration of customary interests, are focused on when eliciting *Requirements* for the model development. This is because, per the distribution of client responses on the field, they were the services most requested out of 40 clients (see Figure 3.4). Table 3.1 shows the semi-structured respondents' (senior staff) distribution within the in-focus agencies.

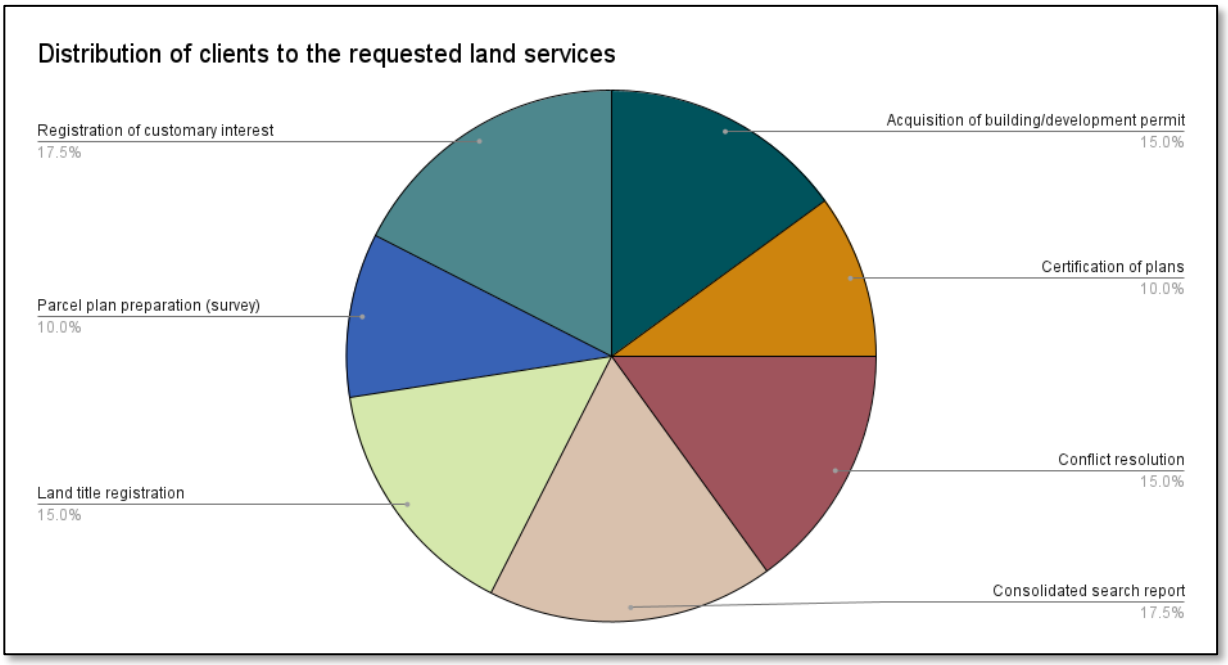

Figure 3.4: Distribution of clients to the requested land services

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 3.1 Interview Respondents

3.3.3. Post Fieldwork

All primary data acquired through audio recording were transcribed and thematised using Atlas.ti and Otter.ai; all additional notes were taken electronically. With Land Act 1036, Land Use and Spatial Planning Act, 2016 (No. 925 of 2016) and Lands Commission Act, 2008 (Act 767), harmonised with the information derived from the senior staff of the in-focus agencies, the "as is" *Requirements* for the services: land title registration, acquisition of building permits and registration of customary interests were documented. These workflow *Requirements*, mainly produced by the Lands Commission, LUSPA and CLS, respectively, were used to support the aggregated assessment approach of land services stated in Chapter 2.12. These service workflows were designed using UML and represented as sequence diagrams. The current workflows were also used as a basis to identify some gaps.

Frameworks and standards, such as the ISO, LADM and draft of the Ghana LADM country profile (Okyere, 2021), EIF and Open Geospatial Consortium (OGC), were also referenced while developing the data interoperability model components. These were selected because they meet general modelling *Requirements* in Land Administration, have been tested within many country contexts and are internationally proven. These, however, were extended to Ghana's socio-cultural, political and economic context. Enterprise Architecture was the primary tool for designing the model's conceptual and relational diagrams. The research matrix is presented in Appendix 7.

3.4. Ethical Considerations, Risks and Contingencies

Per the Research Ethics Policy of the University of Twente, all ethical considerations and contingencies for research were observed before and during the study. The study ensured soundness in primary data collection by protecting all respondents and participants from potential risks. The ethical codes of conducting research were adhered to, including informed consent, voluntary participation and the right to withdraw participation at any point, anonymity, and confidentiality. Before primary data collection, formal permission letters were delivered to all target institutions from which key informants were employed. With this, all respondents were unbound from legal repercussions, such as policies concerning disseminating organisations' information. Also, all respondents were served consent forms stating the research's objectives, potential benefits, harms, and use. All COVID-19 rules were observed during physical interviews.

3.5. Chapter Summary

This Chapter describes the research approach, study area and justification, research design and ethical considerations, risks and contingencies. All tools and technology employed to achieve each objective, from pre- and post-field work, are also stated. The methods used throughout the study proved sufficient, and the results to justify this are presented in the ensuing chapter.

4. LAND SERVICE ASSESSMENT RESULTS

This chapter consists of the requirements for producing selected land services, the assessment results and the analysis derived in line with the land service assessment framework in Chapter 2.13.

4.1. Requirements for Producing Selected Land Services.

This subsection describes all the *Requirements* to reach three selected land services provided by the in-focus land agencies. These services are 1) land title registration, 2) the acquisition of building permits and 3) the registration of customary interest. The *Requirements* for producing these services are stated on the constraints of all relevant acts like the Land Act 1036 (2020), among other literature and interviews from senior staff within the agencies where they are produced. A UML sequence diagram presents all the *Requirements* (processes, elements and actors) based on each service's "as is" Use Cases.

4.1.1. Land Registration (First Registration)

The Greater Accra region is a land title registration jurisdiction. Title registration in this region follows the Torrens system. In other words, a land title is only formed following formal registration in the land registry (Lands Commission). This is defined by Sections 103, 123, and 124 of the Land Act 1036. Indefeasibility, where the rights of a registered proprietor of a parcel (acquired on first registration, subsequently or by a Court order) holds the rights and privileges attached to the parcel of land, is also used. Per the law, the guarantee principle, where the state will indemnify anyone who suffers an injury inferred by the registry, is also practised. According to the GoG Land (Act 1036) 2020, there are three systems for recording and registering land and interests in Ghana. For the scope of this thesis, the *Requirements* of title registration on interests and rights on land (as first registration) and recording customary interests will be discussed in detail.

Use Case: Land Title Registration

Actors:

Requirement 1. Client: The person, entity, business, or government seeking to acquire a land title.

Requirement 2. Client Service Access Unit: The first contact administrative unit responsible for managing land title registration processes and client correspondence.

Requirement 3. Lands Commission: The agency responsible for land registration, essentially issuing land title certificates.

Requirement 4. Land Use and Spatial Planning Authority: The agency responsible for handling land use planning, zoning and management.

Requirement 5. Customary Lands Secretariat: The agency responsible for administering and keeping transactions on stool, skin, family or clan lands.

Processes:

Requirement 6. A client initiates a land title registration process at the Client Service Access Unit.

Requirement 7. The client submits three documents: personal details form, indenture, and approved site plan to the Client Service Access Unit.

Requirement 8. The Client Service Access Unit receives and verifies the submitted documents, including personal details.

Requirement 9. The client pays a stamp duty tax to the Client Service Access Unit.

Requirement 10. The Client Service Access Unit assigns a unique tracking number (lodgement number) to the Client for tracking the registration process until the certificate is issued.

Requirement 11. The Client Service Access Unit batches the documents through the ELIS to the PVLMD and SMD of the Lands Commission, the Land Use and Spatial Planning Agency, and the Customary Lands Secretariat.

Requirement 12. The PVLMD and SMD of the Lands Commission verify the submitted documents and check for any conflicting interests or disputes regarding the RRR.

Requirement 13. The Land Use and Spatial Planning Agency verifies the site plan congruently with the approved zoning scheme and ensures compliance with other planning restrictions.

Requirement 14. The Customary Lands Secretariat verifies the status of the documents and checks for any conflicting interests or disputes.

Requirement 15. The three agencies provide feedback and approvals to the Client Service Access Unit.

Requirement 16. The registration process continues if no objections are raised during the public viewing notification period.

Requirement 17. The Client Service Access Unit updates the registration status and informs the Client.

Requirement 18. The Lands Commission generates the land title certificate, including the registered interests, personal details and spatial unit.

Requirement 19. The certificate is signed, sealed, and approved by the Lands Commission.

Requirement 20. The Client Service Access Unit informs the Client that the land title certificate is ready to be collected.

Requirement 21. The Client collects the land title certificate from the Client Service Access Unit.

Elements:

Requirement 22. Personal Details: Client's information relevant to the registration process.

Requirement 23. Indenture: Transaction agreement document.

Requirement 24. Approved Site Plan: Licensed Surveyor-approved plan delineating the spatial unit boundaries.

Requirement 25. Unique Tracking Number: An identifier/lodgement number assigned to the Client for tracking the registration process.

Requirement 26. Zoning Scheme: A document indicating the permissible land use and restrictions.

Requirement 27. Land Title Certificate: Official document proving the registration of the land title.

Figure 4.1 shows the UML sequence diagram for land title registration involving actors, elements, and processes to be used as a baseline to suggest a new Use Case in Chapter 5.2.6

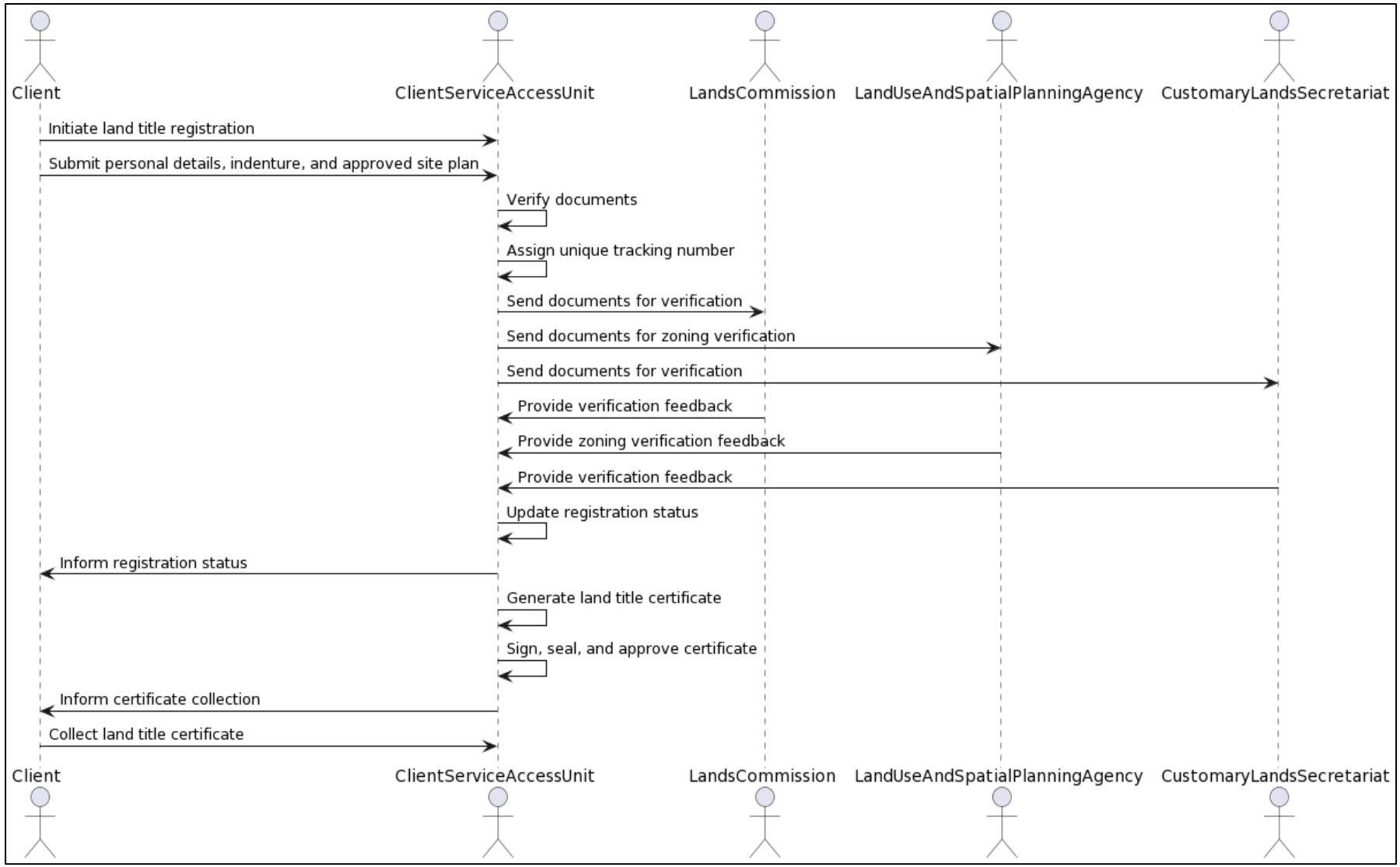

Figure 4.1. UML sequence diagram for land title registration involving actors, elements, and processes. *Source: Authors Construct*

4.1.2. Acquisition of Building Permit

According to the TCPD (2015), now the LUSPA, development permitting is the core instrument for regulating or managing physical development. To that effect, the Local Government Act 1993 (Act 462) stipulates that "*No physical development shall be carried out in a district without prior approval in the form of a written permit granted by the District Planning Authority – Act 462, Section 49 (1*)". Thus, development permits relate to permits issued in connection with planning and construction applications concerning the erection of any structure, structural change or transformation, or the installation of any fittings in tandem with any structure. The requirements below are primarily performed by the TCPD, now LUSPA.

Use Case: Acquisition of Building Permit

Actors:

Requirement 1. Client: The person, entity, business or government seeking to acquire a building permit.
Requirement 2. Secretariat of Spatial Planning Committee (SSPC): specialized department in LUSPA
Requirement 3. Works and Planning Department (WPD): specialized department in LUSPA
Requirement 4. Physical Planning Department (PPD): specialized department in LUSPA
Requirement 5. Technical Sub-committee (TSC): specialized unit in LUSPA
Requirement 6. Statutory Planning Committee (SPC: specialized unit in LUSPA
Requirement 7. Regional Coordinating Council (RCC): specialized unit in LUSPA

Processes:

Requirement 8. A client initiates an application for a building permit to the SSPC by submitting personal details and application documents.
Requirement 9. The SSPC checks the personal details and application documents (Site Plan prepared by a licensed Surveyor, Architectural drawings, Structural drawings, Property rate, Fire report, Block plan, Evidence of ownership of the land (Title/Deeds/Indenture) for compliance, and provides technical guidance if necessary.
Requirement 10. The client pays submission fees to the SSPC, creating a record in the database.
Requirement 11. The WPD conducts structural and architectural assessments.
Requirement 12. The PPD conducts zoning and planning assessments.
Requirement 13. The SSPC collates the technical findings from the WPD for site inspection.
Requirement 14. Together with the client or client agent, the Physical Planning Officer and Works Engineer conduct a site inspection.
Requirement 15. The TSC assesses the application and site plan and makes recommendations to the SPC.
Requirement 16. The SPC decides whether to approve, refuse, query/defer the application
Requirement 17. The client is notified of the decision by the SPC.
Requirement 18. The SPC and Works Engineer jointly prepare and sign the permit certificate.
Requirement 19. The client pays the permit fees after receiving correspondence from the SPC.
Requirement 20. If there are queries or appeals to the RCC, they are discussed and addressed by the client and SPC.
Requirement 21. If there are no appeals, the client collects the issued permit from the SPC.

Elements:

Requirement 22. Fully completed Development Permit Application Form
Requirement 23. Site Plan prepared by a licensed Surveyor.
Requirement 24. Architectural drawings, Structural drawings, Fire report, and Block plan
Requirement 25. Evidence of ownership of the land (Title/Deeds/Indenture)
Requirement 26. Previous permit (if any)
Requirement 27. Property rate

Figure 4.2 shows the UML sequence diagram for acquiring building permits involving actors, elements, and processes to be used as a baseline to suggest a new Use Case in Chapter 5.2.6

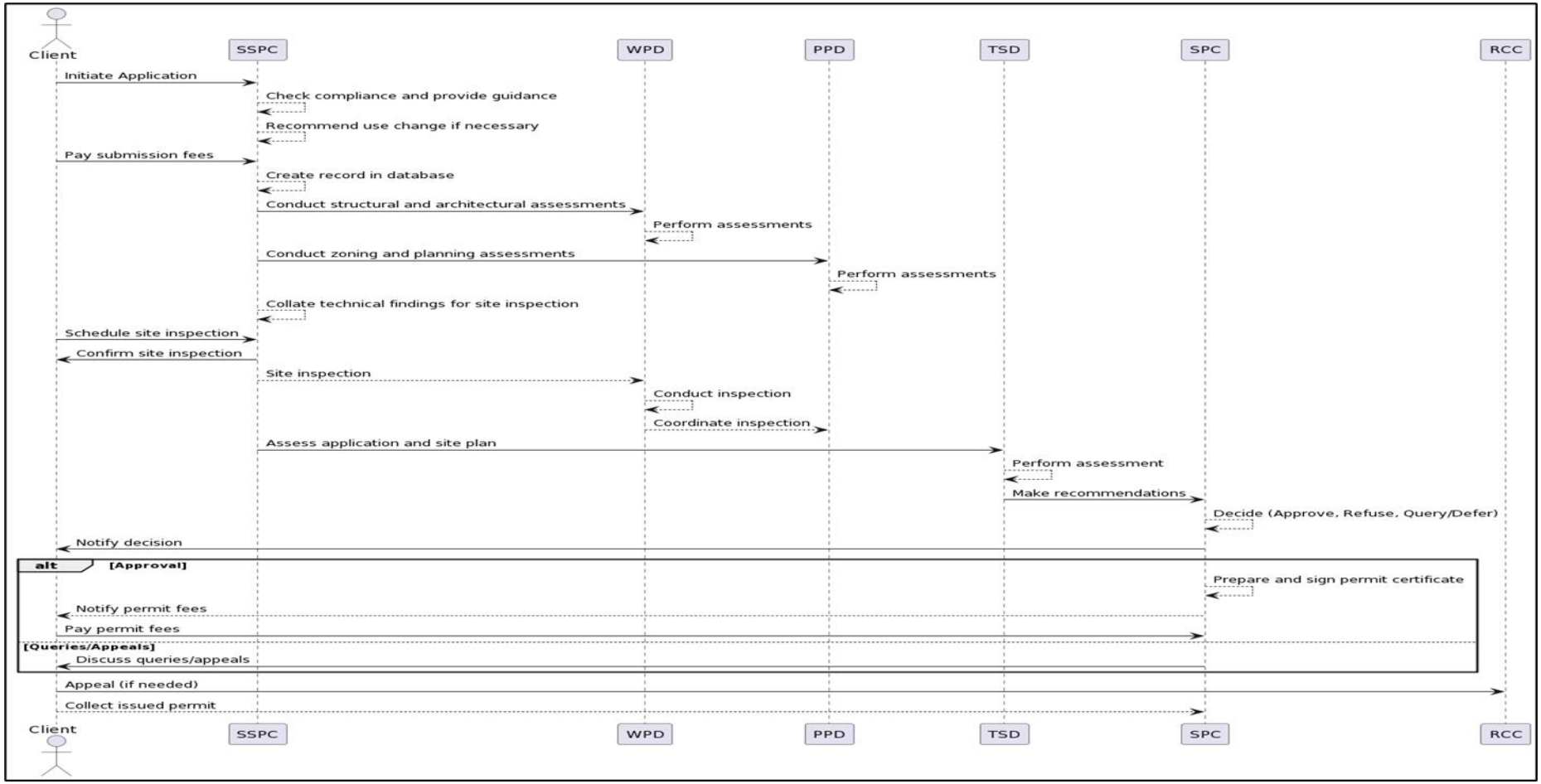

Figure 4.2 UML sequence diagram for acquiring building permits involving actors, elements, and processes. Source: Authors Construct

4.1.3. Registration of Customary Land Interests

According to Kasanga et at. (2001), land holding in Ghana is primarily customary, that being about 80%. Ghana has multiple clans, stools and states, each with unique linguistic and cultural identities. While customary systems vary culturally and spatially, they have a level of cohesions for principles, ownership, use, and land management practices. The two definite ownership categories are lands vested in stools or clans (southern Ghana) and lands vested in Skins (Northern Ghana). According to Asiama et al. (2022), RRR in customary land is transferred chiefly through grants, rentals, sharecropping contracts, inheritances, and gifts regulated by local traditions and customs. These land transfer methods have their roots in tradition and reflect the socioeconomic structures of the area in which the land is located. Unlike documented statutory laws, customary laws are orally preserved and have been modified over time. The CLS is mandated to manage and regulate customary land holdings with other institutions like the Lands Commission. As stated, there are variances in management practices for each customary group in Ghana. Considering that the study area of this research focuses on Accra, the land registration system of the Gbawe Customary area is described below.

