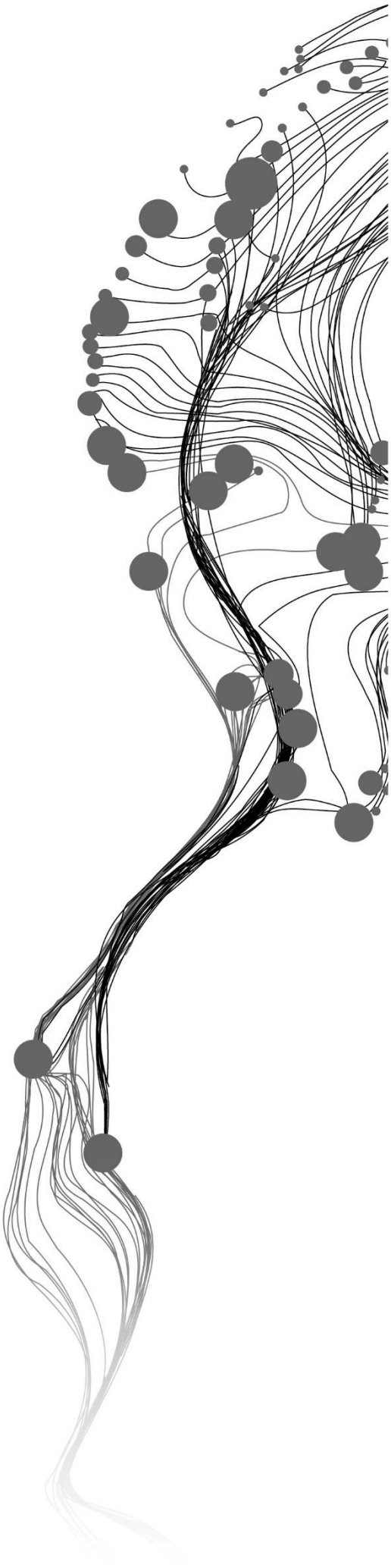

Enhancing interoperability through API for Certificate Issuance at ATR/BPN

CLAVA PRATAMA PUTRA GINTING

JULY, 2024

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Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation.
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DISCLAIMER

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ABSTRACT

Land administration involves the systematic management of land-related processes and data to support governance, economic development, and sustainable land use. Effective land administration systems are critical for ensuring accurate, reliable, and interoperable data exchange among various actors. The usual mechanisms to exchange data in land administration is usually consist of standardised paper-based document that derived from technical standards and regulation frameworks.

Here, we demonstrate that APIs can be designed to be used as mechanism to exchange data in Land Administration. The process begins with identifying the certificate issuance workflow in ATR/ BPN Indonesia. Then, we suggest changes in the workflow to accommodate the API. To maintain the regulatory compliance, we set several interaction requirements to rule the input and output of each process.

Then, we start designing the API by developing the data model that aligns with the Land Administration Domain Model (LADM) to ensure interoperability. The API development involves creating endpoints to handle specific needs of the actor based on the requirements that already devised. A body response also devised for the API to standardize the format and structure of the data exchanged.

Our results show that the developed API prototype, utilizing Node.js and Express.js, successfully handles data submission, retrieval, and updating operations. The API endpoints are designed to manage various processes, such as application submission, assignment management, spatial data collection, and juridical data inspection. The interactions between the API and the PostgreSQL database ensure optimal performance and scalability, enabling concurrent user requests to be handled efficiently.

In a broader perspective, our findings highlight the potential for APIs to standardize interactions within land administration systems, reducing the expertise required for data management and facilitating cross-organizational collaboration. This study contributes to the advancement of land administration practices by providing a practical mechanism for data exchange in land administration.

Keywords:
Land Administration, API, Interoperability

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Alhamdulillah,
-There is an end in every beginning, and with every end, a new way is paved-

Enschede
2024

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Glossary Of Terms

API	Application Programming Interface
ATR/BPN	Agraria dan Tata Ruang/ Badan Pertanahan Nasional (Agrarian Affairs and Spatial Planning/National Land Agency)
FELA	Framework for Effective Land Administration
FFPLA	Fit for Purpose Land Administration
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
LADM	Land Administration Domain Model
LAS	Land Administration Syste
NIB	Nomor Identifikasi Bidang Tanah (Parcel Identifier Number)
RLA	Responsible Land Administration

1. INTRODUCTION

1.1. Background

Land administration is a systematic approach to managing standard processes associated with land delivery and land markets (Williamson, I., Enemark, S., Wallace, J., & Rajabifard, 2010). It encompasses collecting, recording, disseminating, and maintaining data on the relationship between people and land (Zevenbergen et al., 2015). Researchers in land administration are always looking for ways to standardise land administration. Fit for Purpose Land Administration (FFPLA), Responsible Land Administration (RLA), and Framework for Effective Land Administration (FELA) are examples of attempts to standardise land administration in practice (Bennett et al., 2021a; Todorovski & Zevenbergen, 2020; UN-GGIM, 2020).

Standardised land administration can accelerate the implementation of land administration systems that support sustainability objectives (Lemmen et al., 2015). The United Nations Committee of Experts on Global Geospatial Information Management explains the benefits of having the standardised system as follows: "the robust land administration systems linked to geospatial data deliver a range of benefits to society in terms of support for governance and the rule of law; alleviation of poverty; security of tenure; support for formal land markets; security for credit; support for land and property taxation; protection of state lands; management of land disputes; and improvement of land use planning and implementation"(UN-GGIM, 2015). For a country that already has land administration, standardisation can also support the improvement of land administration and facilitate organisational integration between different land management-related agencies (Lemmen et al., 2015). Moreover, standardisation can reduce duplication of efforts, and ensure consistency in data management, resulting in more reliable and accurate land information(Elia et al., 2013).

Efforts are being made to standardise land administration practices, and the Land Administration Domain Model (LADM) provides a robust framework for developing efficient land administration systems. This model facilitates communication among involved parties based on shared concepts (Lemmen et al., 2015). However, the study of interoperability in land administration is more related to integrate the land administration into another system or vice versa. For example, the integration of linking land register and other official register in Croatia(Mader et al., 2015) or the more recent topic of the integration of 3D object through LADM to Cadastral system(Cemellini et al., 2020; Petronijevíc et al., 2021; Rajabifard et al., 2021; Zulkifli et al., 2021)

Studies has been shown the importance of data exchange and Interoperability framework in land administration for the sustainable development goals(Okembo et al., 2024). However, despite these efforts, there is currently no practical mechanism in place to introduce interoperability within land administration systems effectively. This gap highlights the need for a solution that not only aligns with the LADM framework but also facilitates seamless data exchange between different land administration processes.

This study intends to use API as a mechanism for components in land administration system interact with each other. API have the advantage of allowing different systems to interact with the data, thereby promoting interoperability. API implementation also promises flexibility that it could designed to work

with LADM's while accommodating the actor needs. As a result, we are developing a system in which LADM provides the abstract framework and principles for understanding and structuring land administration data, while the API can be designed to facilitate the interaction with this framework. As a result, API can serve as a practical mechanism for digital data exchange in land administration, ultimately leading to more standardised and reliable land data management.

1.2. Research Justification

Processes in land administration necessitate interaction with land administration data, requiring interact with each other with data structures. However, process in land administration system often distributed among different entities, each with specific roles and responsibilities (Ehwi & Asante, 2016). Therefore, it is difficult to standardise interactions across these entities due to varying processes, data formats, and requirements.

The distribution of roles and responsibilities introduces a crucial aspect of inter-organisational dynamics and collaboration(Ho et al., 2021). This necessitates a mechanism that can facilitate seamless digital data exchange and integration across various steps in the land administration process. Since, without the mechanism to data exchange. The distribution of roles and responsibilities become the culprit of contrasting data flow and leading to inefficiencies(Mulolwa, 2002). Therefore, it is essential to develop a standardized interface for data exchange that can be implemented even in cross organisational situation.

API offer a promising solution by providing a standardized interface for data exchange that can accommodate local variations and specific requirements of different entities. By leveraging API, it is possible to ensure that data is consistently formatted and readily accessible in a predefined structure (Wohner et al., 2022). This research by Ping Ong et al. (2014) creates an API for programmatically querying and interacting with the Materials Project database based on the Representational State Transfer (REST) pattern for the web, demonstrating the practical application and benefits of API to provide access to materials data and facilitate data analysis in the field of materials science.

Implementing API in land administration promises interoperability by enabling different systems to interact seamlessly. It should allow actor users to access and manipulate land administration data regardless of the specific platform they are running on. This capability is crucial for supporting land administration process where the systems is where the systems need to be flexible, scalable, and capable of handling diverse requirements efficiently.

1.3. Statement of The Problem

This was observed in Indonesia, where land administration already established since 1950 by the Basic Agrarian Law no. 5/1960. Since its inception, this legislation has laid the foundation for the country's land administration framework, overseeing crucial procedures such as land surveying, registration, and titling. Today, Indonesia's land administration procedures are governed by the Ministry of Agrarian Affairs and Spatial Planning, known as Kementerian ATR/BPN (Agraria dan Tata Ruang/ Badan Pertanahan Nasional) in Bahasa (Aditya et al., 2020). Despite appointed as a single legal and organisational construction, the land administration process frequently necessitates collaboration and data exchange between ATR/BPN Directorate General.

As illustrated in Figure 1, the land administration process in Indonesia involves multiple directorates within the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN), each with specific responsibilities. The Directorate General of Spatial Planning handles the strategic planning

and use of land, while the Directorate General of Surveys and Mapping of Land and Space is responsible for precise surveying and mapping. The Directorate General on Determination of Rights and Land Registration formalises land rights and manages the land registry. The Directorate General of Agrarian Organisation oversees the administrative aspects of land affairs. Additionally, the Directorate General of Land Procurement and Land Development manages the acquisition and development of land, the Directorate General of Land and Space Control and Management focuses on regulation and control, and the Directorate General of Land Disputes and Conflict resolves related disputes. This structured division of responsibilities ensures that each aspect of land administration is addressed by specialised units.