According to Arko-Adjei (2011), in the Gbawe community, the family is headed by the 'Gyaastse' or trustee, the land board, the land allocation committee, and CLS together manage land. The allodial interest of Gbawe Kwatey land is vested in the family. Family lands for this group are primarily given out as leasehold interest.

Use Case: Customary Lands Registration

Actors:

Requirement 1. Client: The individual or entity seeking to lease a Gbawe land.
Requirement 2. Land Allocation Committee (LAC): Committee responsible for vetting and approving land lease applications.
Requirement 3. Gyaasetse: Family head and trustee with authority to give out family land.
Requirement 4. Customary Land Secretariat (CLS): Responsible for land management and registration.

Processes:

Requirement 5. A client initiates the lease application process.
Requirement 6. The client submits the lease application form to the CLS.
Requirement 7. The CLS reviews the application and forwards it to the LAC.
Requirement 8. The LAC vets the application and informs the Gyaasetse (family head).
Requirement 9. The Gyaasetse approves the lease.
Requirement 10. The CLS issues a site plan and receipt to the client.
Requirement 11. The client pays for the leased land.
Requirement 12. The CLS registers the lease and enters relevant information in the land register.
Requirement 13. The CLS stores a copy of the lease indenture and assigns a unique reference number.
Requirement 14. The spatial units (land parcels and buildings) are registered based on cadastral, site, and architectural plans.
Requirement 15. CLS maintains the planning scheme cadastre for the entire Gbawe area.
Requirement 16. The planning scheme cadastre is used for boundary determination.

Appendix 8 shows the UML sequence diagram for registering customary land interests in the Gbawe CLS involving actors, elements, and processes to be used as a baseline to suggest a new Use Case in Chapter 5.2.6.

4.2. Land Service Assessment Indicators

Based on the land service assessment framework established in Chapter 2.13, the results of each identified indicator are presented in the proceeding sub-chapters.

4.2.1. Data Accuracy and Completeness

According to interviews with senior staff of the SMD of the Lands Commission, "*It is still difficult to seamlessly access from the sister divisions even within the Lands Commission after the advent of the ELIS system; the collection method of survey data has always yielded good accuracy, but the unstructured collection of this data results in inconsistencies and gaps of the entire data within the SMD*". Observation of the ELIS system also revealed overlapping cadastral plots from all three divisions despite having the same attribute data and land use. Figure 4.3 shows the ELIS system illustrating these multiple plots from the SMD, LTRD AND PVLMD. Another interview from senior staff in the Lands Commission revealed that "*In other cases, differences in attribute data may be about the schema of the name of the land owner/representative, partly due to the 2021 Ghana card initiative, which saw alterations in name IDs and their ordering; however, attribute data is as accurate as is presented by clients who request services*".

Also, an interview with one senior staff of the regional LUSPA alluded to using different survey base maps by the SMD and LUSPA. It was mentioned that "*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. The LUSPA uses the Universal Transverse Mercator (UTM) 30-31, while the SMD uses Ghana WAR-OFFICE*. For completeness, all in-focus agencies attest to the incomplete data due to various reasons, including sporadic registration, as mentioned by senior staff of the LTRD, the absence of a digital system to manage all zonal demarcations by the LUSPA and the absence of a customary functional register to manage deeds by the PVLMD and CLS.

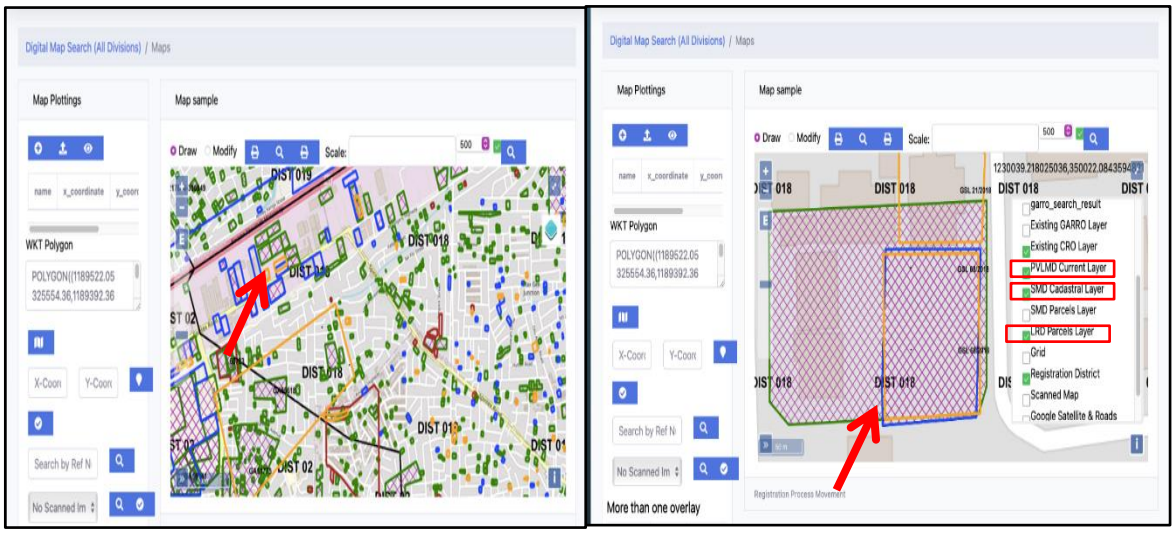

Figure 4.3 Multiple digital plotting in from the SMD, LRD and PVLMD of the Lands Commission

4.2.2. System Integration

Interviews from one senior staff within the Search Unit of the LC revealed that "*there is a nice system in place (referring to the ELIS); however, there is still limited access rights to certain data. I, for instance, would like to view some plotted parcels and how they were hatched (highlighted) by the SMD in the search report phase, but because this responsibility is solely reserved for the technical officers, I cannot interact with the polygons on the screen to view the mapping details. If I have a query, I would have to batch the file back to be checked when I could verify little details by myself to save time*". For other agencies like the LUSPA, an interview with one senior staff revealed that *"…even within this office (referring to the Accra regional office) and between the regional and district level, there is no form of digital*

integration; when I need data on the district level, I have to make calls to have data arranged for me on a storage drive. We have no cloud, and the LUPMIS system is not in use". The fieldwork revealed very little integration between subsystems or databases within the LUSPA and no integration among other agencies. The fieldwork reveals that all correspondence (land transaction records and revenue audits) from the CLS is communicated analogously to the OASL since they act as a supervisory body on quarterly bases. Interviews from the OASL director revealed that "*the digitisation efforts carried out during the LAP 2 did not substantially impact the CLS*". For instance, most customary lands have not been captured with aerial photographs hence, the lack of digitized customary boundaries.

4.2.3. Agile and Client-orientated Procedure (Workflow Efficiency)

After reviewing the current workflows outlined to reach services such as search reports, effective 2021, the Lands Commission, under the new Land Act 1036, no longer issues separate searches from its three divisions but rather consolidates all records into one report for clients after they have requested from the CSAU through the online portal, https://onlineservices.lc.gov.gh. Regarding the collaboration within and between the in-focus agencies to minimise client data input (e.g., the number of times clients should provide the same information for a service, Figures 4.4 and Appendix 9 and 10 show a distribution of client responses peculiar to service and agency. The data shows that, for example, about 83% of respondents who requested building permits consented to submit their details or documents more than once to one or more divisions within the service agency—further probing revealed that for land title registration, three out of six clients who submitted documents to the Lands Commission had to submit documents as much as over three times before they finally received their title. Concerning indicator 5, the fieldwork revealed a culture for continuous improvement toward client-oriented within the CLS and OASL. In an interview, the senior staff of the OASL shared that *"we have been engaged in several workshops and stakeholder meetings to table and review current challenges of the OASL and CLS; implement process enhancements to streamline workflow concerning providing our mandated services".*

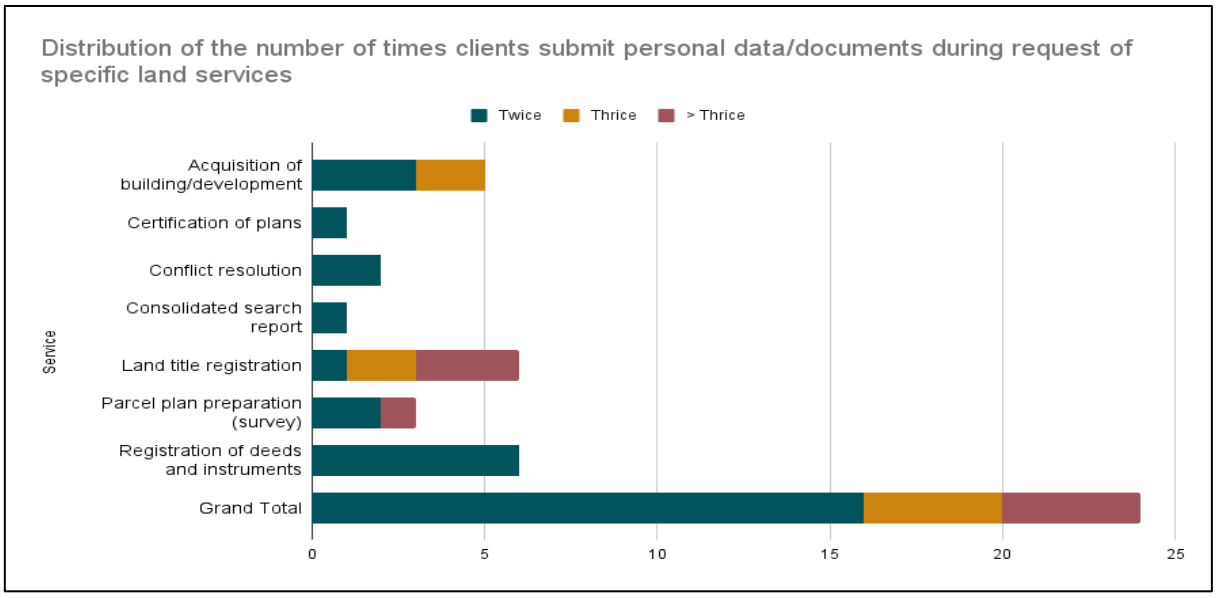

Figure 4.4 Distribution of multiple document submissions for selected services

4.2.4. Use of the Right Tools and Technology for the Provision of Services

Interviews with senior staff of the CLS revealed that the Gbawe CLS is under-equipped with tools and essential devices, including computers and software for operations; this extends to most CLS in Accra. Consequently, most daily work is undertaken with devices supported with analogue tools such as books for record keeping. An interview with one senior staff of the PVLMD in the Lands Commission also disclosed, "We *try to provide services by making do with the technology and tools we have, although they can always be better. We can improve the number of tools, including computers and the functionality of our digital technology".*

Relatively newer offices like the Consolidated Search Unit, the GELIS office, and the CSAU were well equipped with the ELIS software on all laptops, which met the number of staff in the office. For the LTRD and SMD, a handful of devices were broken down and waiting to be serviced; hence, staff requested assistance such as job tracking and batching from colleagues. The LUSPA stated that they lacked data storage systems to facilitate permitting provision and added that the issue worsens as the years go by due to backlogs of requested services compiling. The staff of the OASL and CLS essentially reiterated this complaint during fieldwork interviews. In assessing the functionality of these technologies, including the ability to perform internal searches, track transactions and generate reports, the Lands Commission's performance was optimal due to the ELIS. However, the non-existence of such technologies in the remaining in-focus agencies meant that the analogue system, susceptible to many weaknesses, was used for operations.

4.2.5. Performance Measurement and Stakeholder Engagement

With respect to identifying metrics or key performance indicators (KPIs), such as the turnaround time of services, LUSPA and the Lands Commission have service standards stated in prevailing regulations and legal instruments such as the Land Use and Spatial Planning Act, 2016 (No. 925 of 2016) and The Lands Commission Act, 2020. Interviews with a Lands Commission registration officer revealed that *"although there is a stipulated turnaround time for registration, the complexity of the transaction, and peculiar circumstances surrounding a registration makes this KPI and others difficult to realize"*. When asking all in-focus agencies about the regularity of measuring their performance against service time, cost, and accessibility, their chorus was that performance measurement was done infrequently. Regarding stakeholder engagement, interesting findings were revealed from both clients and staff of agencies. In interacting with some staff of the client service unit of the Lands Commission, they mention, *"We conduct user satisfaction surveys and provide simple opinion boxes within the CSAU; however, they are not yielding much since clients barely make use of them"*. On the other hand, clients who participated in the fieldwork surveys stated they were unaware of the means to engage or participate in decision-making processes in such agencies. Multiple visits to the Gbawe CLS made it clear that relatively few people frequent the agency for services compared to the Lands Commission or LUSPA. Questions directed to the senior staff of the CLS to this end revealed that there was a sense that many people did not know the services provided by the CLS.

4.2.6. Security of Client Information

For tackling the storage, security and privacy of information provided by clients, one interview respondent from the Lands Commission mentioned that "*the LTRD or PVLMD of the Lands Commission, we can see real-time changes to audit trail documents and transactions on every parcel that has been digitized. Until 2015, we operated in the analogue environment, which saw documents susceptible to wear and tear, fire among other challenges"*. Observation of current working protocols of the Lands Commission enforced the above claim that there is an ongoing transition from the use of analogue to digital records, with the current digitization efforts curbing some of the less protected client information records. Also, regarding the Lands Commission's ELIS, strict access controls have been implemented to limit data access to authorized personnel. On the side of IT engineers, they responded to being abreast with incident response plans involving protocols, mitigation and recovery guides in case of security dangers which may ever arise.

One insight collected on the field was that no security awareness training programs were conducted for employees of all three in-focus agencies to educate personnel about data protection practices, sensitization on safeguarding client information and identifying security threats if they are faced with any. Interview questions on security were met with the expression, *"Speak with the IT personnel; they deal with data security",* although security and privacy are a shared responsibility among all staff, especially

when handling sensitive spatial data. The OASL and CLS still function under the analogue environment and are adopting the OASL RevApp [5] to improve operations. The LUSPA regional office does not interact with clients as often as the district offices, which also primarily undertake all their operations analogously with the help of a few digital software such as Microsoft Word. Also, while the CLS has no backup system, the Lands Commission, LUSPA and OASL state that this exists.

4.2.7. Accessibility

It was observed on the client's online application portal, https://onlineservices.lc.gov.gh, that only the consolidated search service could be requested digitally from the Lands Commission. Figure 4.5 shows the distribution of services requested in-person and digitally or hybrid in terms of the availability of digital platforms to request services. Concerning the indicator: making use of Web Content Accessibility Guidelines (WCAG), the Lands Commission, LUSPA and OASL, on observation of their websites and web services, adhere to the WCAG 2.0, which specifies and recommends technical specifications for making web content perceivable, operable understandable and robust for all users including those with disabilities. On the other hand, the CLS operate primarily without websites or web services. Concerning indicator 3: clients' understanding of output documents provided for requested services, Appendix 11 shows a distribution of clients' responses. This indicates that, in total, 88% of respondents understood the output documents of the selected services within the in-focus agencies. Also, out of 40 respondents, all who used digital services in the case of consolidated searches consented that this web service catered to their device and browser needs.

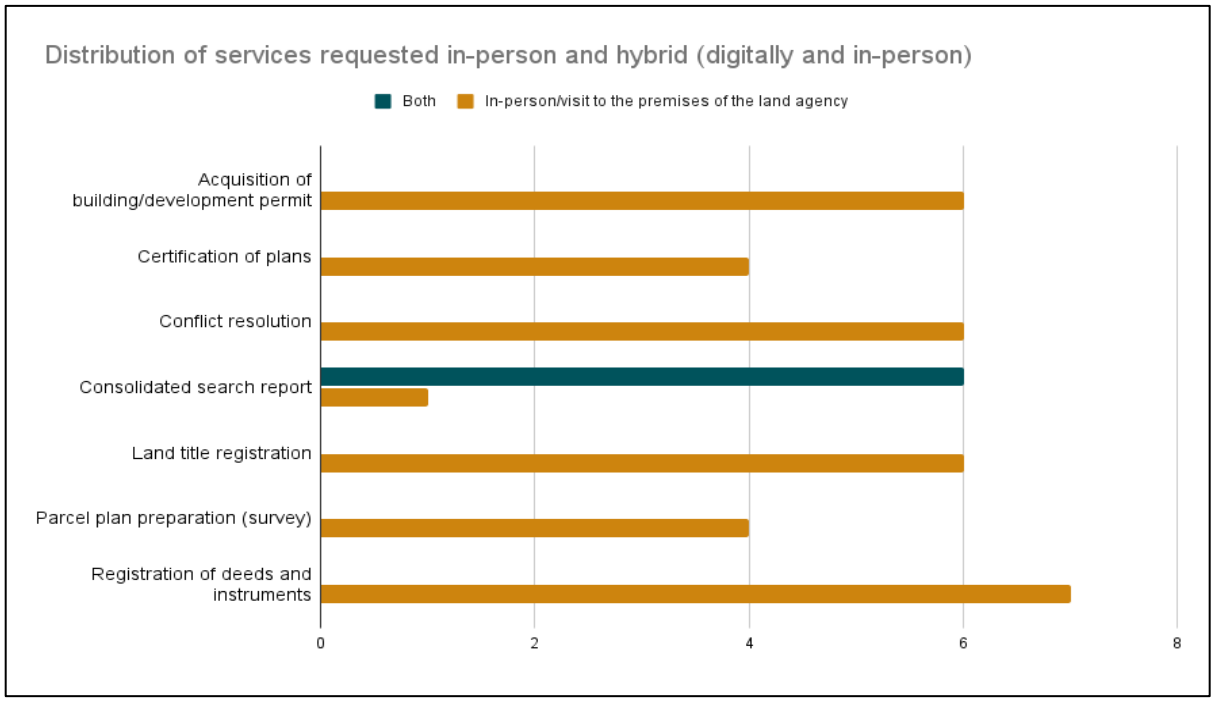

Figure 4.5 Distribution of services requested in-person and hybrid (digitally and in-person)

[5] the brainchild system app of the Office of the Administrator of Stool Lands (OASL) in collaboration with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

4.2.8. Cost of services

Regarding the indicator: assessing the cost of services by agency collaboration (data sharing), and affordability to clients, Figure 4.6 shows the distribution of clients' perceptions to this end. The distribution shows that 68% of respondents stated that the services they requested were expensive partly due to fees being paid to multiple divisions at different stages of requesting the service. The most expensive services based on clients' views were land title registration and parcel plan preparation, while the most affordable was conflict resolution.