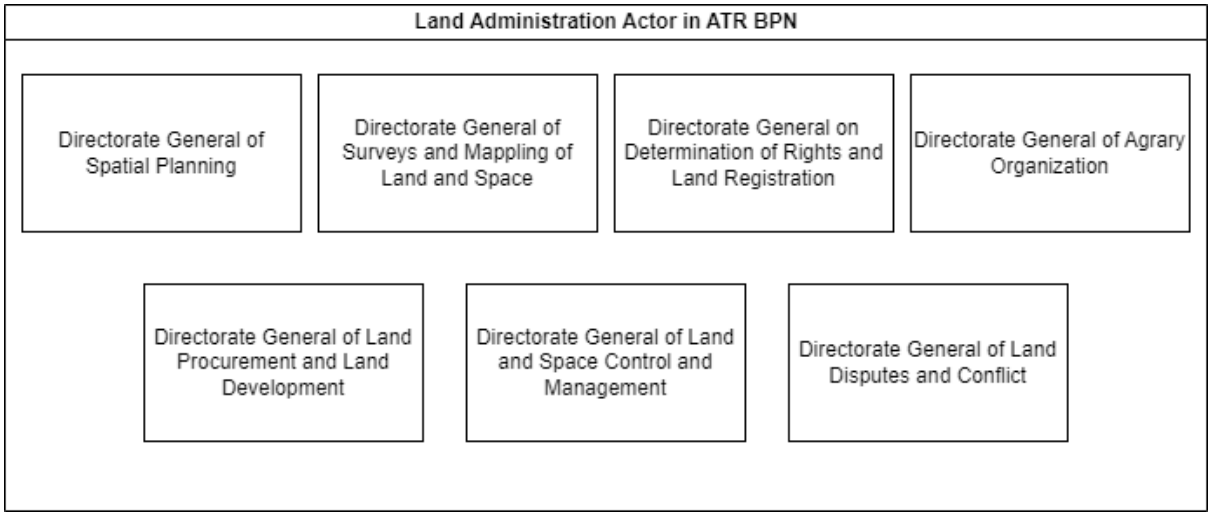


Figure 1. Directorate General division in ATR/BPN (Source: Author)

However, when looking at how the land administration process is carried out in Indonesia, it is clear that it is a multifaceted workflow not limited to a single directorate general. Rather, it necessitates the collaboration of several departments within the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (Kementerian ATR/BPN). Take, for example, the issuance of a land certificate. The Directorate General of Surveys and Mapping of Land and Space and the Directorate General of Determination of Rights and Land Registration play crucial roles in this process.

Ministry Regulation No. 3/1997 provides guidelines to streamline this workflow, specifying the input and output of each step to ensure consistency and efficiency. The problem is the way of handling data is that the data is primarily represented in paper-based documents. While these documents contain the necessary data, the next steps in the process often require extracting and re-entering this data into other systems to proceed. This manual data handling creates an undocumented extra step, leading to inefficiencies and a higher potential for errors. To address these issues, there is a critical need to transition to a digital data exchange system that can standardise and automate the integration of information between different process, thereby enhancing the overall interoperability and reliability of the land administration workflow.

The specific problem that this research aims to address is the creation of a mechanism that allows seamless digital data exchange and integration across the various steps involved in the land administration process. Implementing this system promises to reduce manual data handling and enhance the integrity of the land administration services. These improvements would streamline workflows and make data more accessible, ultimately supporting better coordination and collaboration among different directorates.

Currently, studies are exploring the option of standardizing transactions using smart contracts in a blockchain environment (Stefanovic et al., 2022). While these approaches offer promising avenues for

future integration, there remains a gap in the practical implementation of digital data exchange mechanisms within the current land administration framework.

Perhaps we cannot overlook that the fact that generic processes would be too difficult to model since in many countries different organizations have their own responsibilities in data maintenance and supply but may communicate based on standardised administrative and technical update processes(Lemmen et al., 2018). However, this study seeks to unravel the complexity of the interactions between processes in land administration in an effort to develop a practical solution.

The implications of are promising for the future of land administration in Indonesia and potentially other countries facing similar challenges. By developing a standardized digital data exchange system based on the Land Administration Domain Model (LADM) and API, this research aims to improve interoperability in Indonesia's land administration processes.

Furthermore, the study's approach and findings could offer valuable insights and a replicable model for other nations seeking to modernize their land administration systems. By providing the approach to the implementation of the technology, this research could encourage the adoption of similar approaches in other contexts, promoting greater interoperability and efficiency in land administration practices.

1.4. Objectives and Research Questions

1.4.1. Main Objective

The main objective of this research is:

Main Objective: To propose API as an approach for fostering interoperability for digital land certificate issuance in ATR/ BPN

1.4.2. Sub-objectives and questions

Objective 1. To investigate the network of interaction between actors within the process of issuing land certificate in ATR/ BPN

Q 1.1 What are the existing policies and regulatory frameworks governing the issuance of land certificates in Indonesia?

Q 1.2 What are the roles and responsibilities attributed to different actors for issuing certificate in ATR/ BPN?

Q 1.3 What is the impact of digitalisation on the process of issuing land certificates in Indonesia?

Objective 2: To develop an API structure that can be used in cross-organisational situation for digital land certificate issuance in Indonesia.

Q 2.1 What are the legal requirement for land certificate issuance in Indonesia?

Q 2.2 How can the integration of API address the identified legal requirements within the digital land certificate issuance process?

Q 2.3 What is the specification and structure of the API that can facilitate issuance of digital land certificate?

Objective 3: To demonstrate how the proposed API can be used in cross-organisational situation in ATR/BPN

Q 3.1. How can the API be integrated into ATR/ BPN digital land certificate issuance workflows?

Q 3.2. How is the data model structured to enable cross-organisational collaboration in digital land certificate issuance within ATR/BPN?

Q 3.3 How can the API be utilised by another stakeholder beyond land certificate issuance process in ATR/BPN?

1.5. The structure of the thesis

The structure of the thesis is organized as follows:

- Chapter 1 introduces the research background, justification, problem statement, objectives, and research questions.
- Chapter 2 provides a literature review on land administration systems, processes, problems, interoperability standards, system requirements, and API.
- Chapter 3 describes the redesign of the Indonesia's certificate issuance workflow.
- Chapter 4 details the development of the API.
- Chapter 5 discusses the implementation and testing of the API.
- Chapter 7 presents the discussion for this study.
- Chapter 7 concludes with findings, limitations, and recommendations for future research.

2. LITERATURE REVIEW

This chapter explores the land administration system in Indonesia, emphasizing its context and operational framework. It outlines the foundational elements, including institutional frameworks, land registries, and cadastral maps, and details the management by the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN). The chapter identifies opportunities for improvement, focusing on enhancing interoperability among various directorates and integrating digital solutions to streamline processes. This chapter also provides approach that this research taken to implement the API in Land Administration.

2.1. Land Administration System

The foundation of land management activities lies in the land administration system. These systems are institutional frameworks designed to oversee the management of land and natural resources in pursuit of sustainable development (Enemark, 2005). They are established by governments or governing bodies to regulate and manage land resources within their jurisdictions. A land administration system typically encompasses core components such as a registry of rights and a cadastre map, although it may include other elements. This study highlights that understanding the components of a country's land administration system is essential for the development of digital systems.

Several papers have described the components of a land administration system. For example, Steudler et al. (2004) define it as a system composed of land attributes and land administration functions. Enemark (2005) expands on it by classifying it according to functions such as land tenure, land value, land use, and land development. Dawidowicz et al., (2013) take a newer approach, describing the land administration system as a multi-purpose cadastral system that is integrated with other spatial information systems and public registers. This is typical of multifaceted land administration. In this case, a system developer should be familiar with these components to ensure that digital tools and technologies are used effectively to streamline processes.

Depending on the components of the land administration system, digitalisation can address specific issues that arise from communication. Digitalisation promises a new mechanism for the components inside of the system to communicate with each other. A land administration system (LAS) provides a framework for managing land and natural resource management activities, which is essential for achieving sustainable development (Enemark, 2005). A well-functioning LAS can facilitate the implementation of various aspects of land policy, such as ensuring secure tenure, promoting efficient land use, and managing land and natural resources effectively (Steudler et al., 2004). However, if these components are not properly identified and integrated, the system is prone to significant problems in land management and governance, ultimately hindering sustainable development efforts.

2.1.1. Indonesia's Land Administration system

The management of the land administration system in Indonesia is overseen by the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN). The duty of ATR/BPN is stated in the Law Number 39 of 2008 concerning State Ministries. This regulation delineates the roles and responsibilities of ATR/BPN, highlighting its mandate in managing land, agrarian affairs, and spatial planning. The institutional arrangements in ATR/BPN consists of seven general directorates, each responsible for different aspect of land administration.

According to the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation (Ministrerial Regulation) Number 16 of 2020 concerning the Organization and Work Procedures of the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency, ATR/ BPN consist of Directorate General of:

(1) Directorate General of Spatial Planning,
(2) Directorate General of Surveys and Mapping of Land and Space,
(3) Directorate General of Determination of Right and Land Registration,
(4) Directorate General of Agrarian Organization,
(5) Directorate General of Land Procurement and Land Development,
(6) Directorate General of Land and Space Control and Management, and
(7) Directorate General of Land Dispute and Conflicts. For land tenure.

According to Enemark (2005), a land administration system encompasses functions such as land tenure, land valuation, land use, and land development. In Indonesia, these functions are governed by multiple general directorates within ATR/BPN. Specifically, Land tenure is primarily handled by (2) the Directorate General of Surveys and Mapping of Land and Space and the (3) Directorate General of Determination of Right and Land Registration. Land valuation falls under the (5) Directorate General of Land Procurement and Land Development. Land use is managed by the (1) Directorate General of Spatial Planning and the Directorate General of Land and Space Control and (6) Management. Finally, land development is overseen by (4) Directorate General of Agrarian Organization and the (5) Directorate General of Land Procurement and Land Development. This distribution of responsibilities among the directorates can be visualised in Figure 2.

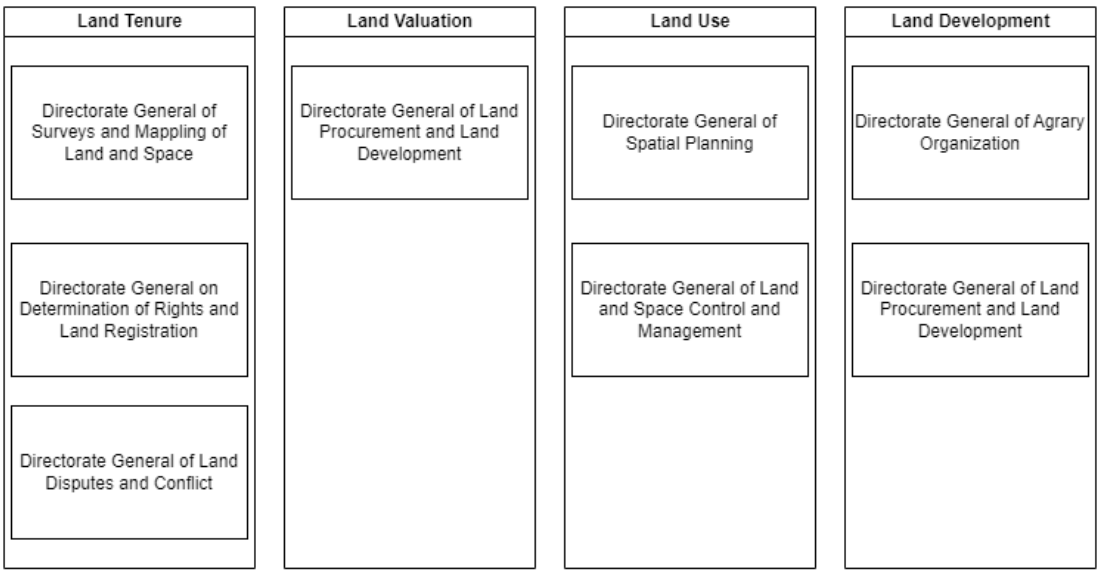


Figure 2. Directorate General categorized by Function (Source: Author)

This study argues that the multi-directorate approach necessitates a high degree of interoperability both between and within these directorate general to ensure a cohesive and efficient land administration system. Without reducing the importance of other functions, this study will focus on the land tenure function. However, the approach of this study can then be replicated in the other three function, providing a well-functioning LAS.