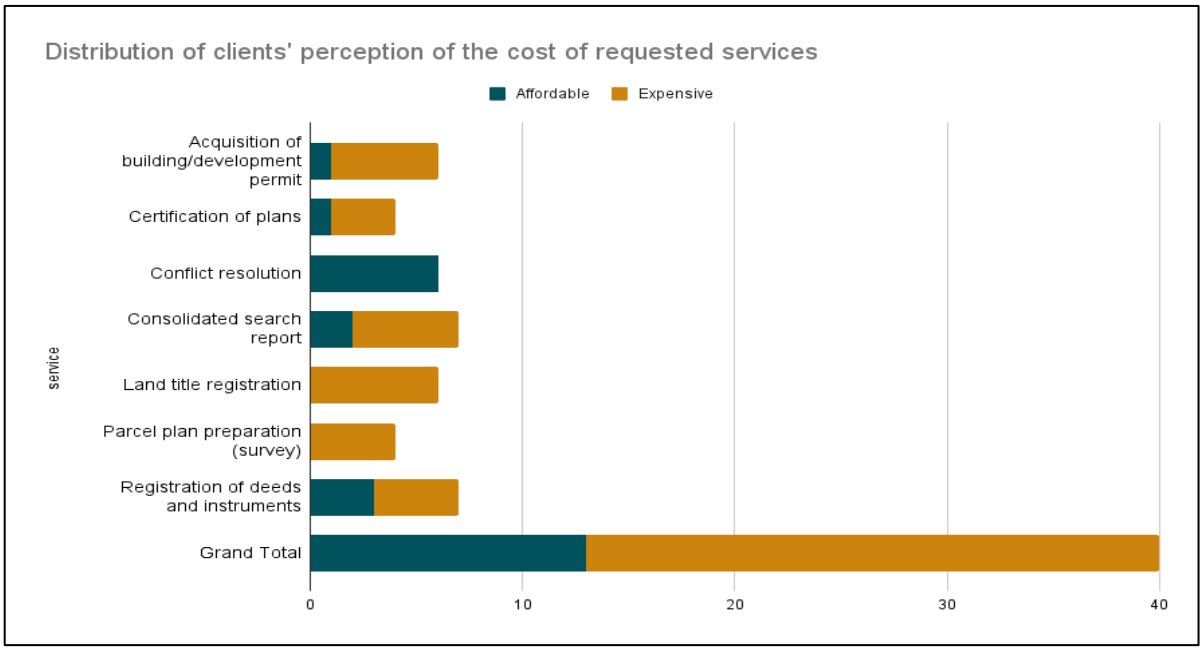

Figure 4.6 Distribution of clients' perception of the cost of requested services

4.2.9. Timeliness

Regarding providing specific land services against stipulated time frames, 100% of clients who requested lant title, search report and conflict resolution services revealed that these services were received after the corresponding agency's defined expected timeframe. Certification of plans was one of four others that clients consented to receive within the expected timeframes. Nonetheless, looking at the total distribution of client responses, the timely provision of these services was still low, with a comparative score of 10% to 90%. Figures 4.7 and Appendix 12 show the distribution of client responses.

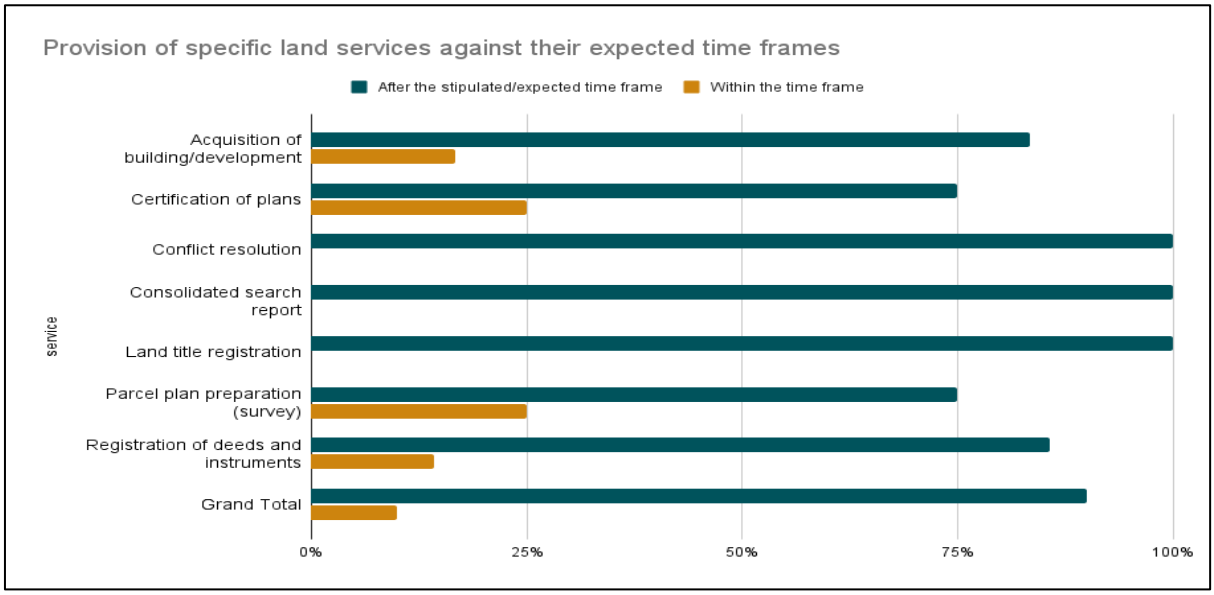

Figure 4.7 Provision of specific land services against their expected time frames

4.2.10. Response Mechanism/Complaint Procedures

Regarding the availability of complaint and response mechanisms to clients who request the selected land services, clients' satisfaction is recorded in Figure 4.8. The results show the results of the selected land services and the corresponding agencies that produce them. It was recorded that out of 100% of clients who made complaints against services, just over 25% were satisfied with the responses received. Interestingly, the CLS proved to be the best-performing agency providing satisfactory responses for conflict resolution and supporting the deed registration process. The LUSPA was the worst-performing, with all respondents being dissatisfied with responses when requesting permits for building.

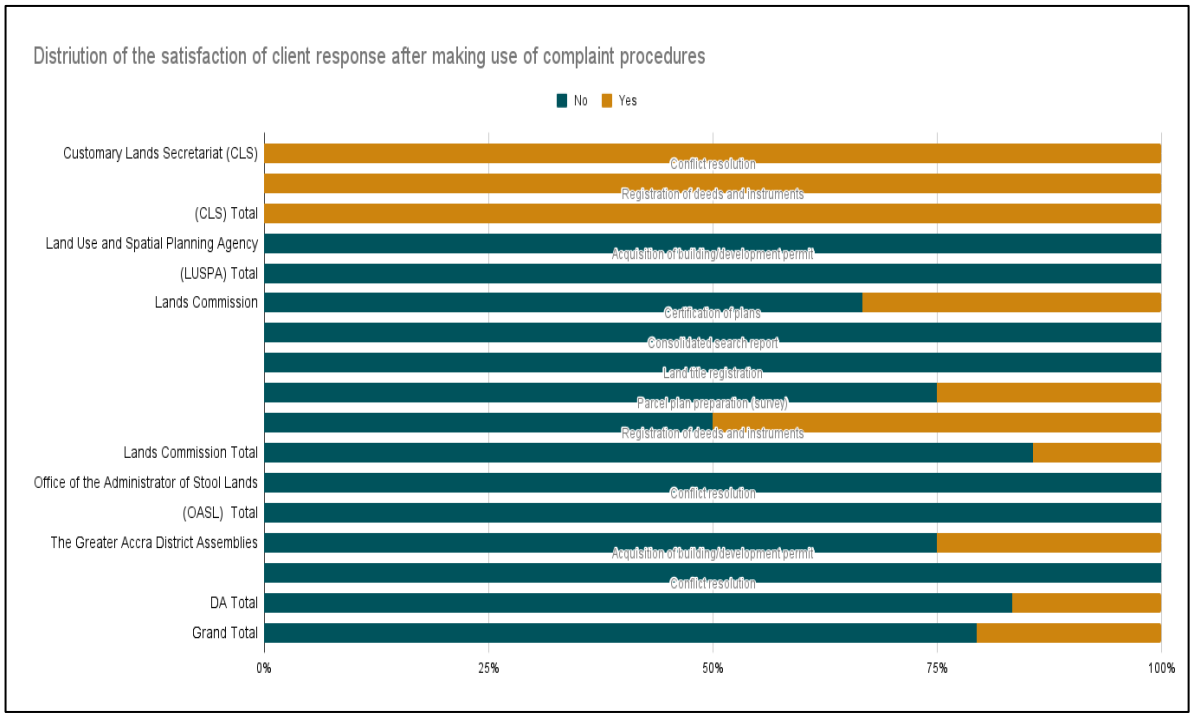

Figure 4.8 Satisfaction of clients after making use of complaint procedures

4.2.11. Scope of Information

Regarding the sufficiency of the information provided to clients after receiving the requested land services, results from the fieldwork show that 83% and 75% of all clients who requested land titles and permits considered the provided information sufficient (See Appendix 13). On the other hand, up to 71% of clients who conducted consolidated searches to ascertain information about spatial units were not satisfied with the information provided by the Lands Commission. Further probing to determine the reasons for clients' dissatisfaction and where clients visited next for supplementary information is illustrated in Figure 4.10. The results show that up to 12% of clients who visited the CLS flocked to the Lands Commission for supplementary information. Interestingly, the survey revealed that up to 18% of clients who visited the Lands Commission also frequented the State Housing Company. Most respondents who stated this agency mentioned visiting mainly for regularization[6].

[6] Making an encroached government property or land legal after receiving PVLMD search reports.

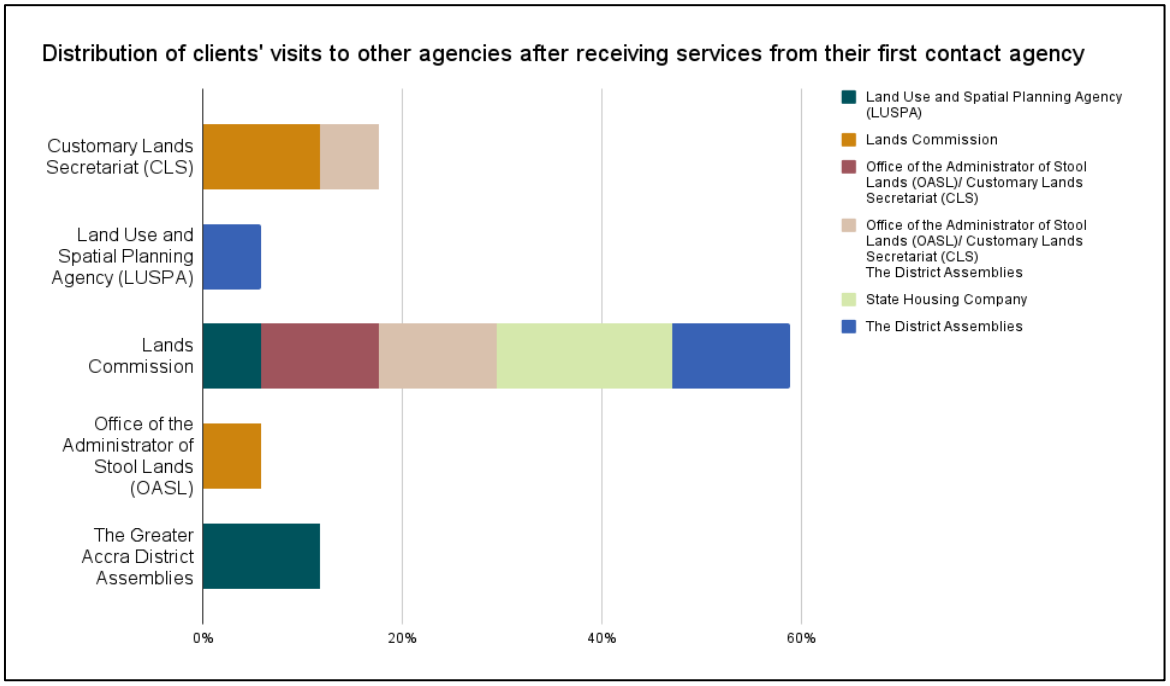

Figure 4.9 Distribution of clients' visits to other agencies after receiving services from first contact agency

4.3. Analysis of Land Service Results

Concerning **data accuracy and completeness**, all in-focus agencies acknowledged incomplete data and sub-par accuracy for several reasons. It was deduced from the results in Chapter 4.3.1 and Figure 4.3 that overlapping cadastral plots on the ELIS from all three divisions despite having the same attribute data and land use was due to independent business operations of the SMD, LTRD, and PVLMD prior to the Lands Commission Act 2020). This challenges data integrity since correspondence on requested services can be based on inconsistent data, increasing the prevalence of land conflicts or litigations within the land market. The LUSPA's attempt to acquire auto-rectified aerial maps for planning purposes independent of the SMD introduces a coordinate reference system heterogeneity. As the results show, the use of the Universal Transverse Mercator (UTM) 30-31, and WAR-OFFICE, is bound to affect accuracy when there is a transfer of data between these agencies due to geometric conversions; and completeness since data is stored on two different reference systems. The ideal case for the completeness of data is for Accra's land registration database to contain all digitized plots (formal, informal and customary). However, considering that there is sporadic registration, the absence of a digital system to store zonal plans and available registers to manage deeds, the spatial data of land agencies can be considered incomplete. This is also justified by recent studies from Quaye (2020), which showed that, for instance, only 29% (30,439) of title certificates were issued from 106,435 applicants between 2006-2014. Interpolating this issuance rate to 2023 helps to approximate that less than 30% of formal lands have been registered in the Accra region, with customary lands performing worse.

While the field results show an integrated system for internal operations (ELIS), analysis of the functionality and scope of this system proves that it is not adequately improving **system integration** among in-focus agencies. Integration is only limited to subsystems and databases of the LC and not extending beyond, causing the exchange of data for providing permits, for instance, to be disjointed and time-consuming. This challenge of internal integration inhibits the prospect of any external integration with agencies like the LC or CLS to support the interoperability of spatial data. Considering the CLSs and OASL, there is merely high-level organisational integration in the sense that, on a quarterly and yearly bases, all correspondence (land transaction records and revenue audits) from the CLS is communicated analogously to the OASL since they act as a supervisory body, but this is not executed

over a digital system which is another challenge. The manual system's persistence makes it challenging to establish spatial data interoperability between the CLS and state registries such as the Lands Commission. With the lack of digitised spatial data on traditional boundary demarcation, the CLS remains disjointed from state land registration and the digitalisation process of the LC, encouraging multiple sales of land.

While the Lands Commission no longer issues separate searches from its three divisions but rather consolidates all records into one report for clients after they have requested from the CSAU through the online portal, https://onlineservices.lc.gov.gh, observation of this portal revealed that the consolidated search is the only service that can be applied for, making it still an inundating task to initiate applications for all other services. Nonetheless, the introduction of this online platform has also facilitated **accessibility** and convenience for clients to apply for searches since they do not need the services of quark "middlemen".

In analysing the positive responses about the progress made on **data security** iterated by senior staff of the Lands Commission, it can be seen that the data legislations relating to spatial data interoperability in Ghana (outlined in Chapter 2.10.2) are being followed. Legislations such as the Data Protection Act 2012 and the Ghana Electronic Records and Data Management Standard (ERDMS) account for the observed use of strict access controls, data encryption and measures to prevent data alterations with real-time changes to audit trail documents and transactions on every parcel that has been digitized on the ELIS. This progress is seeing that client data is safeguarded. While the infrastructure has been put in place in the LC, we can discuss that the personnel still lack consciousness of data security and threats and need security awareness training programs to sensitise safeguarding client information. Other agencies like the CLS and LUSPA should invest more to transition into digitally inclined business processes while training staff on security measures.

Regarding the **sufficiency of the information provided to clients after receiving the requested land services**, analysis of Figure 4.15 shows interesting findings which reinforce the inter-agency relationships model component. It is clear from the results that although services are primarily confined to an agency, various *Requirements* to produce such services and additional information (which are not included in output documents) should be sourced from other agencies. Observing the LC alone, clients flocked to as many as five other agencies for supplementary information, which could have been conveniently sourced from a one-stop shop.

4.4. Chapter Summary

This chapter presented the *Requirements* for producing three land services and land service assessment results based on the framework developed in Chapter 2.13. These results and analysis are the premises for identifying the interoperability gaps, and a model to support spatial data interoperability is developed in the next chapter. This chapter addresses Objective 1, research questions (a) *What are the Requirements to provide selected land services of the in-focus land agencies?* and *(b) When considering the selected indicators from global land frameworks or principles, what is the state of land administration service in Accra, Ghana?*

5. A MODEL TO SUPPORT SPATIAL DATA INTEROPERABILITY

This chapter consists of four sections. These are split into the interoperability gaps, model components, evaluation of the model and the mechanisms to support the model's adoption to support spatial data interoperability.

5.1. The Gaps Hindering Spatial Data Interoperability Among Land Agencies in Accra, Ghana

The gaps hindering spatial 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 from Chapters 4.3 to 4.4 and the literature review in Chapters 2.5 and 2.6. Commensurate with these gaps, the model to support spatial data interoperability among the in-focus land agencies was designed. This Chapter addresses the research question (b) of Objective 2.

5.1.1. Semantic Heterogeneities

After observing the datasets of the in-focus agencies, they essentially had varying management protocols and systems, and there are differences in attribute definitions, terminology, classification, vocabularies and associations between spatial elements among them. With each in-focus agency handling different aspects of land administration, the fieldwork revealed that one prevailing issue was the divergent interpretations of data. For instance, it was observed that the 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 senior staff of the LTRD, *"In 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 revealed that *"in the LUSPA, I believe freehold is referred to as "private ownership" here: 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. Such as other slight differences also exist between the CLS and LUSPA. Interviews with technical staff revealed that within these agencies, due to experience, they can decipher these differences; nonetheless, these variances pose challenges to making spatial datasets across these agencies interoperable. These inconsistencies also affect the completeness of Ghana's NSDI. According to the European Commission (2017), semantic interoperability allows communicating organisations to perceive external data and process it for use understandably. Semantic interoperability concerns data elements and the relationship between them using vocabularies as established in Chapters 2.5 and 2.6. However, this is not the case among the in-focus agencies, necessitating interventions to address this.

5.1.2. The Lack of Metadata

Another significant gap determined from fieldwork through current systems observations was the non-existence of a metadata structure for spatial data among land agencies in Ghana. First, there is 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 based on international standards like the [ISO 19115], [ISO 19119], [ISO 19139] and [ISO 15836] which are abstract standards providing technical specifications including a structural model that specifies the content of metadata elements and their encodings (ISO/TC, 2019). The same can be said for the CLS, which operates primarily manually. There were few to no written descriptions of documented data due to the less formal mode of operation. The LUSPA also faces this challenge. According to an interview

with senior staff of the LUSPA, *"There was the development of LUPMIS[7]; however, it was discontinued and hence has seen the operations of LUSPA concerning data storage and metadata being stifled"*. Spatial data is stored on local computers and disseminated internally by portable storage drives without accompanying metadata. According to Roy & Das (2015), metadata summarises basic information about data (who, when, what, why, where, and how data was generated), making it easier to trace its origin and quality and facilitate its use and reuse. We can deduce from the absence of metadata that the ability of in-focus agencies first to discover smaller datasets amid large datasets, assess the fitness for the use of essential datasets and further misinterpretations in the case of integrating with other datasets from other agencies is stifled.

5.1.3. Differences in Standards, Models and Formats for Managing Spatial Data

According to the World Bank (2023), data standards are norms for organising information a system acquires to allow interoperability. As a result, they are a set of agreed-upon rules that ensure data placed into a system can be sorted, indexed, retrieved, and transmitted across systems.

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: *"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 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. Additionally, spatial datasets referenced utilizing different coordinate systems demand conversion before overlays for analysis or decision-making can be done. The manual for the preparation of survey plans for the LUSPA states that basemaps showing administrative boundaries, roads, railway lines, canals, main rivers and lakes, coastlines, power transmission lines, and existing development should be solicited from the SMD; however, since both agencies function with their distinct data collection and processing approaches, transferred data always goes through transformations before it is functional which is expensive time-wise.