Enemark (2005) further elaborates land tenure activities within a land administration system includes surveys to determine parcel boundaries, the transfer of property or use from one party to another through sale or lease, the use of land as collateral, and the management and adjudication of doubts and disputes

regarding rights and parcel boundaries. In Indonesia, these activities are reflected in Government Regulation No. 24 of 1997 concerning Land Registration, which outlines the necessities related land tenure in Indonesia. The regulation lists components such as processes, entities, and attributes related to land. This study argues that developing a digital system for Indonesia should address the intricacies of land tenure as outlined in Government Regulation No. 24 of 1997. By focusing on these processes, the study sets the stage for a deeper exploration of the land administration system in Indonesia, which is crucial for understanding and overcoming the implementation challenges.

2.2. Land Administration Proccess

If the land administration system establishes the framework for land management, the land administration process describes how this management is carried out in practice. According to Zevenbergen et al. (2015), land administration is the process of collecting, managing, and disseminating information about land, land rights, and land use. These procedures differ between countries, making standardisation unlikely. This study argues that understanding how these processes are carried out in different contexts and considering the interactions involved is critical for developing an appropriate land administration system.

Within the land administration process, one of the core elements for a functioning land administration system is the formalization of land tenure through land registration. Land registration is a process of the official recording of rights in land through deeds or titles (Zevenbergen, 2004). The procedures for land registration itself may vary. The procedures for land registration can vary due to the underlying registration system. In title registration, the legal consequences of a transaction are recorded, while in deed registration, the deed itself, describing a specific transaction, is registered (J.A. Zevenbergen & H.D. Ploeger, 2019). This difference affects how information about the land and its legal status is entered into the land register. Title registration requires a separate procedure for entering this information, whereas deed registration includes it within the same deed that is registered. Additionally, it is important to note that each country has its unique system for land registration, with no two countries sharing the same or even a very similar system (Zevenbergen, 2002). the same process may require different interactions with the system depending on the context.

Understanding the specific intention of a land administration process is critical for the system's ability to streamline it. Land registration systems vary across countries, as do the legal requirements and regulations governing them (Zevenbergen, 2002; Zhao et al., 2009) This emphasises the importance of designing a digital system to meet the unique needs of each country. Failure to do so can lead to incompatible systems that eventually fail to meet the requirements of the respective countries. At worst, this could result in a failed implementation of the digital system, creating a duality of systems, digital and paper based.

2.2.1. Indonesia's Land Administration Processes

To understand the land administration process in Indonesia, it is crucial to recognize that the county follows a title registration system. This system was established under Government Regulation No. 24 of 1997 concerning, which mandates the official recording of land titles. This system serves as a formalization for all right recognized in Indonesia since the establishment of Basic Agrarian Law (BAL), Law number 5 of 1960. Each of this title is meticulously documented and stored in a land register called *Buku Tanah*. For each recorded entry in the land register, ATR/BPN issues a land certificate that formally verifies ownership. The process of documenting the land register and issuing a certificate is referred to as certificate issuance. This regulation also introduces another important component of the land administration system, a cadastral map called *Peta Pendaftaran*. This map contains a representation of

parcels of all the registered land. The regulation underscores the importance of both the registers and the maps for the land administration process.

To further elucidate the land administration process in Indonesia, it is important to reference the Ministerial Regulation Number 3 of 1997 concerning the Implementation Provisions of Government Regulation Number 24 of 1997. It is important to highlight that the certificate issuance process is not only applicable to first-time registrations but also to any process that involves changes in the land register. Every alteration, whether it be a transfer, subdivision, or consolidation of land, will results in the issuance of a new certificate of ownership. The usual steps for certificate issuance is application, survey and mapping, collection and examination of juridical data, recording in the land register, and finally the issuance of the land certificate.

The certificate issuance process in Indonesia's land administration system begins with the application stage, where the applicant submits a formal request for certificate issuance. This step is not explicitly explained in Ministerial Regulation Number 3 of 1997. The regulation stipulates for each of the application should be accompanied by a set of original documents that prove the rights to the parcel. These documents include proof of identity, previous land certificates (if applicable), and other relevant legal documents. According to the newer Ministerial Regulation Number 3 of 2023 concerning the Issuance of Electronic Documents in Land Registration Activities, a front office has been introduced to check and digitalise these documents. The front office is responsible for verifying the completeness of the submitted documents before the application proceeds to the next stage.

Once the application is checked, the next step involves conducting a survey and mapping of the land. Ministerial Regulation Number 3 of 1997 mandates that an officer or a team from the land office, or a licensed surveyor or their team, visits the site to carry out this task. A survey refers to the activities of collecting spatial data (measurement) and determining the boundaries and dimensions of the parcel. The output of the survey is a document called *Gambar Ukur* (Measurement Form), which contains the precise measurement of the specific boundary. Each parcel with determined boundaries is assigned a *Nomor Identifikasi Bidang Tanah* (NIB) or Parcel Identifier Number. Meanwhile, mapping refers to the process of integrating the measurement form into national Cadastre Maps that contain all the surveyed parcels. According to the regulation, only officers from the land office are authorized to update the Cadastre Maps.