5.1.4. The lack of an Integrated Web-based Platform

Another gap hindering spatial 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 in the AIF and EIF (Berre et al. 2007; European Union 2017). While progress has been seen in digitisation and digitalisation within land agencies, the slow adoption of the 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. While the staff of these agencies are competent in their trade, adopting new technology requires extensive training for it to be done effectively. The lack of an integrated web-based platform, even within agencies like the LUSPA and CLS, was seen to cause many processing steps and increased bureaucratic delays and coordination in the production of the selected services. For the Acquisition of Permits, see Appendix 5 illustrating the inefficient as-is steps, particularly at step 2, which is done manually due to the lack of such a system.

[7] An information management system in the shape of ELIS which possessed functionalities of storing metadata.

5.1.5. The Culture of Resistance to Data Sharing

Some organisational gaps were also identified in this regard. One is the culture of resistance to data sharing, which is crucial for interoperability and developing an NSDI, as stated in Chapter 2.5. 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 to their direct or indirect benefit. Additionally, there are concerns or uncertainties about the integrity of their data. Hence, there is an unwillingness to share, which would demand more responsibility and accountability for their datasets. Another indirect cause is limited financial resources to invest in modern technology like ELIS country-wide and across all agencies.

5.2. Model Components for Spatial Data Interoperability

The proposed components of the model leverage the guidelines, elements, and principles of standards such as the LADM, ISO, EIF, AIF and INSPIRE, as presented in Chapter 2. Following these standards, the model to support spatial data interoperability comprises five components. The model's five components consist of organizational and technical, thus, high-low level 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 joins together to form a comprehensive model that addresses all identified gaps hindering spatial data interoperability (see Chapter 5.1) among land agencies while satisfying the *Requirements* for producing the selected services in a new suggested Use Case. The model is presented such that the components address spatial 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 spatial 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. Another aspect of the practical level is the Spatial Data Dissemination Mechanisms. This component can be found in the connections between the in-focus agencies and act as facilitators to ensure that the spatial data stored according to the proposed standards within the in-focus agencies are interoperable. In summary, the model focuses on actions to tackle the organisational, inter-organisational and practical interoperability challenges among the in-focus agencies in service provision. Figure 5.1 illustrates the components of the spatial data interoperability model at a high level.

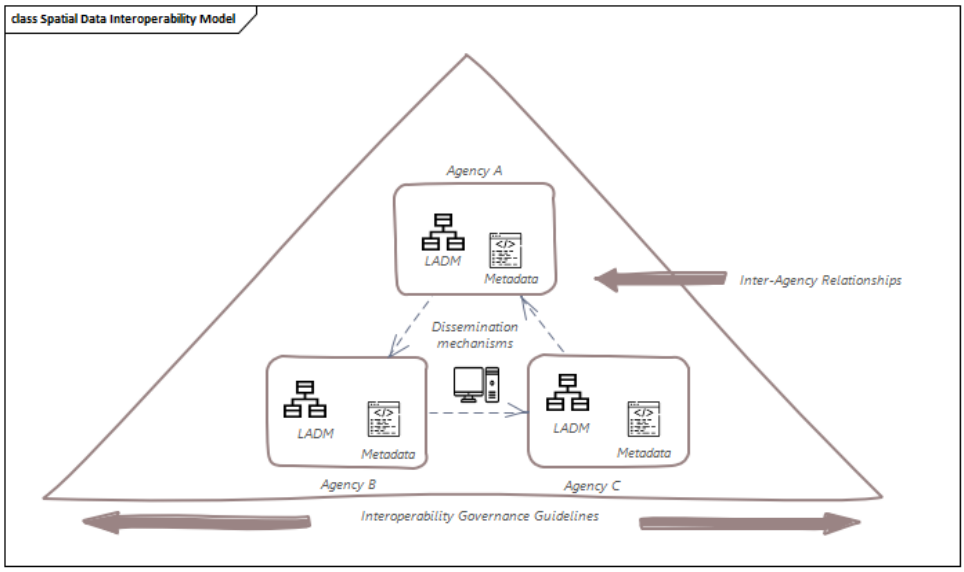

Figure 5.1 Model to support Spatial Data Interoperability among Land Agencies in Accra. Source: Authors Construct

5.2.1. Interoperability Governance Guidelines

We propose interoperability governance guidelines as the first high-level component imperative for spatial 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. Table 5.1 shows the principles and strategies of the interoperability governance guidelines.

Principle	*Description*
The principle of user-centredness	*The needs of citizens and businesses should determine the services provided, their scope, and the means through which they are delivered.*
The principle of operational simplicity	*Land agencies should re-engineer all business workflows and processes to reduce administrative complexities for producing services.*
The principle of transparency	*Beneficiaries should be able to understand and interact with the administrative processes and decisions that lead to the provision of services.*
The principle of reusability	*All data records should be stored and available to facilitate sharing and reuse among in-focus land agencies.*
The principle of technological adaptability and agility	*There should be a culture of employing up-to-date technology for work processes and an incremental, iterative prototyping approach within in-focus agencies for producing services.*
The principle of openness	*In-focus agencies should make all policies and procedures about managing data readily available without any barriers set against data access.*
Strategy	*Description*
Implementing Data Governance Policies	*Developing and implementing robust data governance policies to outline data collection, ownership, responsibilities, and access rights among in-focus agencies. Defined data governance policies and procedures will ensure that spatial data is managed harmoniously and effectively across in-focus agencies.*
Data Sharing Strategies	*Establishing formal agreements and partnerships between land agencies to govern the exchange of spatial data fosters collaboration and interoperability. This can be implemented with Data Sharing Agreements or MOUs. These agreements should define the terms, conditions, and protocols for data sharing.*
Standardization	*Encourage the adoption of widely acknowledged standards and specifications to guarantee system and agency compatibility and interoperability. Standards such as the ISO 191xx series or (OGC) and Metadata specifications such as Table 16 to describe spatial datasets would enhance the discoverability of available data resources for interoperability.*
Stakeholder Engagement Strategies	*Strategize to include all stakeholders, including beneficiaries, in the formulation and execution of development initiatives to ensure all user Requirements and viewpoints are considered.*

Table 5.1. Principles and Strategies of the interoperability governance framework Source: Authors Construct

5.2.2. 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 ideal dependencies primarily (producers/collectors, users, or viewers) of spatial data are outlined. With these unified conceptual relationships, the collection management and use of spatial data are 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. This is illustrated as a high-level system architecture diagram in Figure 5.2. Taking this as a starting point, we propose new relationships, including the roles, responsibilities and dependencies among land agencies that would be optimal for producing the selected services and extended to others. The relevant actors (agencies) proposed are CSAU, LTRD, PVLMD, SMD, LVD, LUSPA, CLS, and GRA. This component was inspired by the Dutch system of key registers (Bakker, 2009).

The CSAU should be accorded the responsibility of being the client's central unit when requesting all land services in Accra, notwithstanding the department or agencies producing the final output of the service. Essentially, the CSAU should collect and manage all personal details and documents of clients. All other agencies should reuse or view this data based on their needs while providing services. In the same way, the SMD could be the sole producer/collector of parcel boundaries and maps, with other agencies being users or viewers. The LUSPA, which currently collects parcel boundaries in verifying site plans (see *Requirement 14* of the permitting process in Chapter 4.1.2*,* coincident with the SMD, should be limited to being an activity of the SMD only. All surveys and mapping within the jurisdiction of Accra should be undertaken by the Licensed Surveyors of the SMD, stored in the SMD database and made accessible through use to the LUSPA for all zonal and planning purposes. The LUSPA should carry out all other responsibilities per its mandates, excluding map preparation and collection of parcel boundaries. It was taken into consideration that the LUSPA, as an independent agency in this model, could be put out of operation since most of its activities can be undertaken by the SMD. However, this agency should be kept in operation for two reasons. One of which is that the assessment of clients' accessibility to the SMD's services in relation to location was done in person (see Chapter 4.2.7, Figure 4.6), considering that the SMD serves a land-user population of approximately 5,455,692 people (GSS, 2021) in Accra, it will be most efficient to keep the LUSPA operational to reduce the burden of the SMD performing additional planning and land use functions. The LUSPA's specialized functions and services will also decentralize physical and digital accessibility for clients. The LTRD, PVLMD and CLS should be solely responsible for collecting all clients' interests (essentially the RRRs) to the spatial units they are connected to. While the LTRD could collect RRRs on formal interest, the PVLMD and CLS should do the same for vested public interests and customary interests, respectively. Other agencies, such as the GRA, are introduced in the inter-agency relationships to produce the selected services and others. Considering the link between the LVD and GRA, the GRA could maintain viewing dependency on the tax duty cost produced by the LVD. The GRA does not need to use the personal details collected by the CSAU since the LVD directly uses such data and should be corresponded to the GRA. All other roles, responsibilities and dependencies of the in-focus agencies and added agencies are detailed in Figure 5.2.

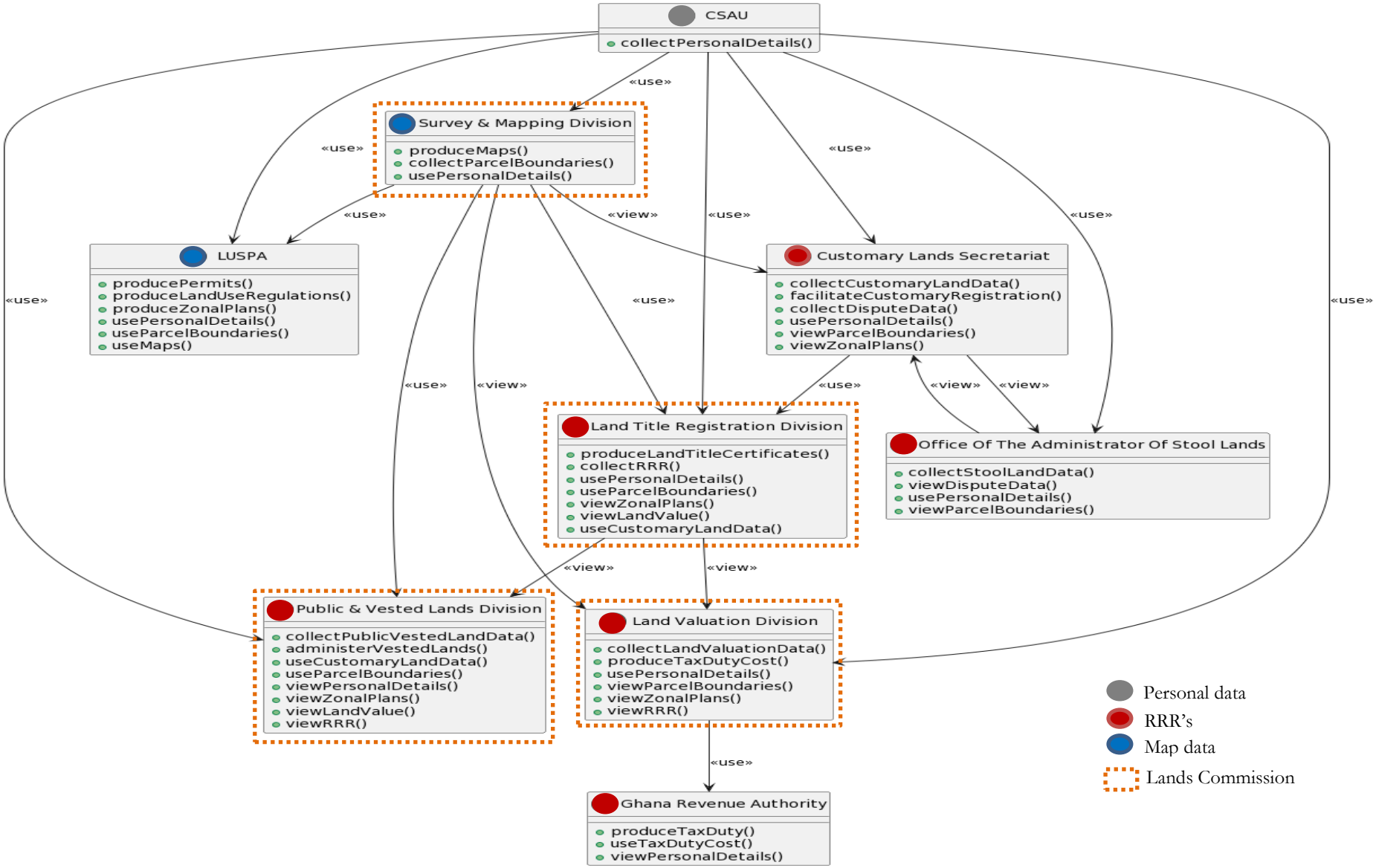

Figure 5.3 High-Level Inter-Agency Relationships *Source: Authors Construct*

5.2.3. Spatial Data Standardisation 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. 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. The three core packages and the elements to be followed by all in-focus agencies are presented in the next paragraphs. 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.

- *Party Package*

In *Requirements 7, 5,* and *6* (Chapter 4.1) for land title registration, acquisition of building permits and registration of customary interests, respectively, it is identified that the personal details of a client are needed to initiate these services. The significance of these details is that they link the agencies and beneficiaries during the service provision process. To ensure that these elements are collected homogeneously and made interoperable across all three agencies, they should be collected in a standardised way. These details comprise the party package of the LADM and can be modelled as such. Having established in Chapter 5.2.2 that the CSAU should be responsible for collecting this package, the essential aspects of this package relevant to ensure its interoperability from the CSAU to all other using or viewing agencies are detailed below.

Like the three core classes of the LADM party package (*LA_Party, LA_GroupParty, and LA_PartyMember*), CSAU should collect party details for *GH_Party, GH_GroupParty and GH_PartyMember*. Within the class *GH_Party,* the Tax Identification Number (TIN) should be demanded as part of the personal details submitted during the request of the selected services. Considered the Dutch equivalent of the *'BurgerServicenummer'* BSN, the TIN is an 11-digit unique '*pID'* generated for all individuals and entities residing in Ghana for administrative and tax purposes covering four core client/party types (natural, non-natural, citizen, or non-citizen). While not currently used, the model proposes that this should be the only number recognised and accepted by the CSAU during service requests (title registration, Acquisition of Permits, registration of customary interests) to prevent heterogeneities caused by accepting multiple IDs when sharing correspondence about clients. The justification for the proposal to use this ID lies in its adequacy to capture all party types, supported by the deficiencies of other IDs (not covering all client/party types).
Regarding deficiencies, the voter ID only covers citizens above 18, excluding infants and foreigners who can possess in-trust land rights according to the Land Act 1036. Also, the Ghana Card ID is not issued to non-natural persons and BA units which, according to Act 1036, may be parties to land rights. The passport number also does not cover non-natural persons and citizens who do not own passports but hold interests in land. The model proposes that this should be collected in addition to other personal details like full name, biometric, and sex data since the TIN *pID* does not have this inherent information.

For all three selected services, the *GH_GroupParty* is also an essential class since legal constraints like the Land Act 1036, for instance, allow party groups such as businesses, churches, or associations to register

land titles or customary interests. It is, therefore, imperative to ensure that all recognised groups are accounted for within the party package collected at the CSAU, especially for services that demand such data. The same applies to the *GH_PartyMember* class, which should account for data about a party's proof of membership to a group. While an LADM Country Profile would comprehensively outline all Code Lists and attributes contained within each class (see Okyere, 2021), this is beyond the scope of this research and limits the party package to the essential classes, attributes, multiplicities, constraints, and operations imperative to the provision of the selected services in line with the ISO 19152. Figure 5.3 presents a UML showing the three core classes, attributes and operations proposed for the CSAU to collect as Party Package.

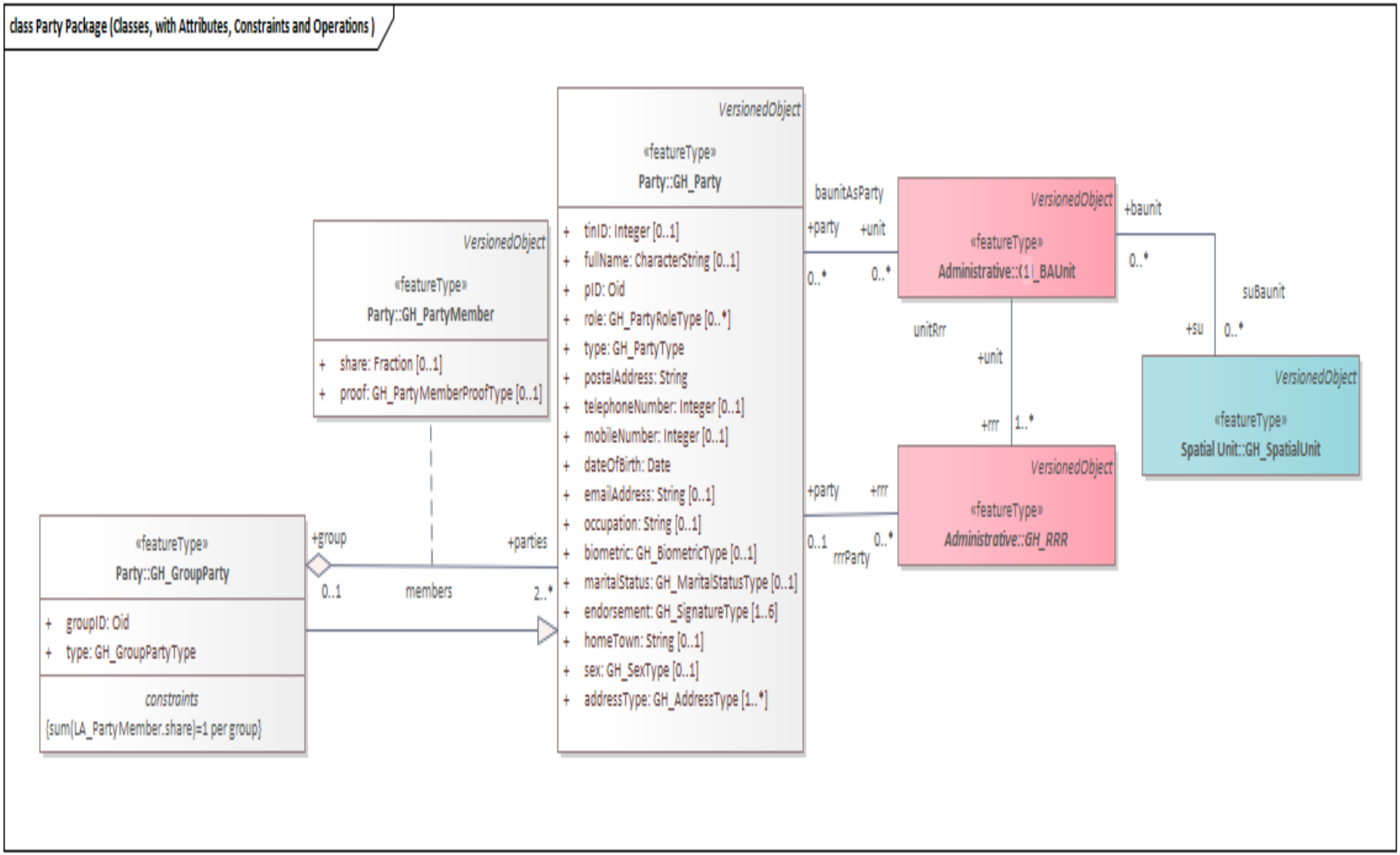

Figure 5.3. The client personal details represented as the Ghana LADM Class Party Package with (classes, attributes, constraints, and operations). Adopted from (Okyere 2021)

- *Administrative Package*

In *Requirements 12* and *7* (Chapter 4.1) of land title registration and registration of customary interests, there is a process of verification of a client's interests in a spatial unit. This is perhaps the most challenging aspect of representing such interests with the LADM because of the plurality of land administration in Ghana, which has many legitimate interest types, which are formal, informal, and customary. Nonetheless, these interests are needed throughout the process of providing the selected services and should be recorded standardly. These interests comprise the administrative package of the LADM and can be modelled as such. Having established in Chapter 5.2.2 that the LTRD, PVLMD and CLS should be responsible for collecting the elements of this package, the essential aspects relevant to ensure its interoperability between the LTRD, PVLMD and CLS and to all other using or viewing agencies are detailed below.