At this stage, ATR/BPN collects and examines all relevant juridical data related to the land. This involves verifying the legal status of the land, ensuring there are no disputes, encumbrances, or claims from other parties. As mandated by Ministerial Regulation Number 3 of 1997, this task is performed by the rights determination section. If the documents are found to be inappropriate or incomplete, the issue is referred to *Panitia A* (Adjudicator) to resolve the problem. At the end of this stage, juridical information, data, and survey results will be announced to provide an opportunity for the concerned parties to raise objections.

After the survey and juridical data examination are completed, the information is recorded in the land register. Ministerial Regulation Number 3 of 1997 mandates that the register contains information such as the Parcel Identifier Number, area, Map Number, encumbrance status, and possession status. This register is stored together with the documents related to the identity and history of the rights, which are called *warkah*.

The final step in the process is the issuance of the land certificate. Based on the updated records in the land register, ATR/BPN issues a new land certificate of ownership to the landowner. Ministerial Regulation Number 3 of 1997 stipulates that a land certificate can be issued to the applicant after

completing the registration process. The step and the corresponding actor can be found in Table 1. The number on the actor is corresponds to the directorate general in the section 2.1.1.

Table 1: Summary of the Certificate Issuance Proccess

Step	Actor	Input	Output
Application Retrieval	Front Office	Application and original documents	Checked and digitized documents
Measurement (Survey)	Land office surveyors or licensed surveyors (2)	Checked and digitized documents	*Gambar Ukur* (Measurement Form), Parcel Identifier Number (NIB)
Mapping	Land office officers (2)	Spatial data and boundary measurements in *Gambar Ukur* (Measurement Minute), Parcel Identifier Number (NIB)	*Peta pendaftaran* (Cadastre map)
Juridical Data Examination	Land office officer from right determination section, *Panitia A* (Adjudicator) (3)	Gambar Ukur, Parcel Identifier Number (NIB), checked and digitized documents	Spatial and juridical data announcement for objection, Validated land register entry
Recording in Land Register	Land office officers (3)	Validated land register entry	Updated land register, *warkah* (administrative source)
Issuance of Land Certificate	Head of land office (3)	Land Register	Land Certificate

2.3. Land Administration Proccess Problem

The implementation of the land administration process however is hindered with numerous challenges. Several studies have identified issues such as regulatory barriers and institutional obstacles (Lemmen et al., 2015; Silva & Silva T Bauer, 2007). These problems collectively impede the effectiveness of land administration processes, leading to delays, inefficiencies, and inaccuracies.

A significant problem is the lack of comprehensive and consistent land administration standards. This absence creates inefficiencies, as highlighted by Lemmen et al. (2015). Additionally, fragmentation and poor coordination among various institutions involved in land administration exacerbate these inefficiencies and result in significant delays (Nega et al., 2021). This study argues that the root of this problem is interoperability.

To address these issues, several solutions have been proposed. Implementing standardized frameworks such as the Land Administration Domain Model (LADM) can enhance consistency and efficiency in land administration (Lemmen et al., 2015). Improving interoperability through guidelines for achieving institutional cooperation ((Silva & Silva T Bauer, 2007). Effort also made by adopting a Fit-for-Purpose Land Administration to ensure that land administration systems developed fit the contexts and needs (Bennett et al., 2021b). Following previous research, focuses on tools that can help to address the interoperability problems within land administration. By examining the challenges of land administration

process in Indonesia, it aims to contribute to the development of more effective and efficient land administration systems.

2.3.1. Indonesia's Land Administration Process Problem

From the previous section, we can conclude that Indonesia has established a land administration system complete with processes, with land registers and cadastral maps as its foundation. Each process within the Certificate Issuance workflow can be viewed as a distinct system that necessitates different formats. The Ministry Regulation Number 3 of 1997 attempted to address this problem by standardizing the documents needed in every process and sub-process of certificate issuance. These documents serve as the data representation of what is being transferred from each process to the next. Historically, these standardized documents provided the mechanism for actor to interact between the process.

Over the years, numerous updates and amendments have been made to refine and improve the system. Most notably, the recent Regulation Number 3 of 2023 by the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency offers a significant opportunity to leverage technology in land administration. This regulation aims to digital environment for the certificate issuance process.

The first step in the land administration process is application retrieval. This involves the submission of application and original documents by the applicant, which include identification, proof of ownership, and detailed application data. These documents are meticulously checked and digitized by front officer to ensure their accuracy and completeness. The digitized documents are then used to create a set of records that serve as the basis for all subsequent steps in the land registration process.

If the application requires a survey, the next step is the measurement and mapping process. It starts with the measurement, where a surveyor from the land office or a licensed surveyor visits the site to carry out the task. The checked and digitized documents, including the applicant's identification and application data, are used as a formal basis to conduct a detailed survey of the land. This step involves the creation of a Gambar Ukur (Measurement Form) and the assignment of a Parcel Identifier Number (NIB). The measurement data and parcel identifiers collected during this survey are crucial for registering the boundary to the Cadastral Map. This step of registering the boundary to the Cadastral Maps called Mapping. This phase highlights one of the significant challenges in Indonesia, which is keeping the cadastral data current. Measurement form is necessary to update the Cadastral map. It is cumbersome to update parcel in this manner, as it requires to ensure that all records are aligned.