Like the core classes of the LADM administrative package (*LA_BAUnit and LA_RRR,* with specific classes: *LA_Right, LA_Restriction, and LA_Responsibility*), the LTRD, PVLMD and CLS should collect *GH_BAUnit and GH_RRR,* with specific classes: *GH_Right, GH_Restriction, and GH_Responsibility*. Within the class *GH_RRR,* the model proposes that an *elisCaseNumber* and *registrationNumber* for the LTRD, PVLMD and CLS should be generated. The *elisCaseNumber* should be the unique ID to share all correspondence on the ELIS dissemination tool. The *registrationNumber* should be the unique ID used for all three divisions, which other agencies can use and view.

Again, while an LADM Country Profile would comprehensively outline all Code Lists and Attributes contained within each class, this is beyond the scope of this research and limits the party package to the essential classes, attributes, constraints, and operations imperative to the provision of the selected services. The party package is presented in Figure 5.3, and the same is done for the administrative package in Appendix 14.

- *Spatial Unit Package*

Another recurring data element identified within all three selected service *Requirements* is the spatial details (parcel boundary and its details) linked to clients' interests at the early stages of land service requests. The Spatial Unit Package of the LADM can be related to a parcel of land, building or utility network and hence, is used to represent elements such as the details of a site plan presented at the early stages of the selected services. The three as-is Use Cases illustrating the *Requirements* for the selected services show the actors and what data elements should be stored under the spatial unit package. Having established in Chapter 5.2.2 that the SMD should be responsible for collecting the elements of the Spatial Unit Package, the essential aspects relevant to ensure its interoperability between the SMD, LUSPA and all other using or viewing agencies are detailed below.

Like the core classes of the LADM spatial unit package, the SMD should collect *GH_SpatialUnit*, *GH_SpatialUnitGroup, LA_LegalSpaceUtilityNetwork, and GH_LegalSpaceBuildingUnit.* Within the class *GH_SpatialUnit,* the model proposes that the Ghana Land Parcel Identification Number (GLPIN) should be collected as a unique ID attached to all spatial units mapped by the SMD. This should represent all spatial units mapped by the SMD within the Accra Region, for which use or viewing agencies like the LUSPA can prepare plans and permits. Other essential elements, such as the block number, district name, locality name, street address and parcel number, should be collected in addition to this ID to facilitate spatial data interoperability using dissemination mechanisms discussed in the subsequent sub-chapters.

Again, while an LADM Country Profile would comprehensively outline all Code Lists and Attributes contained within each class (see Okyere, 2021), this is beyond the scope of this research and limits the Spatial Unit Package to the essential classes, attributes, constraints, and operations imperative to the provision of the selected services. The party package is presented in Figure 5.3, and the same is done for the spatial unit package in Appendix 15

In summary, this component is a technical/ practical element to implement the conceptual inter-agency relationships alluded to in Chapter 5.2.2. Tying this component to the conceptual inter-agency relationships (see Figure 5.3), the CSAU of the Lands Commission is proposed to collect the party package details (personal data), the LTRD, PVLMD and CLS are to collect the Administrative package details (RRRs), while the SMD is to collect the Spatial Unit Package (Map data). Subsequently, these details can be used or viewed directly among these in-focus agencies while providing the selected land services.

5.2.4. Metadata Technical Specifications Guide

Spatial data interoperability is achieved when access and use of these data and datasets are automated and retrievable by both human and machine. Achieving spatial 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 of electronic records and data, considering technological obsolescence and evolving formats. In the context of metadata for spatial 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. For example, the namespace and prefix *gmd* "Geographic Metadata Discovery" represent elements and attributes describing metadata for geographic information as well as *"gco"* "Geographic Coordinate Objects", which represents coordinate values, among others. 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 Table 5.2. the complete list, including descriptions of each element, is presented in Appendix 16

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1. GENERAL ***REQUIREMENTS***	2. RESOURCE IDENTIFICATION INFORMATION
1.1 File identification	*2.1 Resource Title*
1.2 Metadata language	*2.2 Resource Abstract*
1.3 Metadata contact information	*2.3 Metadata on Data Access and Use*
1.4 Metadata date and time	*2.4 Coordinate reference system (CRS)*
1.7 Limitations on Public Access	*2.5 Temporal resolution*
	2.6 Data Encoding

Table 5.2 Metadata specifications guide to support interoperability. Source: Authors Construct

5.2.5. Spatial Data Dissemination Mechanisms

A crucial component/mechanism to support the implementation of the model for spatial 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 5.3 shows the technical infrastructure and electronic platform functionalities essential for spatial data dissemination among land agencies.

Technical infrastructure	*Description and Functionalities*
Web services	*Web services facilitate data interoperability by providing standardized communication and data exchange protocols. 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 5.3. Spatial data dissemination mechanisms Source: Authors Construct

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.

5.2.6. 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 the as-is situation detailed in 4.1.2. In this suggested Use Case, the "as-is" *Requirements* for acquiring permits detailed in Chapter 4.1.2 are re-modelled with the new *Requirements* (actors, processes and elements).

New actors (agencies) are introduced in the Use Case of acquiring a permit in the remodelled scenario. These agencies are the CSAU (party package holder), which collects party details at the service initiation; the SMD(spatial unit package holder), which conducts a site inspection with the client and LUSPA; and the GRA, which receives client permit payments. Also, redundant processes are removed, with others being added. The added processes are *Requirements 14, 24 and 25,* compared to the as-is Use Case in Chapter 4.1.2. Additionally, three new elements are introduced. These are the ELIS, the spatial data dissemination mechanism that documents data and metadata stored, and the service portal, which in this Use Case, enables clients to complete the online payment of permitting fees to the GRA through web service (Payment Gateway integration)[8]. In Chapter 5.3.1, the *Requirements* detailed in this Use case are revisited, showing where and how improvements are made based on the proposed model components, validating the viability of this suggested use case.

Suggested Use Case with all model components in place: Acquisition of Building Permit

Actors:

Requirement 1. Client
Requirement 2. Client Service Access Unit (CSAU)
Requirement 3. Secretariat of Spatial Planning Committee (SSPC): Department in LUSPA
Requirement 4. Works and Planning Department (WPD): Department in LUSPA
Requirement 5. Physical Planning Department (PPD): Department in LUSPA
Requirement 6. Technical Sub-committee (TSC): Unit in LUSPA
Requirement 7. Statutory Planning Committee (SPC: Unit in LUSPA
Requirement 8. Regional Coordinating Council (RCC): Unit in LUSPA
Requirement 9. Survey and Mapping Division (SMD)
Requirement 10. Ghana Revenue Authority (GRA)

Processes:

Requirement 11. A client initiates an application for a building permit at the CSAU, in person or digitally through the CSAU service online portal.
Requirement 12. The CSAU collects clients' details (including the *TIN* unique ID) and the application documents.
Requirement 13. The client pays submission fees to the CSAU.
Requirement 14. The CSAU generates a unique permitting tracking number, stores document details, and creates a metadata record in the ELIS.
Requirement 15. The CSAU batches the relevant application documents through the ELIS to the WPD to conduct structural and architectural assessments.
Requirement 16. The CSAU batches the relevant application documents through the ELIS to the PPD to conduct zoning and planning assessments.
Requirement 17. The PPD and WPD batch their assessments to the SSPC and collate the technical findings.

[8] Used to secure payment transactions and facilitate the transfer of funds between clients and agencies.

Requirement 18. Together with the client or client agent, the Physical Planning Officer Works Engineer and SMD conduct a site inspection.

Requirement 19. The TSC assesses the application and site plan and makes recommendations to the SPC.

Requirement 20. The SPC decides whether to approve, refuse, query/defer the application.

Requirement 21. The SPC conveys the decision of the application and cost of the permit to the CSAU through the ELIS.

Requirement 22. The client is notified of the decision and the cost of the permit by the CSAU.

Requirement 23. The SPC and Works Engineer jointly prepare and sign the permit certificate.

Requirement 24. The SSPC updates the metadata record in the ELIS.

Requirement 25. The client pays the permit fees through payment gateway integration to the GRA after receiving correspondence from the CSAU.

Requirement 26. If queries or appeals are made to the CSAU, they are discussed by the RCC and the client.

Requirement 27. If there are no appeals, the client collects the issued permit from the CSAU physically or digitally through the CSAU service portal.

Elements:

Requirement 28. Enterprise Land Information System (ELIS)

Requirement 29. Application documents (Fully completed Development Permit Application Form, Site Plan prepared by a licensed Surveyor, Architectural and architectural drawings and block plan, Evidence of ownership of the land, Previous permit (if any)

Requirement 30. CSAU service portal.

Figure 5.4 presents the suggested Use Case of the Acquisition of a Building Permit in Accra after all model components are in place.

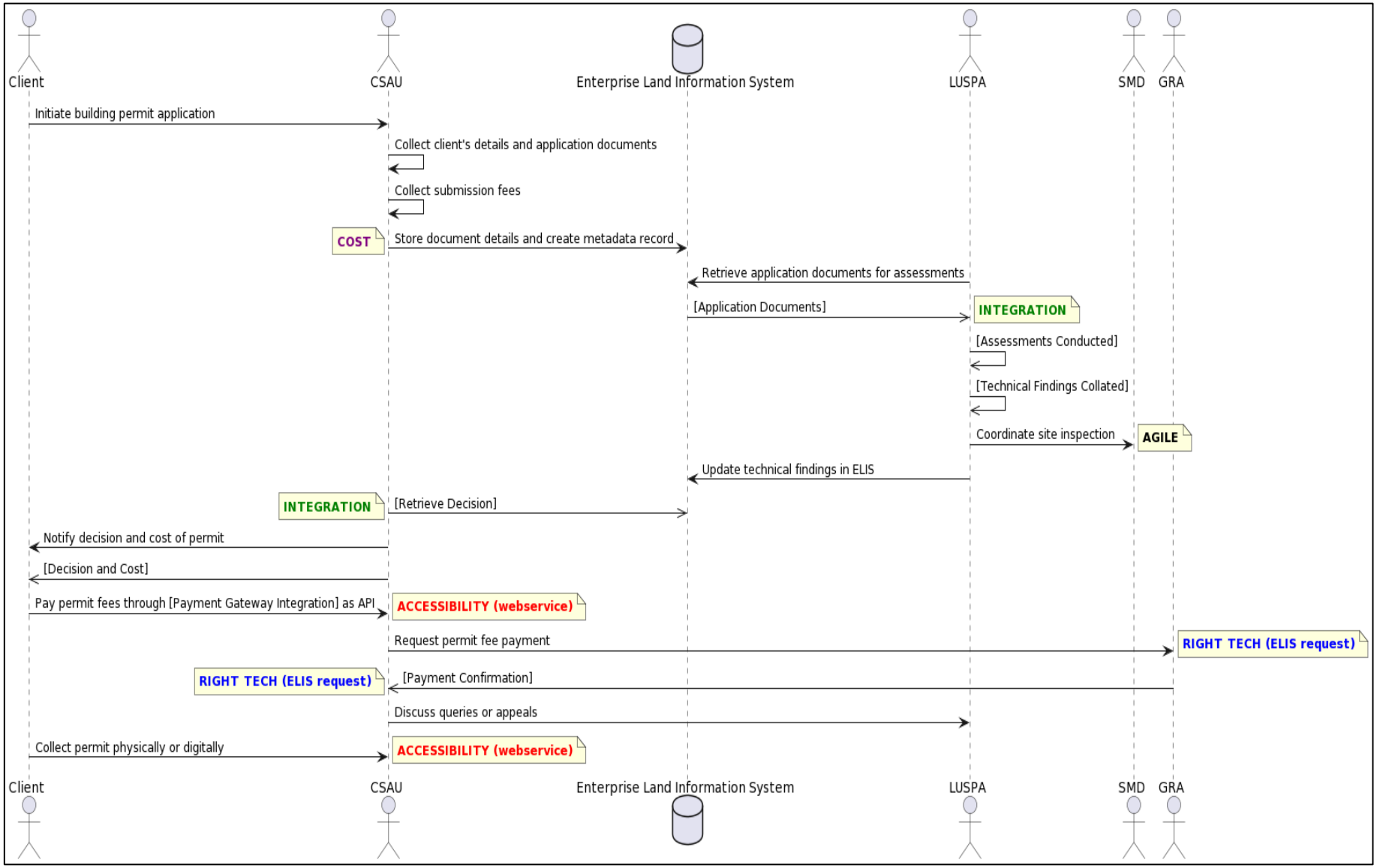

Figure 5.4. Suggested Use Case of Acquisition of Building Permit after all model components are in place. Source: Authors Construct

5.3. Model Evaluation

According to Kaplan & Norton (1997), as we build models, we should also develop methods sufficient to evaluate them. Model evaluation uses metrics to understand a model's performance, strengths and weaknesses, essential for monitoring and improvement. Considering that this model was developed intending to be implemented into the real business process of land agencies in Accra to improve land services, it is all the more imperative that it is optimal for use. On account of this, the model is evaluated; and it is done in two ways. First, the model is evaluated by considering the viability of how its components were developed. Second, the model is evaluated on its viability in meeting the requirements of selected services and its ability to tackle the gaps hindering spatial data interoperability. In the second approach, the one suggested Use Case (Acquisition of Permits) is used to provide a focused evaluation. Considering that different frameworks and not just one inspired the models' components, we consider it a daunting task and out of the study's scope to evaluate each model component against an authentication framework or test suit (compliance register). However, on reviewing models such as the LADM and AIF (Lemmen et al. 2013; Berre et al. 2007), we implicitly derived their evaluation approach, which is based on MDA (defining model *Requirements* before model design) (see chapter 2.8), which we went by. This chapter section addresses research question (a) of objective four.

5.3.1. Viability of How The Model Components Were Developed

As established in preceding chapters, international standards like the LADM, ISO, AIF, INSPIRE, and EIF inspired the model's components. National legislation on interoperability identified in Chapter 2.10.2 also served as constraints for developing each model component while considering these internationally to ensure they were tailored to Ghana's socio-political context. While the model's components are not designed to be fully compliant with the standards mentioned above, they stand as relevant references to support various aspects of their design. By evaluating the model through the lens of these national and international standards, we can identify its strengths and potential areas of improvement to facilitate its adoption.

According to Oukes et al. (2019), the MDA development life cycle begins by defining the user *Requirements*, after which model components are created to be understood by technology or humans. Our model is developed on the principles of MDA as established in Chapter 2.8 since we first took the critical step of identifying the *Requirements* (actors, processes and elements) for providing three selected services. This is the first point buttressing the viability of the proposed model. Also, according to Berre et al. (2007), the AIF builds on the FP5 network IDEAS (Interoperability Development for Enterprise Applications and Software, IST-2001-37368), identifying and capturing interrelated information from many perspectives. Considering the model's multi-level components, it aligns with the AIF principles, substantiating the model's viability also seeing how the AIF has been employed in several interoperability initiatives, such as in the German federal state of North Rhine-Westphalia as part of their eGovernment interoperability efforts (Jahns et al., 2009). The EIF also specifies layers of interoperability (European Union, 2017) which we used as a guide to categorize each identified gap. This enabled the model components to be focused on detailed aspects of each identified gap. Hence, it can be seen how each model component aligns under one EIF interoperability layer. For example, the inter-agency relationships fall under the organisational layer, while the dissemination mechanisms fall under the technical layer. Finally, the review of national legislation (see Chapter 2.10.2) shows how all the suggested model components align with Ghana's spatial interoperability vision. We see the adoption of principles such as the principles of transparency, reusability and openness are mirrored in the ERDMS and Data Protection Act of 2012 (GOG, 2012; NITA, 2021)

5.3.2. Model Viability Against the Land Service *Requirements* And Interoperability Gaps

By evaluating the model through the lens of service *Requirements* and its capacity to address the identified interoperability gaps, we can identify its strengths and potential areas of improvement to facilitate its

adoption. The model components aimed at improving service *Requirements* elicited from stakeholders through surveys and observation of existing models and policies. Taking the suggested case of Acquisition of Permits in Chapter 5.2.6 (also see Figure 5.4), key indicators such as the use of the right tools and technology and agile working processes, system integration, service cost and accessibility and usability of digital service, identified within the service assessment framework in Chapter 2.13 are used for the model's evaluation. While more indicators are mentioned in the earlier Chapters, we settle on these five indicators since they clearly show where and how improvements are made in the suggested permitting Use case (these indicators are interoperability-inclined). Also, we consider that indicators such as performance measurement and stakeholder engagement are not directly addressed per the model components and stand as indicators to understand other aspects of service provision which are not necessarily interoperability-inclined. The subsequent paragraphs discuss the selected indicators.

Using the right technology and their functionality in providing services: The proposed model introduces three core technologies/ digital functionalities within the suggested Use Case of acquiring building permits (see Figure 5.4). These are 1) an online client portal to initiate the request for the permit service at the CSAU; 2) the ELIS among all involved agencies (CSAU, LUSPA, GRA) for data storage and transfer and 3) payment gateway integration as a web service to facilitate client payment of permitting fees to the GRA in *Requirement 25*. Given the gap identified in Chapter 4.3.4, where the LUSPA states a growing backlog of requested services due to the lack of data storage and dissemination systems, the ELIS will serve as an enterprise infrastructure to meet this need. Also, since the fieldwork revealed that the permit request is only made analogously (see Figure 4.6 in Chapter 4.2.7), the proposed online client portal meets clients' digital service initiation needs; clients can perform searches, track transactions and make online payments. These three technologies/ digital functionalities team up to enhance the interoperation of the providing agencies and improve land services from the perspective of the beneficiaries. One weakness regarding these suggested technologies is the financial muscle required to acquire and maintain them. These proposed technologies are costly and may require financing from external sources.

Agile and client-orientated procedure (workflow efficiency): The suggested permitting Use Case proves optimal considering the collaboration within and between the in-focus agencies to minimise client data input (e.g., the number of times clients should provide personal details) for a service. The justification is that, for instance, the proposed inter-agency relationships ensure that the client submits personal details and documents only once to the CSAU when initiating the permitting service instead of multiple times. Comparing this with the results revealed on the field, which showed that about 83% of client respondents who requested building permits consented to submit their details or documents more than once to one or more divisions within the LUSPA, the process is made more efficient. This shows that economic data production and maintenance will occur due to less redundant data among agencies. Also, see black text notes as stages where the agile procedure is realised (Figure 5.4). Two potential weaknesses we can associate with the model regarding its inter-agency component are that 1) it will require building extensive consensus among the identified stakeholders to implement changes in business processes, also 2) it will require extensive education and training of all levels of staff (managerial to technical) to understand the proposed principles, strategies and general re-engineered business processes within and among in-focus agencies.

System Integration: Concerning how well-integrated the various information systems are among the agencies, the remodelled permitting Use Case proves sufficient. *Requirements 14-16* (Chapter 5.2.6) show how ELIS's simple batching functionality facilitates data interoperability from the CSAU to three other divisions of the LUSPA. Of course, this dissemination infrastructure is built on the established standardisation of spatial data using the LADM, technological adaptability and agility principles, and the data-sharing strategy, among others. The integrity of spatial data is maintained with the metadata

documentation (*Requirements* 14 and 24). Also, client information used by different divisions is synchronized throughout the permitting process using the ELIS-generated unique permitting tracking number among all agencies/divisions. Using the ELIS and metadata, as proposed by our model, will enable the discovery of existing spatial data enhancing transparency for better service provision to beneficiaries. Additionally, see green text notes as stages where integration is realised (Figure 5.4). Again, one potential weakness associated with this is the need for extensive technical training of staff to manage metadata repositories or catalogues.