In the next step, a land office officer from the right determination section will match the spatial information obtained with the juridical information from the documents submitted by the applicant. The juridical data examination includes examining application data, applicant identification, proof of ownership, and parcel boundaries. If there are no discrepancies, this spatial and juridical data are validated as a land register entry. Ministry Regulation Number 3 of 1997 provides the standard for the output of this step as a document called *Berita Acara Pengesahan Data Fisik dan Data Yuridis* (Minutes of Physical and Juridical Data Validation). Issues might arise due to inconsistent data matching between the spatial information obtained and the juridical data from the applicant. These inconsistencies can lead to delays in the verification process, potential errors in the land register entry, and difficulties in integrating the data into the cadastral system. At worst, it might lead to disputes, highlighting the needs of mechanism for data matching to maintain the integrity of the land administration system. Before the recordation in land register, the spatial and juridical data is announced to muster objection from any concerned party. Only if no objections are declared can the data be recorded in the land register.

Once validated, the entries are then recorded in the land register. This step involves the conveyancing of the right from the verified spatial and juridical data into the land register. Ministry Regulation Number 3 of 1997 stipulates that the registration includes the of rights and the associated restrictions, such as limitations on the transfer of rights and land usage restrictions. It also stipulates the content and manner of filling out the land register, ensuring the documentation is legally compliant. This updated register serves as a formal and authoritative record of all legal statuses of land. The data in the land register is essential for maintaining accurate and current records of land ownership and rights.

Once the entries are recorded in the land register, the final step is the issuance of the land certificate. This certificate serves as the official proof of land ownership and consolidates all verified spatial and juridical data into one authoritative document. Ministry Regulation Number 3 of 1997 stipulates that the land certificate must be an exact reflection of the land registers. This is intended to provide the landowner with clear and undisputed proof of ownership. Therefore, every update in the registers also necessitates a corresponding update in the certificate to ensure accuracy and consistency.

All these steps can be summarized in Table 2.. The land administration process in Indonesia involves several meticulous steps, from application retrieval to the issuance of land certificates. Each step requires careful handling of both spatial and juridical data. The complexity of the land certification step arises from the need to accurately match the style of data received (output of the previous process) with the actual input needed for the next step. This complexity is especially pronounced when the data is being transferred from the Directorate General of Surveys and Mapping of Land and Space (2) to the Directorate General of Determination of Right and Land Registration (3).

One promising solution to address these challenges is the implementation of mechanisms to facilitate seamless data exchange between processes by standardizing the data needed as input for each process and ensuring the output can be efficiently utilized by the next process via endpoints. This can be realized through the development of API (Application Programming Interface). By utilizing clear data standards, protocols, and custom endpoints, an API can enable the various systems within the process to communicate and share information accurately. This standardization ensures that data are consistently formatted and readily accessible, improving coordination and reducing redundancy.

Table 2. Complexity of the submission and retrieval of certificate issuance

Step	Input		Output	
	Standardised as	Data Content	Standardised as	Data content
Application Retrieval (2) (3)	Application and original documents	Applicant's identification, Proof of ownership, Application data	Checked and digitized documents	Applicant's identification, Proof of ownership, Application data
Measurement (Survey) (2)	Checked and digitized documents	Applicant's Identification, Application data	*Gambar Ukur* (Measurement Form)	Measurement Data, Parcel Identifier Number
Mapping (2)	*Gambar Ukur* (Measurement Form), Parcel Identifier	Measurement Data, Parcel Identifier Number	*Peta pendaftaran* (Cadastre map) and *Peta Bidang Tanah* (Parcel	Parcel Boundaries

Step	Input		Output	
	Standardised as	Data Content	Standardised as	Data content
	Number (NIB)		map)	
…	…	…	…	…
Juridical Data Examination (3)	Gambar Ukur, Parcel Identifier Number (NIB), checked and digitized documents	Application Data, Applicant identification, Proof of ownership, Parcel Boundaries	Spatial and juridical data announcement for objection, Validated land register entry	Parcel Boundaries and Right Information
Recording in Land Register (3)	Validated land register entry	Parcel Boundaries and Right Information	Updated land register	Land Register Data
Issuance of Land Certificate (3)	Land Register	Land Register Data	Land Certificate	Land Certificate Data

2.4. Interoperability Standard in Land Administration

The universal definition of interoperability is the ability of two or more systems to exchange data and use the data exchanged without additional effort (de Lange, 2023). The interoperability of system can be categorized into technical interoperability, syntactic interoperability, semantic interoperability, and organizational interoperability (Rezaei et al., 2013). The technical interoperability focuses on the hardware and software components that need to work together (Rezaei et al., 2013). While syntactic involves the use of common data formats and protocols to ensure that the data can be understood at a basic level. It is achieved by the presence of structure of interfaced or data formats that exchanged within the systems (de Lange, 2023). Semantic interoperability goes a step further by ensuring that the meaning of the data is preserved across different systems. It means that the systems involved understand and can use the terms, data schema, and data model (de Lange, 2023). Finally, organizational interoperability addresses the ability of different organizations to effectively communicate and coordinate their processes and policies (Rezaei et al., 2013) For land administration systems, achieving organizations interoperability can lead to seamless data sharing, streaming process, and ultimately resulting in more efficient operations.

In land administration, the importance of interoperability cannot be overstated. The complexity of land administration processes necessitates the use of systems that can effectively communicate with each other(Lemmen et al., 2015). Therefore, it is critical to have tools and standards that enable effective communication between these various subprocesses. Standards serve as guidelines or frameworks that define common protocols, formats, and procedures for data exchange and interoperability (Hasselbring, 2000). Adoption standards such as those developed by voluntary consensus, such as the International Organisation for Standardisation (ISO) and the Open Geospatial Consortium (OGC) helps to ensure different able to communicate with each other. It is also important to highlight land administration is a type of geographic information (Kalantari et al., 2008).