Cost: As the fieldwork revealed, 83% of respondents who requested permits stated that it was expensive partly due to fees paid to multiple divisions at different stages of requesting the service. This is tackled in the remodelled Use Case by principles such as operational simplicity and reusability proposed in the interoperability governance guidelines (Chapter 5.2.1). The suggested process of acquiring permits shows how the documentation of metadata, combined with the overarching inter-agency relationships, team up to ensure that during the request of this service, payment of permitting cost reduces from being done multiple times to twice. In the remodelled permitting process, the first payment is made at *Requirement 13*(submission fees), and the second at *Requirement 25*, guaranteeing a reduction in the total cost of the permitting service. Again, while the payment frequency is reduced to only two times, it is also more convenient due to the CSAU online service portal (dissemination mechanism). In this reference, the model is sufficient and satisfies the service *Requirements*. Additionally, see purple text notes as stages where cost is reduced (Figure 5.4).

Accessibility and usability of digital service: Another need and identified indicator on the field was the need for web service platforms that can be used to request services, including acquiring permits. In *Requirements 11 and 27* of the permitting Use Case, the model's dissemination component comes into use. Comparing the suggested Use Case to the "as-is" case (where filed results revealed that only the consolidated search service could be requested digitally among all selected services), the interoperability governance guidelines, together with all the practical/technical components ensure that after all data needed on the operational level of agencies are homogenous and usable, they can be made accessible to beneficiaries. Additionally, see red text notes as stages where integration is realised (Figure 5.4). These justifications show the strengths and viability of the proposed model.

5.3.3. Mechanisms to Support the Adoption/Implementation of the Model in Land Agencies

Developing a model is one thing, but implementing it is another. This section elucidates essential mechanisms to support successfully adopting the proposed spatial data interoperability model for improved land administration services in Accra, Ghana. The strengths and weaknesses identified from the model evaluation in Chapter 5.3.2 informed these mechanisms. This chapter section addresses research question (b) of objective four.

One critical measure to support the adoption of the model is by building awareness among relevant stakeholders on the existence of the model and encouraging a consensus for its use. As authors of this research, we can play a role by showcasing the benefits and use of the model for data interoperability, heightened operational efficiency and enhanced decision-making among the in-focus agencies. In reference to the director of the OASL, "*the model should be developed fundamentally involving those anticipated to use it; so do not expect to collect data from us, only to return after two years of study with a framework which we should accept; so right from today, as you are doing, get our needs and continuously communicate with all your end users"*. Having successfully developed the model based on the requirements of the in-focus agencies, dialoguing with them should foster consensus to incorporate the model to support spatial data interoperability smoothly.

Considering the technical nature of the model, it is quintessential to provide training programs, workshops and symposiums to boost the technical capacity of all senior to junior-level staff within these agencies. Educating and building the knowledge base of staff will enable them to adopt and utilize the interoperability model effectively. This should involve comprehensive programs to explain the

principles, strategies, concepts, protocols, and tools embedded in the model. These programs should be structured in ways that cater to the different professional and technical expertise of staff, thus including managerial, operation, and technical staff to ensure a unified sense of direction within each agency.

The acquisition of funds internally and internationally is an important measure to facilitate the adoption of this model. The model necessitates significant changes in business processes, which may be financially costly. Additional funding can be received by highlighting the model's value-added outcomes to governmental agencies, ministries, international donor entities and developmental partners. With the ongoing discussions for improved service provision through interoperability, existing partnerships can be leveraged to support improvement for agencies in Accra, Ghana.

The incremental implementation of each model component is also crucial for its complete adoption. This means breaking down the model into manageable components presented in Chapter 5.2, and implementing them iteratively, beginning with the organisational components. Land agencies can address rising challenges or complexities by adopting an incremental approach while learning valuable insights for implementing subsequent components. This approach will also enable a manageable development and reduce the risk of its failure.

After thorough education and training on the model and its aspects, there should be continuous monitoring and evaluation of the staff's effectiveness and the model's viability for the current land administration system. This would allow for ongoing improvements and adjustments to ensure optimal staff performance and usability of the model, facilitating its full adoption. Evaluation of the model's performance will help identify its impact on interoperability and alignment with Ghana's broader perspective of land administration. To do this, (KPIs) suited to interoperability assessment should be established and used for continuous monitoring of these agencies to identify areas of improvement and make necessary adjustments to enhance the adoption of the interoperability model.

5.4. Chapter Summary

This chapter presented the gaps hindering spatial data interoperability among land agencies as a starting point of the model development, a model to support spatial data interoperability and its evaluation. This achieved research Objectives 3 and 4. The next chapter presents the conclusions and recommendations of the research.

6. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions derived from the study. In effect, all results from each objective are revisited and summarised. Additionally, the study's limitations, recommendations and areas for further research are stated.

6.1. Objective 1: To Assess the State of Land Administration Services in Accra, Ghana.

This objective was intended first to assess the state of land services in Accra, Ghana and was done comprehensively using a standardized approach. The review of global frameworks identified relevant themes, dimensions and indicators for evaluating land service provision, leading to an assessment framework suited to Ghana's context (see Chapters 2.11 and 2.12). The review of global frameworks enabled meaningful comparisons and benchmarking, ensuring the developed assessment framework was comprehensive. Investigating the *Requirements* of selected land services laid a solid foundation for addressing the ensuing study objectives. The assessment results revealed crucial insights about the weaknesses (high cost, non-integrated agencies, non-agile business approaches) of land service provision laying valuable bases to develop a model to support spatial data interoperability among land agencies.

Looking beyond this study, we consider that the outputs from this objective, even as a stand-alone, are quintessential for Ghana's land administration. The outputs derived within this objective: 1) a detailed description of selected land service *Requirements* (actors, processes and elements) and 2) a comprehensive land service assessment based on globally inspired frameworks, are crucial foundations for several research themes within Ghana's Land Administration. These results go beyond facilitating the development of a model for supporting spatial data interoperability to becoming a road map to address other people-centred land administration challenges bordering on themes such as poverty reduction and gender equality.

6.2. Objective 2: To Identify the Factors Hindering Spatial Data Interoperability among Land Agencies in Accra, Ghana

The national data standards and policies regulating spatial data interoperability and the spatial data interoperability gaps among land agencies in Accra, Ghana, were outlined under this objective. Through literature reviews (see Chapter 2.10.2), the national data standards and policies regulating spatial data interoperability established a clear understanding of the existing framework governing data exchange and integration within land agencies. The study successfully highlighted the gaps that hinder spatial data interoperability among these agencies in Accra, Ghana, by thoroughly analysing semi-structured interviews, client surveys, and observation of the agency systems. The findings highlight gaps, including semantic heterogeneities, the lack of metadata, differences in standards models and formats for managing spatial data, the lack of an integrated web-based platform and the culture of resistance to data sharing. What was concluded from these gaps was that they cause duplication of effort in data collection, waste of resources, increase the cost of services, delay the timely provision of services and impede inter-agency integration. From the lenses of global standards and frameworks such as the EIF and AIF, these gaps were seen to be common denominators of layers or levels of interoperability; this facilitated their synthesis for developing the model in the ensuing Chapter. Overall, the analysis conducted under this objective accentuates the pressing need for interventions such as a model to support spatial data interoperability among land agencies in Accra, Ghana.

6.3. Objective 3: To Develop a Model to Support Data Interoperability Among Land Agencies in Accra, Ghana.

Problem identification is relatively straightforward; the real challenge lies in problem-solving. This demands a profound understanding of the underlying challenges, innovative thinking and the ability to explore several avenues to find satisfactory solutions. On account of this, we adjudge the crux and novelty of this research to be found under this objective. On the foundation of the achieved objectives one and two, a model to support spatial data interoperability among land agencies was developed. The developed model incorporated three selected land service *Requirements* (see Chapter 4.1) and gaps

hindering spatial data interoperability among land agencies for its development. The model acknowledges the significance of Interoperability Governance Guidelines, Inter-Agency Relationships, Spatial Data Standardization using LADM, Metadata Technical Specifications Guide, and Spatial Data Dissemination Mechanisms to enhance interoperability among in-focus land agencies. By addressing the identified gaps in data interoperability, the model components would potentially foster semantic homogeneity of data among land agencies, data accuracy and completeness, and timely and economical provision of land services. Considering that no research has been put into developing such a model for Ghanaian land agencies, especially in the wake of organisational cooperation and openness, we consider this a solid foundation for Ghana's future land administration initiatives.

6.4. Objective 4: To Evaluate This Model Against Country *Requirements* And International Standards and Provide Possible Recommendations for its Adoption.

Though earlier stated, we reiterate Kaplan & Norton (1997), "*You cannot improve what you cannot measure" or "If you cannot measure it, you cannot manage it*". The evaluation results substantiated the proposed model in meeting the selected land service *Requirements* and addressing the interoperability gaps identified in Objective Two. Firstly, the model proved sufficient when considering the land service assessment indicators. Also, it positively addresses the identified organisational, semantic, and technical gaps in interoperability among in-focus agencies. By presenting Interoperability Governance Guidelines, Inter-Agency Relationships, Spatial Data Standardization using LADM, Metadata Technical Specifications Guide, and Spatial Data Dissemination Mechanisms, timeliness, efficiency, and effectiveness in land administration services are achieved.

Judging from the evaluation, a few mechanisms were suggested to facilitate the model's adoption. 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; soliciting funds internally and internationally; incremental 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 were the suggestions tabled. This objective was achieved in Chapter 5.3.

6.5. Study Limitations, Recommendations and Areas for Further Research

6.5.1. Limitations of the Research

Although this thesis has added significant knowledge to Ghana's Land Administration, it is essential to recognize its limitations.

The research limits its geographic scope to land agencies in Accra, and it may be argued that it does not fully represent the outlook of the other fifteen regions of the country, especially considering the complex and pluralistic nature of land administration in Ghana. For that reason, the results and proposed solutions in the form of the land service assessment results and model should be interpreted within the context of Accra.

The study employed interviews, system observations, and surveys as data sources. Although these methods presented essential insights for the study, they are limited by subjectivity. For example, considering the research sampling strategies: purposive and convenience, subjective bias might have been introduced, as in most qualitative surveys. However, considering this, all measures were taken to be objective during the sampling stage. Additionally, the interviews solicited information based on the experiences of staff, which may not fully capture the reality of the current land administration situation in respondents' agencies.

Another limitation was tied to the incomplete digital dataset in the LIS of in-focus land agencies due to the slow pace of data migration and overall adoption of entirely digital workflows. For objective three, developing a model to support spatial data interoperability, it would have been ideal to have access to entirely digitised datasets across all in-focus land agencies to facilitate an in-depth analysis of all interoperability barriers; however, this was not the case. Nevertheless, the available digital data was leveraged in designing a potential spatial data interoperability model.

6.5.2. Recommendations and Areas for Further Research

Despite the abovementioned limitations, this thesis presents a potential model for improving land administration services and grounds for future research.

We strongly recommend that the findings of this research should be implemented. This model is a suitable knowledge base and should be implemented iteratively in Ghana's land administration system. We also recommend that Ghana focus on developing additional interoperability models as a guiding principle for future work in Ghana's land administration, considering how relevant it has been established in this thesis.

For areas of future research:

1. We propose that further research is needed to validate the model's applicability in all other regions in Ghana. This should be done with an in-depth evaluation of several land service *Requirements* among several land agencies.
2. Another plausible direction for further research is to explore emerging technologies such as artificial intelligence and blockchain (as mentioned in Chapter 2.10.2) to be incorporated into the model to support spatial data interoperability among land agencies in Ghana.
3. The socioeconomic impacts of improved land administration services on land tenure security, the land market and sustainable land management is another area that could be considered for future research.

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APPENDICES

Appendix 1: Functions of Land Service Agencies

The Survey and Mapping division of the LC, according to the Lands Commission Act 2008, is among other functions mandated to "*supervise and regulate operations that relate to the survey of any parcel of land; co-ordinate the production of photogrammetric surveys including aerial photography, and Orthophoto mapping, and remote sensing; supervise, regulate and control the survey and demarcation of land for land use and land registration*" GOG (2008), all of which beneficiaries such as clients may pay for.
The Land Title Registration Division of the LC, according to the Lands Commission Act 2008, is among other functions mandated to secure the *"registration of title to land and other interests in land; registration of deeds and other instruments affecting land in areas outside compulsory title registration districts; and publication of notices of registration upon receipt of an application for registration"* GOG (2008), all of which beneficiaries such as clients may pay for.
The Land Valuation Division of the LC, according to the Lands Commission Act 2008, is among other functions mandated to "*ensure the preparation and maintenance of valuation list for rating purposes; valuation of interests in land or related land interests for the general public at a fee; and valuation of interests in land for the administration of estate duty*" GOG (2008), all of which beneficiaries such as clients may pay for.
The Public and Vested Lands Management of the LC, according to the Lands Commission Act 2008, is among other functions mandated to "*facilitate the acquisition of land for Government; and manage state acquired and vested lands in conformity with approved land use plans*" GOG (2008), for which is primarily geared towards serving the government.
The Land Use and Spatial Planning Authority is a service delivery agency under the Ministry of Environment, Science, Technology and Innovation (MESTI), which operates at the National and Regional levels. They are also responsible for "*providing spatial planning services (spatial plan extracts, technical advice, planning comments and reports) and spatial plans (SDF), Structure plan, Local Plan*", among other functions LUSPA (2022).
The Customary Lands Secretariat, according to the Lands Act 2020 (ACT 1036), is among other functions mandated to "*provide relevant records on land, information on the hierarchy of interests and rights in customary land, and laid down processes for effective dispute resolution; and facilitate the settlement of land disputes through alternative dispute resolution*" (Land Act, 1036, 2020), all of which beneficiaries such as clients or the government of Ghana may pay for.

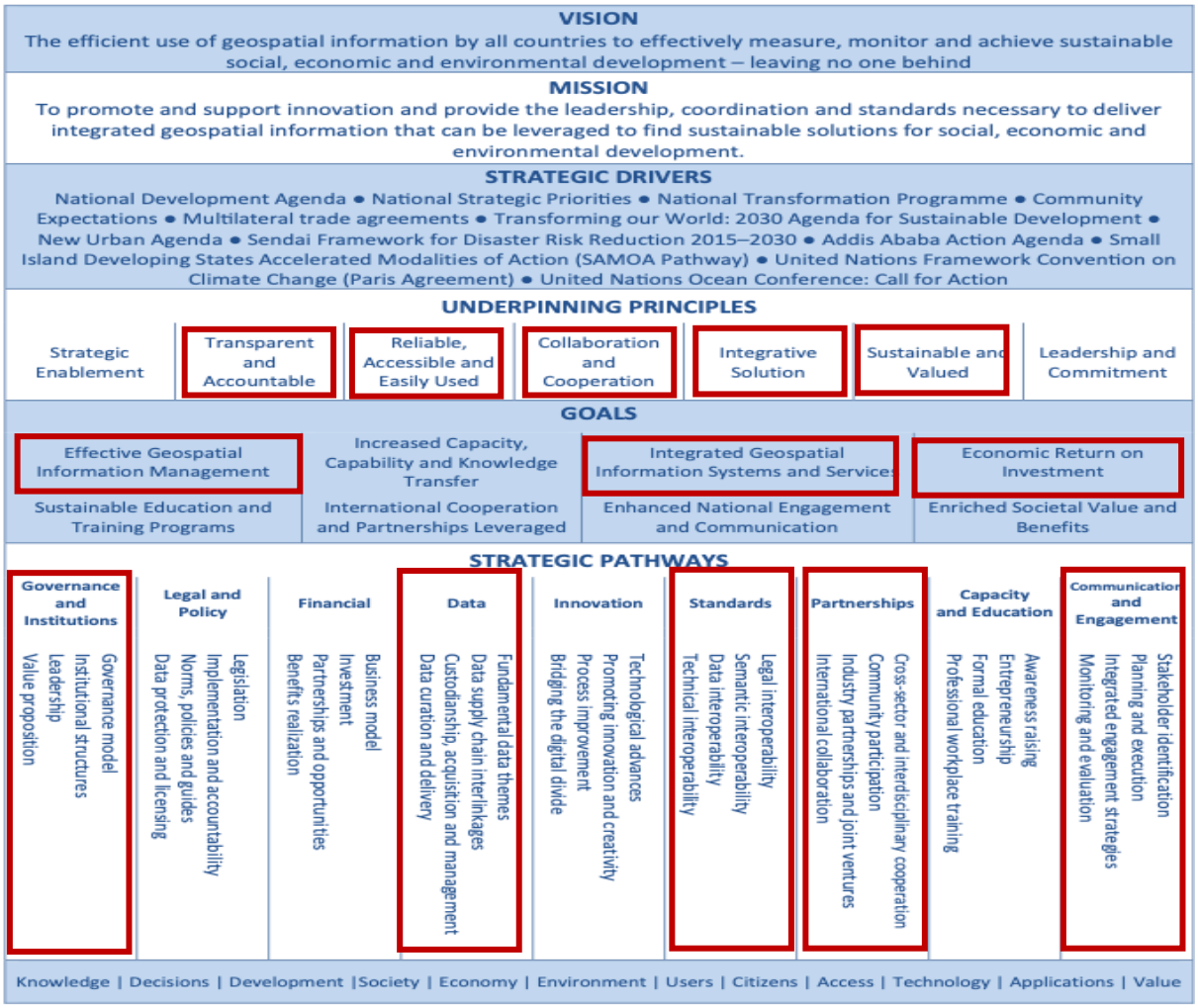
Appendix 2: Framework For Land Administration System Assessment: Operational Level (Steudler, 2004)

Evaluation Area	Evaluation aspects	Criteria
Operational Level	1. Definition of users, products and services	1. Being aware of users, products, services
	2. Aspects affecting the users	1. Reliability 2. Security 3. Accuracy 4. Efficiency 5. Transparency, clarity and simplicity 6. Accessibility
	3. Aspects affecting the products and services	1. Spatial data infrastructure aspects 2. Information technology aspects 3. Data standards and integration

Appendix 3: The World Bank's LGAF

Panel	Indicator	Dimension
Panel 6. Public provision of land information: registry and cadastre	18. Completeness of the land registry	d1. The cost of registering a property transfer is low d2. The mapping of registry records is complete. d5. There is a timely response to requests for accessing registry records. d7. Records in the registry are easily accessed.
	19. Reliability of registry information is updated	d1. Information regarding land rights maintained in different registries is routinely synchronised to reduce transaction costs for users and ensure the integrity of information. d2. Registry/cadastre information is up to date.
	20. Land administration services are provided cost-effectively.	d1. The registry is financially sustainable through fee collection. d2. investment is sufficient to cope with demand and provide high-quality services.
	21. Fees are determined transparently to cover the cost-of-service provision	d1. The schedule of fees is publicly accessible. d3. service standards are published and monitored.

Appendix 4: Integrated Geospatial Information Framework



Appendix 5: Survey Questionnaire

Section A: Details of Respondent

1. Gender: ☐ Male ☐ Female
2. Age: ☐ Below30 ☐31-40 ☐41-50 ☐Above50
3. Educational level/Literacy:
   ☐ No formal education ☐ Basic Education ☐ Secondary Education ☐ Tertiary Education

Section B: Assessment of Land Administration Services

Agency and Service information

4. Have you requested land services from any land agency in Ghana over the past two years? ☐Yes ☐No
5. Which agency have you requested land services from?
   ☐Lands Commission (LTRD, PVLMD, LVD, SMD) ☐LUSPA ☐ CLS ☐ District assembly
6. What type of service did you request? ☐ Consolidated search report ☐ Land title registration ☐ Deeds Registration ☐ Land valuation ☐ Building permit ☐ Conflict resolution ☐ Survey/parcel demarcation ☐ Plan preparation ☐ Stamping ☐If other, please specify_____

Accessibility

7. How was this service requested? ☐ Through a digital system ☐ In-person/visit to the premises of the land agency ☐ Both digitally and in-person
   *If **analogue** Answer 7-8*
8. If you had to visit the premises of the land agency, where do you live?
   Please state your answer in km _____. NB: *Alternatively, state your area of residence.*
9. Was the service agency accessible to you based on your location?
   ☐ Not accessible ☐Moderately accessible ☐Very accessible
   *If **digital** Answer 9-12*
10. If digital, did you have enough information about the procedure? ☐ Yes ☐ No
11. Did the web service platforms cater to your device and browser needs? ☐ Yes ☐No
12. How was the navigation through the digital system? ☐ User-friendly ☐Complex
13. Did you require any assistance? ☐ Yes ☐No

Cost

14. What was the total cost for your requested service? Please state your answer in Ghana cedis _____.
15. How do you consider the above amount based on your economic status? ☐ Cheap ☐ Affordable ☐ Expensive

Timeliness

16. How long did you expect/ is stated as the standard completion time for this service? Please state your answer in weeks ____.
17. How long did this service take to be completed/delivered? ☐ Earlier than the stipulated/expected time frame ☐ Exactly within the time frame ☐ After the stipulated/expected time frame

Usability of service tools

18. Were the output documents presented in plain and understandable language? ☐ Yes ☐No
    *If requested **digitally***
19. How were the functionality and usability on the service web platforms? ☐ User-friendly ☐Complex

Response mechanism/complaint procedures

20. Did you make use of complaint procedures in correspondence with your requested service?☐ Yes ☐No
21. Were the responses accurate and concise during the processing of your documents?☐ Yes ☐No

Scope of service

22. When the service was completed, was the information provided to you sufficient? ☐ No ☐Somewhat sufficient ☐Yes
23. Did you have to visit another agency to get other information to supplement the service you initially requested?☐ Yes ☐No *If yes, please state which* _____.

Appendix 6: Semi-Structured Interview Guide For Senior Staff Of La Service Agencies

Interview Protocol

Thank you for your time and agreeing to participate in this research interview. You are welcome!
I am Roy Joannides, a graduate student of the University of Twente, ITC, pursuing an MSc in Geo-Information Management for Land Administration. In partial fulfilment of my M.Sc., I am conducting research titled: "*Towards improved land administration services: A model to support spatial data interoperability among land agencies in Ghana*". I am pleased that you agreed to participate in this research.
This interview is intended to collect data to facilitate this research and will be confined to this purpose. All survey questions are formulated to address the study's research objectives.

- Would you like any clarification on the consent form?
  This interview will last approximately 30 minutes.
- Is this time frame convenient for you at this moment?
  Before we get started, are there any questions/concerns for clarification?
- May I proceed to record the discussion?

Briefing and warm-up questions

You can expect to hear two recurring terms throughout this interview: spatial data and interoperability. For the scope of my research, spatial data can be described as elements or features that possess geographic information about the Earth (space) and time. Interoperability may be used interchangeably with "data sharing" during this interview and is described as the capability of different systems or entities to exchange information via standard formats or protocols and to maximise this shared information.

- What is your position/role in this land agency?
- How long have you been working in the land domain, and what is your experience working with spatial data?

OBJECTIVE 1:
Sub-objective 1: To assess the state of land administration services in Accra, Ghana.
"Services" here are limited to the primary service(s) provided by your division/agency.

- What is/are the main service(s) provided by this agency/division?
- How do you perceive the general performance of this agency when providing these services in terms of your internal workflow and business processes?
- Is there a collaboration between your agency and others for service provision? Prompt: On what level?
- How up-to-date is the data (spatial and non-spatial) used in providing the service(s) in this agency/division?
- Is client information maintained in different agencies routinely synchronised to ensure the integrity of information?
- How securely is the (spatial and non-spatial) provided by clients stored?
- How often does the agency actively identify security, privacy threats and fraud risks associated with client information after requesting services?
- Do you know of service tasks/functions overlapping with other agencies? If yes, please state them.
- Are there any data gaps when processing information for a service you provide?
- Do you have metrics/standards (key performance indicators) for your service(s)? Can you mention a few?
- How often do you measure and monitor your performance in line with service provision against these (KPIs)?
- How do you rate the technology/tools used to provide services now? Do they support efficient service provision?

OBJECTIVE 2: *To identify the factors hindering spatial data interoperability among land agencies in Accra, Ghana.*

- According to your knowledge of the business processes of this agency, to what extent do you share spatial data with other land agencies?
- Is there a need to increase data interoperability with other land agencies in line with providing land administration services?
- What organisational factors hinder data sharing between your land agency and others?

- What technical factors hinder data sharing between your land agency and others?
- In your opinion, which of these factors is/are the most prominent?

OBJECTIVE 3: *To develop a model to support data interoperability between land agencies in Accra, Ghana.*

- Does your agency follow any national data policies/standards regulating data sharing? Name them.
- How well are these standards/policies accessible to and understandable by all staff within your agency?
- Are these standards/policies sufficient for your current land administration service needs?
- How well are these current standards/ policies being applied in the day-to-day activities of this land agency?
- What spatial units are stored in your (database/ land information system) or paper archives (if analogue)?
- Do you expect this to change in the future? If yes, what changes do you expect?
- Describe all the essential information that should be present in client documents before they are accepted/ stored/ filed in the provision of (the agency's main service). Prompt: What Features, geometries, dimensions, structure, et cetera
- Describe how you enter/file/store these data/features (e.g. topological polygons, lines, points). Prompt: Do you follow a data model/structure during this process?
- Do you have different data models for different functions/processes? Prompt: For example, different coordinate reference systems.
- Can I see this data model if it is documented?
- Do you have a metadata system/structure? Can I see and take pictures of them?
- What is the nature/composition of your analogue archive/register? Can I see them?
- What are the priorities/necessities to support spatial data sharing between your land agency and others?

OBJECTIVE 4: *To evaluate this model against country Requirements and international standards and provide possible recommendations for its adoption.*

- What is your view on the prospects created from spatial data interoperability for land administration services?
- Have you had first-hand experience implementing a similar sharing model in this land agency? Prompt: How did it go?
- In your opinion, how feasible is this model's implementation into this agency's business process?
- Do you envision/foresee any challenges in adopting this model should it be completed/designed?
- In your experience, what are some mechanisms to help adopt this model should it be completed? Prompt: you can suggest ideas in line with policy, technical, behavioural changes, et cetera.

CONCLUSION

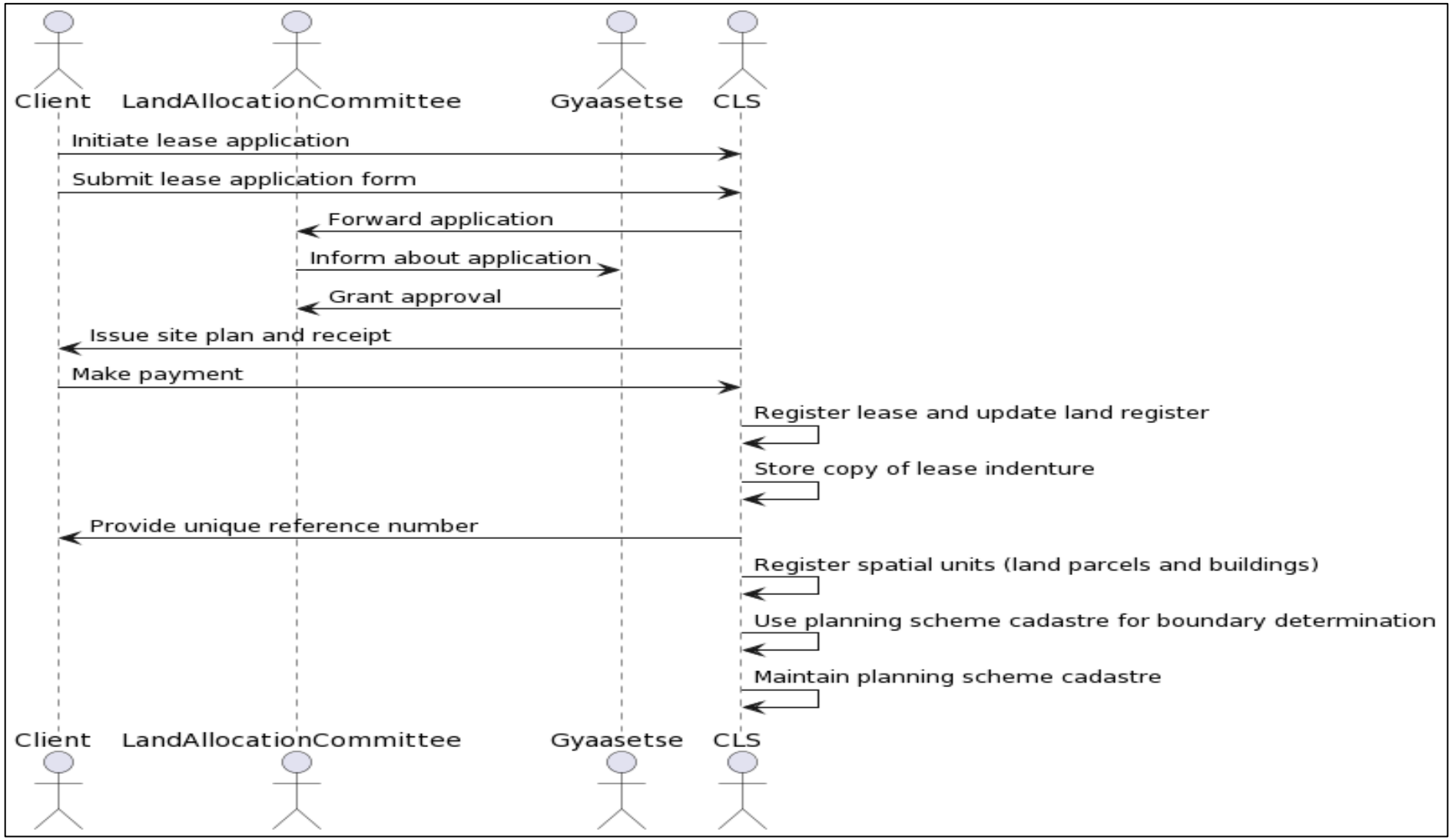
- Unfortunately, we need to close the discussion.
- Is there anything else you would like to bring to my attention?
- Hopefully, you do not mind me reaching out for further clarifications in future on this research.
- In the consent form, find my email for any concerns you may have later.
- Thank you again for your time.

Appendix 7: Research Matrix

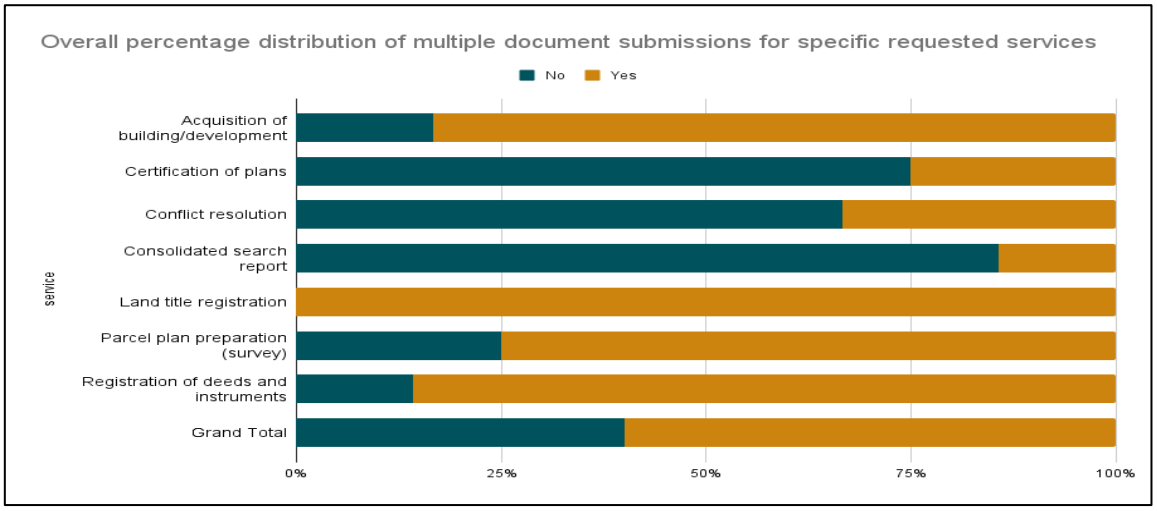
Research Question	Data collection mode	Respondent/ Sources	Data Processing & Analysis	Anticipated Output/ Results
Objective1. To assess the state of land administration services in Accra.				
Q2. What global land frameworks or principles can be adopted to assess land administration services in Ghana?	Literature review		Comparative analysis	A table of assessment themes, dimensions and indicators adopted from existing frameworks

Q2. What are the *Requirements* to provide selected land services of the in-focus land agencies?	Literature review	Existing literature and senior staff of the selected land agencies	Descriptive analysis	"As-is" Use Cases of three selected services.
Q3. When considering the selected indicators from global land frameworks or principles, what is the state of land administration service in Accra, Ghana?	Semi-structured interview, Client survey, Literature review	staff and clients of the selected land agencies Existing literature	Quantitative and qualitative analysis, Descriptive analysis	Performance table showing the state of land administration services
Objective2. To identify the factors hindering spatial data interoperability among land agencies in Accra, Ghana.				
Q1. What are the national data standards and policies regulating spatial data interoperability?	Literature review	Existing literature on data laws, standards, data Acts and data policy regulations	Descriptive analysis	A literature review section of standards and data policies regulating data interoperability in Ghana
Q2. What are the gaps hindering spatial data interoperability among land agencies in Accra	Semi-structured interview, Observation of models used in land agencies	Senior staff of selected land agencies	Descriptive analysis	A chapter section describing the identified gaps hindering data interoperability between land agencies
Objective3. To develop a model to support data interoperability among land agencies in Accra.				
How can the identified gaps be incorporated into a model to support spatial data interoperability?	Literature review, Observation of models used in land agencies		Modelling	A model consisting of components to support spatial data interoperability among land agencies
Objective4. To evaluate this model against country Requirements and international standards and provide recommendations for its adoption				
Q1. Does the proposed model satisfy the land service *Requirements* and national data standards?			Evaluation/ Comparative analysis	A description of the to-be situation when the model is implemented.
Q2. What are some mechanisms to support the implementation of this model?	Literature review Semi-structured interview	Key staff of the land agencies		A chapter section of recommendations to support model adoption

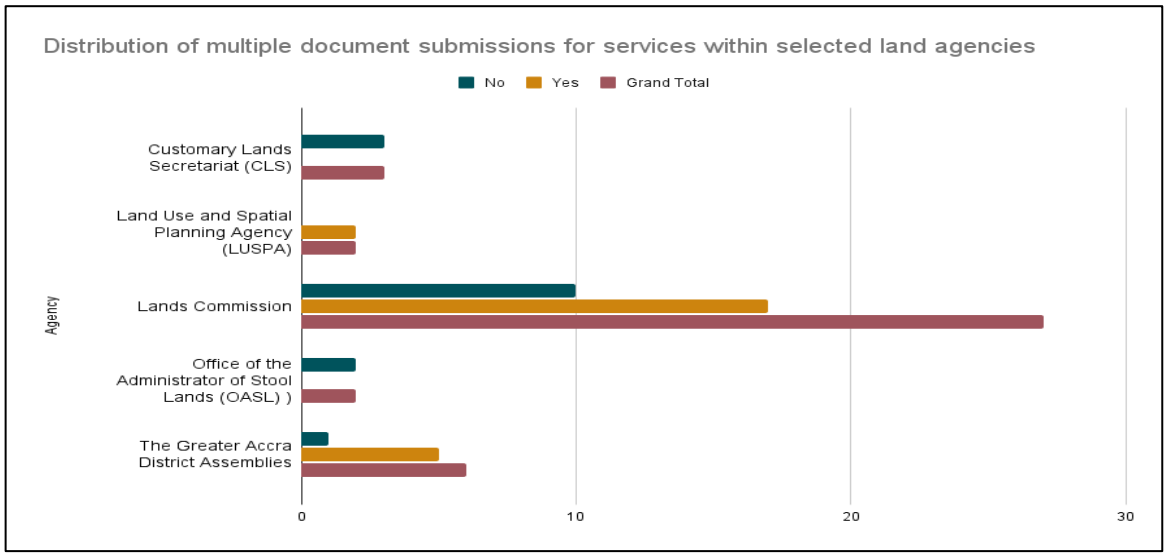
Appendix 8: UML Sequence Diagram For The Registration Of Customary Land Interest In The Gbawe CLS Source: Authors Construct



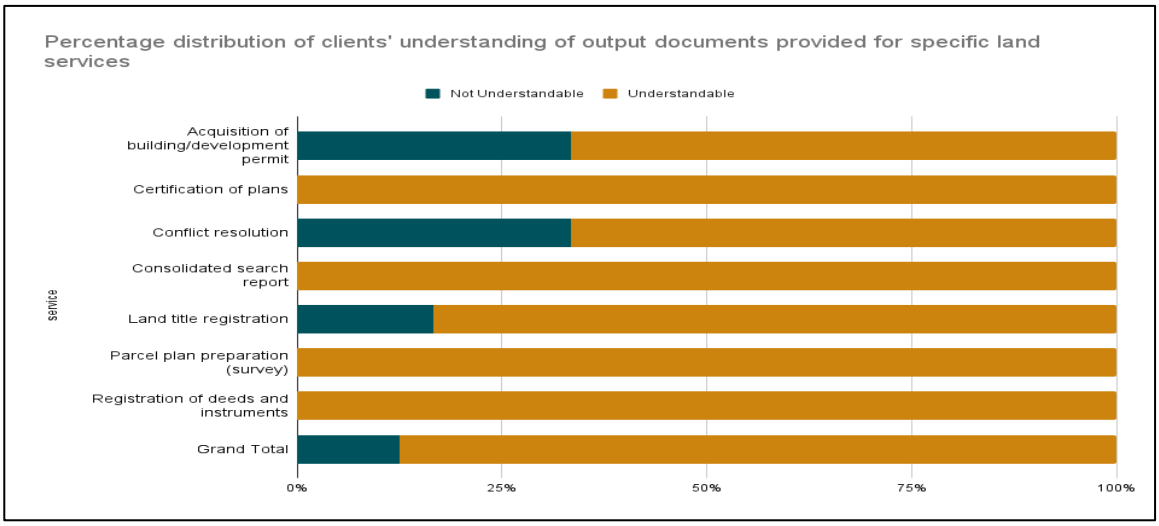
Appendix 9: Distribution Of The Number Of Times Clients Submit Personal Data During Service Requests



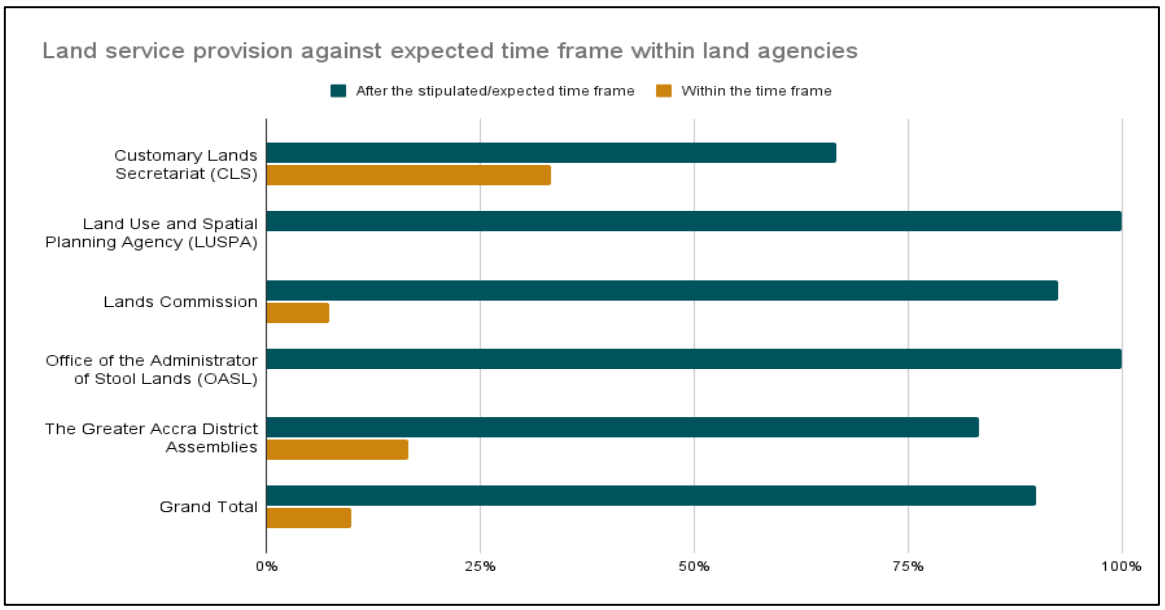
Appendix 10: Distribution Of Multiple Document Submissions For Selected Services Within Selected Land Agencies



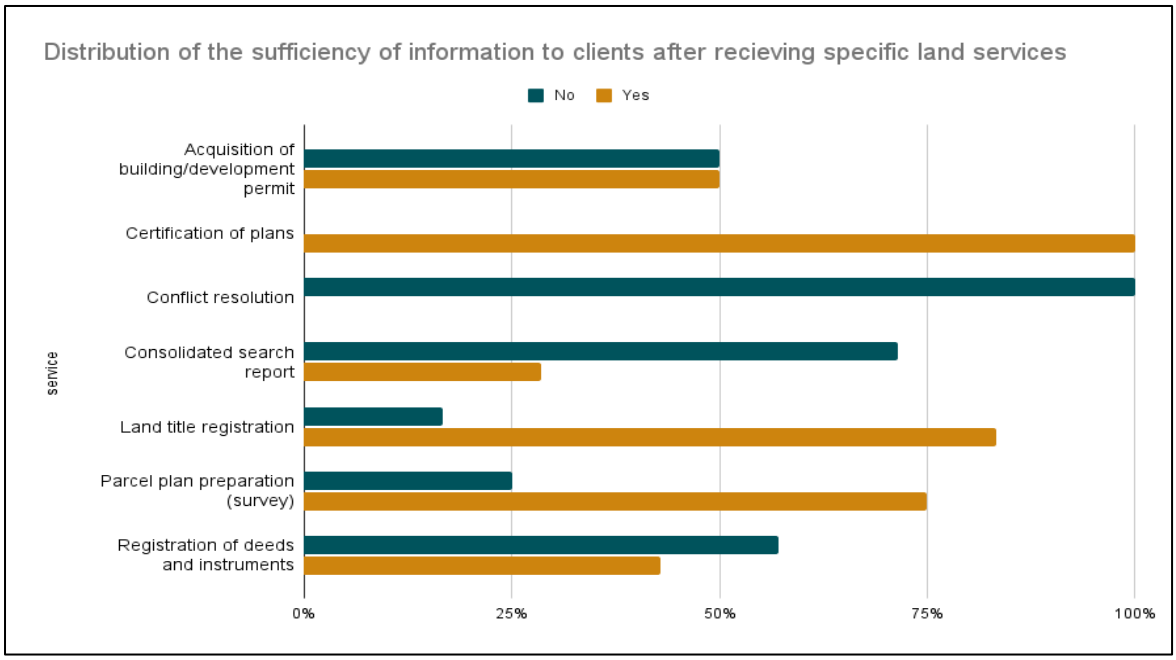
Appendix 11: Distribution Of Clients' Understanding Of Output Documents Provided For Specific Land Services



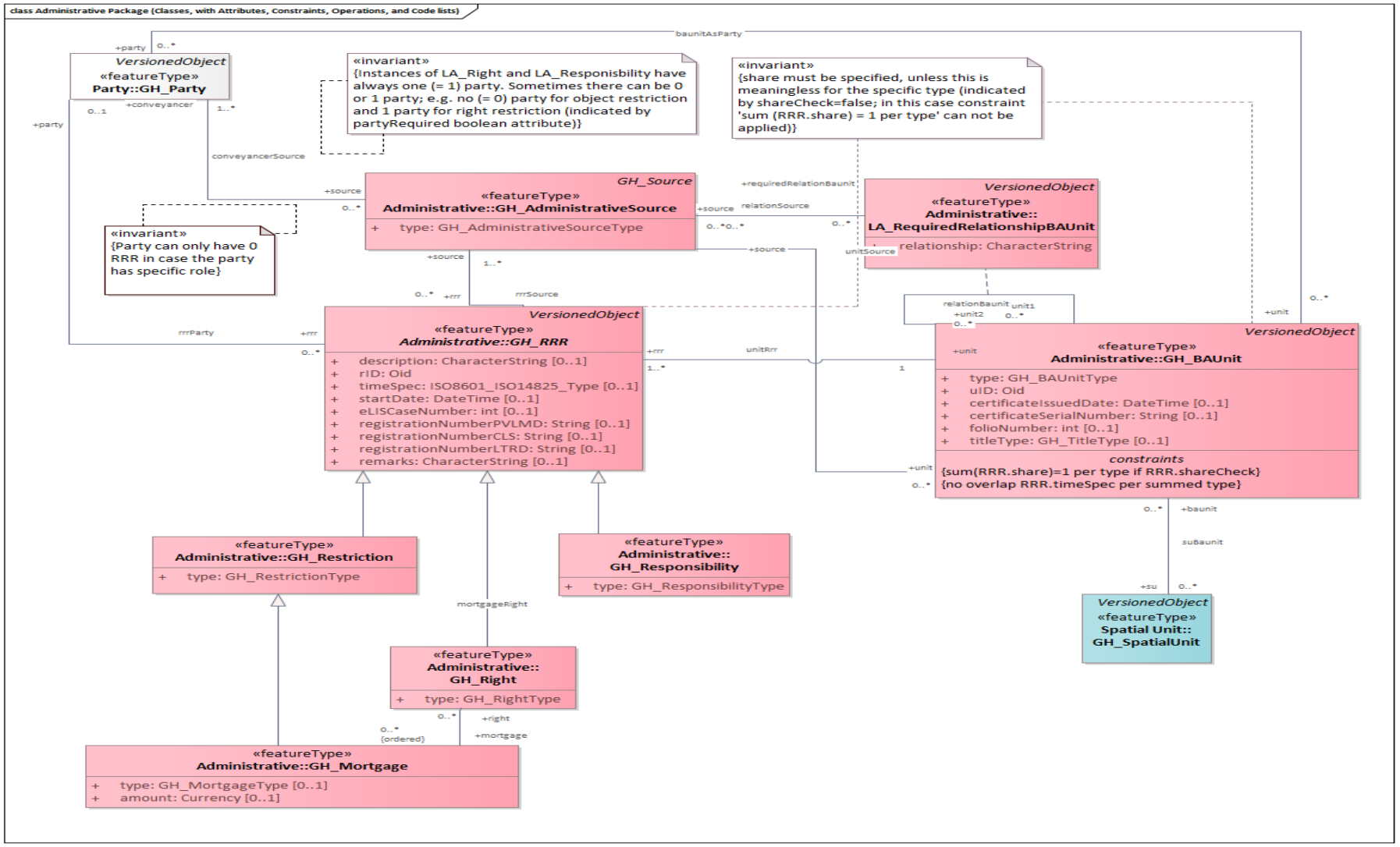
Appendix 12: Provision Of Land Services Against Their Expected Time Frames Within Land Agencies



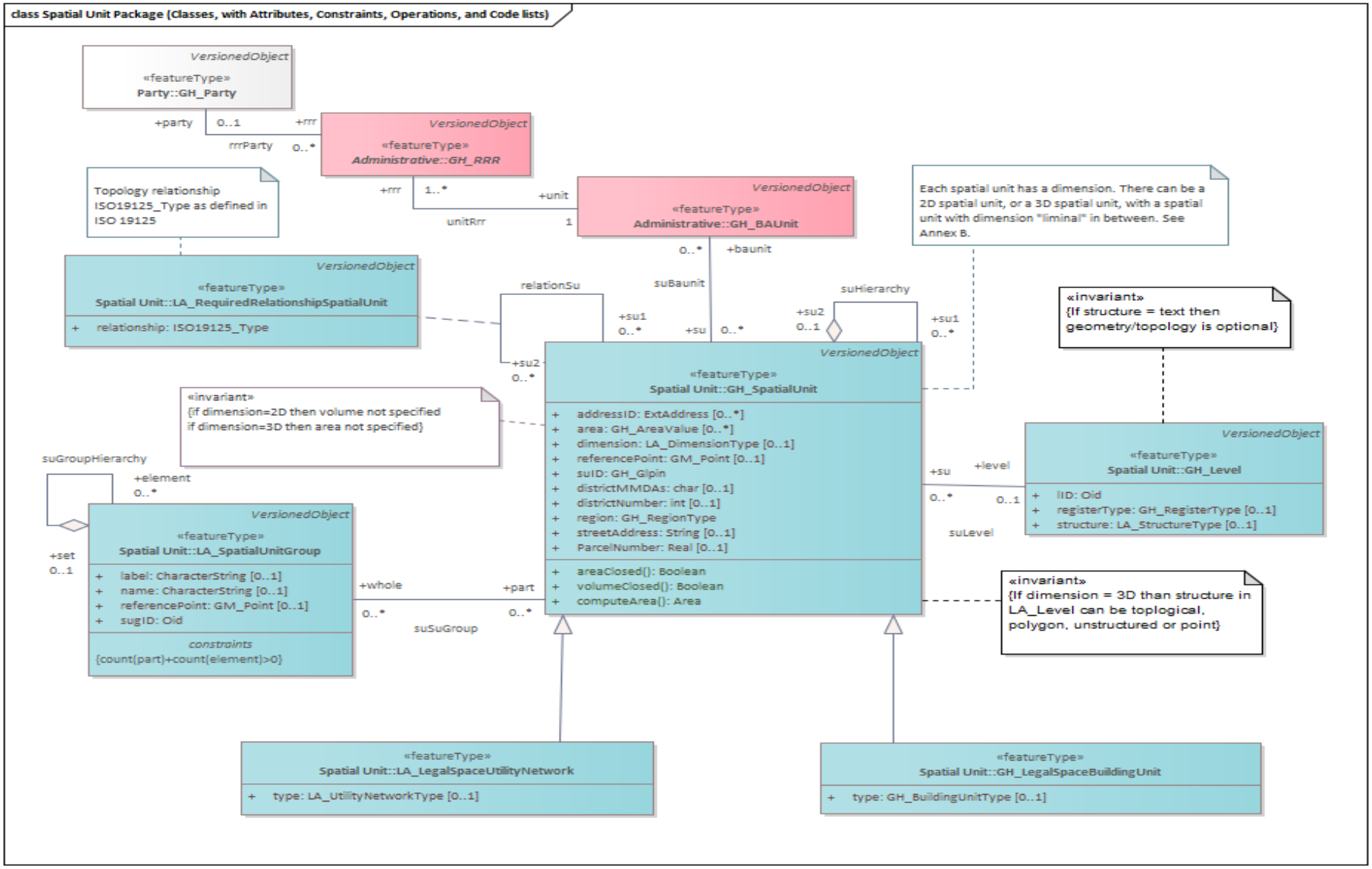
Appendix 13: Sufficiency Of Information To Clients After Receiving Selected Land Services



Appendix 14: Land Interests Represented As The Ghana LADM Class Administration Package With (Classes, Attributes, Constraints, And Operations). Adopted From (Okyere, 2021)



Appendix 15: Spatial Unit Details Represented As The Ghana LADM Class Spatial Unit Package With (Classes, Attributes, Constraints, And Operations). Adopted From (Okyere, 2021)



Appendix 16: Metadata Specifications Guide To Support Interoperability. Source: Authors Construct

1. GENERAL *REQUIREMENTS*
1.1 File identification
Provide a globally unique and persistent identifier of the metadata record through the *fileIdentifier* element using UUIDs, e.g. *138a4517-c89b-12d3-e496-420055441100*, or using the ISO/TS 19139 XML identifier scheme including Ghana's country code prefix, e.g. *gh_luspa_railwaylines_2-1_networking (gh_<producer>_<product>_<version>_<theme>)*. The multiplicity of this element should be 1.
1.2 Metadata language
This is the language in which the metadata content is provided or expressed. The value domain of this metadata element should conform with ISO 639-2. For land agencies in Ghana, English being the official language, the code value *"eng"* should be used. The multiplicity of this element should be 1.
1.3 Metadata contact information
This is the description of the agency accountable for creating the metadata. This description shall include the agency's name represented by free text, a functioning contact e-mail address represented by a character string and a phone number represented by numerals. The multiplicity of this element should be 1..*(one or more). The name of the agency should be represented as XML such that *gmd:agencyName*, the phone number represented as *gmd:phoneNumber,* including the country code: *"+233"* and the subscriber number, which in total should not be more than 15 digits, the email address of the organisation should be represented as *gmd:electronicMailAddress*.
1.4 Metadata date and time
This specifies the metadata record creation or modification date and time in conformity with ISO 8601. For example, June 6, 2023, at 6:34 pm, should be represented as 2022-06-6 18:34:00.000. The multiplicity of this should be 1.
1.7 Limitations on Public Access
This describes the limitations set on datasets and the reasons for them. Relevant Acts like the Ghana Data Protection Act 2012 and Electronic Transactions Act 2008 contain cases and reasons where limitations on public access can be set. The value domain of this element should be free text. The multiplicity of this element should be 1..*
2. RESOURCE IDENTIFICATION INFORMATION
2.1 Resource Title
This is a unique characteristic, usually a name by which a resource should be labelled. This should be Human and machine-readable, and non-empty title of a dataset, and written in the language of the metadata *"eng"* in this case. It shall be encoded using XML and represented as gmd: title/ gmd: citation. For example, a dataset about parcels falling within a zoned district under the Land Administration Project can be titled *"Parcels within Adentan (LAP-1).* If the spatial data or dataset falls into a bigger project, the project should be indicated at the end of the title. In that case, full project names or abbreviations should be used are allowed, making sure abbreviations are alluded to in the abstract that follows. When no abstract is stated, abbreviations should be avoided for ambiguity. The value domain of this element should be free text. The multiplicity of this element should be 1.
2.2 Resource Abstract
This is a dataset summary describing its content written in this case's metadata 'eng' language. The value domain of this element is free text. The summary could include information about the location, data sources and dataset references. The multiplicity of this element should be 1.
2.3 Metadata on Data Access and Use
This describes the conditions for the access and use of datasets. If there are no conditions or unknown conditions to access and use data, it should be specified as "noConditions" or "unknownConditions". In the case of spatial data used by in-focus land agencies, no datasets should be licensed or priced among agencies. The value domain of this element should be free text. The

multiplicity of this element should be 1..*.
2.4 Coordinate reference system (CRS)
This is the description of the dataset's coordinate reference system. The domain value of this element should be free text. The multiplicity of this element should be 1…*. Only one well-known CRS common to most land agencies should be used. In the case of Ghana, the Ghana National Grid based on the Transverse Mercator projection (using World Geodetic System 1984 (WGS84) ellipsoid) is the common CRS for mapping. Based on this information, in Ghana's CRS using the ISO/TS 19139 XML can be, for example, encoded with the name faces and prefix: <gmd:MD_ReferenceSystem>, <gmd:referenceSystemIdentifier>, <gco:CharacterString>Ghana, National Grid</gco:CharacterString>, <gco:CharacterString>EPSG</gco:CharacterString>, </gmd:referenceSystemIdentifier>
2.5 Temporal resolution
This is the description of the temporal reference of the dataset. The value domain of this element should be free text. The multiplicity for this element should be 0..*. In Ghana, this can be stored using the Gregorian calendar with 24-hour local time.
2.6 Data Encoding
This describes the computer language used to represent the elements within a dataset. For spatial data interoperability among land agencies in Ghana, metadata encoding can b done in XML as it can capture geographic datasets. The multiplicity of this element should be 1..*.

Appendix 17: Land Service Assessment Tables

Distribution of services requested in-person and hybrid (digitally and in-person)

Service	*Request Means*		
	Both	In-person/visit to the premises of the land agency	Total
Acquisition of building/development permit		6	6
Certification of plans		4	4
Conflict resolution		6	6
Consolidated search report	6	1	7
Land title registration		6	6
Parcel plan preparation (survey)		4	4
Registration of deeds and instruments		7	7
Grand Total	**6**	**34**	**40**

Distribution of clients' perception of the cost of requested services

Service	*Cost Assessment*		
	Affordable	Expensive	Total
Acquisition of building/development permit	1	5	6
Certification of plans	1	3	4
Conflict resolution	6		6
Consolidated search report	2	5	7
Land title registration		6	6
Parcel plan preparation (survey)		4	4
Registration of deeds and instruments	3	4	7
Total	**13**	**27**	**40**

Distribution of clients' understanding of output documents provided for specific land services

Service	*Output Documents being understandable.*	
	No	Yes
Acquisition of building/development permit	33%	67%
Certification of plans		100%
Conflict resolution	33%	67%
Consolidated search report		100%
Land title registration	17%	83%
Parcel plan preparation (survey)		100%
Registration of deeds and instruments		100%
Grand Total	**13%**	**88%**

Distribution of the sufficiency of information to clients after receiving specific land services

Service	*Information Sufficiency*	
	No	Yes
Acquisition of building/development permit	50%	50%
Certification of plans		100%
Conflict resolution	100%	
Consolidated search report	71%	29%
Land title registration	17%	83%
Parcel plan preparation (survey)	25%	75%
Registration of deeds and instruments	57%	43%
Grand Total	**50%**	**50%**

Provision of specific land services against their expected time frames for clients		
	Service Time	
Service	After the stipulated time frame	Within the stipulated time frame
Acquisition of building/development permit	5	1
Certification of plans	3	1
Conflict resolution	6	
Consolidated search report	7	
Land title registration	6	
Parcel plan preparation (survey)	3	1
Registration of deeds and instruments	6	1
Grand Total	**36**	**4**

Distribution of multiple document submissions for specific requested services			
	Multiple Document Submission		
Service	No	Yes	Grand Total
Acquisition of building/development permit	17%	83%	100%
Certification of plans	75%	25%	100%
Conflict resolution	67%	33%	100%
Consolidated search report	86%	14%	100%
Land title registration		100%	100%
Parcel plan preparation (survey)	25%	75%	100%
Registration of deeds and instruments	14%	86%	100%
Grand Total	**40%**	**60%**	**100%**

Provision of land services against their expected time frames within land agencies		
	Service Time	
Agency	After the stipulated time frame	Within the stipulated time frame
Customary Lands Secretariat (CLS)	67%	33%
Land Use and Spatial Planning Agency	100%	
Lands Commission	93%	7%
Office of the Administrator of Stool Lands	100%	
The Greater Accra District Assemblies	83%	17%
Grand Total	**90**	**10%**

Distribution of the number of times clients submit personal data/documents during the request of specific land services			
	Number of Clients		
Service	Twice	Thrice	> Thrice
Acquisition of building/development permit	3	2	
Certification of plans	1		
Conflict resolution	2		
Consolidated search report	1		
Land title registration	1	2	3
Parcel plan preparation (survey)	2		1
Registration of deeds and instruments	6		
Grand Total	**16**	**4**	**4**

Appendix 18: Data Management Plan

Overview

1. What kind of data would be used during this project	Qualitative and Quantitative data
2. What is the source of the data?	Field data (Semi-structured interviews and survey questionnaires)
3. Are various data sources integrated into the datasets you are going to use?	No
4. Data owners	The Researcher
5. Can you easily find out what you are allowed to do with the data you will use?	Yes

Organising and documenting your data

Data Organization: 1. How will you organise your data during the project? E.g., folder structure and names	The data is stored in one folder in the student University of Twente One drive, with the outputs organized under different names and dates. This will be the sorting criteria for sub-folders. a. Enterprise Architect folder ▪ EA files b. Semi-structured Interviews folder ▪ LC data ▪ LUSPA data ▪ CLS data ▪ OASL data ▪ AMA data ▪ MLNR data c. Client survey folder ▪ All survey data
2. What can you tell about the quality of the data?	They are primarily collected on the field with no third-party /secondary interferences.
Metadata: 1. What metadata comes with the data?	No metadata was recorded.
2. Is there any metadata missing?	No

Processing your data

Versioning: 1. What would be your strategy concerning versioning your data files during the project?	The different versions of data files/documents are saved in the same folder with new version names.
2. How can different versions of a data file be distinguished?	By date of creation and names

Protecting your data

Ethical consideration: 1. Do you think your project requires ethical approval by the ITC Ethics Committee?	No
2. Why?	The data collected is not sensitive.