2.4.1. ISO Standards for Land Administration

ISO, or the International Organisation for Standardisation, hosts various technical committees. Technical Committee 211, also known as ISO/TC 211, is dedicated to working on standards for geographic information (Kresse & Fadaie, 2004). This committee addresses matters such as the Land Administration Domain Model (ISO 19152:2012), Spatial Schema (ISO 19107:2003), Metadata (ISO 19115:2013), and Observations and Measurements (ISO 19156:2011). Despite the existence of several standards related to land administration, this study will primarily focus on the Land Administration Domain Model (ISO 19152:2012) in the implementation of digital systems.

The Land Administration Domain Model (LADM) is an international standard encompassing rights, responsibilities, restrictions, ownership, spatial units, and parties (Lemmen et al., 2015). It is structured around key essential packages to define land administration, including Rights, Responsibilities, and Restrictions (RRRs), Parties, and Spatial Units. RRRs articulate the legal and administrative aspects of land tenure, defining the relationship between land and subject matter. The Party package consists of legal entities that can be subjects or objects of legal relationships. Spatial Units define the concepts related to spatial units, including geometry and location. By clearly defining these components, LADM facilitates interoperability and standardisation across different jurisdictions and systems.

It is important to facilitate effective communication between components for interoperability between system. Hasselbring (2000) stated that effective communication can be achieved by defining common data models for the involved information sources. LADM in this context play a role in providing semantic for different information for land administration. Lee & de Vries (2020) stated that all land tenure-related data components include parties, legal/administrative units, spatial objects, and data on surveying and spatial representation. LADM should be able to facilitate diverse land administration system to interact seamlessly by establishing common language and structure.

2.4.2. Open Geospatial Consortium (OGC) Standards

The Open Geospatial Consortium (OGC) is an international organisation dedicated to developing and maintaining standards for geospatial and location-based services (Reichardt, 2017). The OGC focuses on establishing interoperable methods for data encoding, access, processing, visualization, and metadata and catalogue services. Among its many contributions, the OGC has developed several key standards for web services, including the Web Feature Service (WFS) and Web Map Service (WMS). Both are arguably excellent examples of how we could standardise access, manipulation, and visualisation for a wide range of applications and industries.

In web based geospatial services the use of WFS together with WMS will provide user view geospatial features on a web map and also interact with it. WFS standard provides a common interface for web services to request and receive geospatial feature data in a platform-independent format (Azevedo et al., 2007). It allows clients to retrieve specific features of interest from a web service, retrieve all features matching a query, and modify or delete features on the server. WMS provides a standard interface for web services to retrieve map images from a server in a platform-independent format (Azevedo et al., 2007). It allows clients to specify a geographical area of interest, a desired output format, and other parameters to customise the map image output. (Azevedo et al., (2007) also put emphasis of importance of modelling the knowledge of the domain on a formal basis, creating an ontology that serves as a conceptual schema of reference and allows the standardisation of the available geographic information syntax and semantic interface. The newest iteration of these standards is OGC API Standards.

The OGC API standards are a suite of standards developed by the Open Geospatial Consortium (OGC) that leverage contemporary web approaches (Hobona et al., 2023). It enables developers to implement

geospatial capabilities consistently between web APIs that handle or publish location data and maps. The OGC API Features standard specifies a service interface for accessing geospatial features, which are representations of spatial objects with vector-formatted geometry component via HTTP method (Lehto & Kähkönen, 2021). Therefore, allowing feature to interact with geospatial data using familiar HTTP methods like GET, POST, PUT, and DELETE. In the later section, the relationship between OGC API and the developed system will be explained further.

2.5. System Requirements

2.5.1. Legal Requirements

Adherence to legal frameworks should be one of aspect in defining a Land Administration System. Experts in Land Administration should understand that actors involved in land administration domain often bounded by the policy related to land tenure. Therefore, there should be a way to introduce this requirement for developing the system.

In requirement engineering, Otto & Anton (2007) vouch for the importance of identifying the regulations that apply to the system and extracting the relevant requirements, especially when defining a system that governed by regulation and law. By identifying and analysing the requirements of actors, software developers can ensure that the final product aligns closely with user needs, business goals, and regulatory constraints(Cheng & Atlee, 2007; Van Lamsweerde, 2000). In the realm of land administration systems, land policy plays a crucial role in shaping the functionality, usability, and accessibility of the system for the actors involved (Enemark, 2005). Therefore, incorporating the legal requirements into consideration for this study is essential for building robust and user-centric digital systems that promote transparency, efficiency, and equity in land management practices.

In this study, these requirements ensure that processes and data exchanges within the system are compliant with national laws and regulations. Regulations provide the legal framework for various administrative processes, outlining necessary steps, defining roles and responsibilities of actors, and specifying required documentation. Compliance with these regulations also helps mitigate legal risks and enhances the reliability and acceptance of the digital system among stakeholders.

2.5.2. Use Case Scenarios

A use case scenario represents a path of possible behaviour through a use case, which helps in elaborating requirements and connecting development tasks to the use context(Sutcliffe, 1998). These scenarios are crucial in describing system behaviours by system developers and validating requirements by customers(Shiota & Ohnishi, 2016). A Use Case is a structure of text, associated with a functional goal and usually a primary role or 'actor'.(Alexander & Maiden, 2004). For this study, the use case scenario is constructed to determine the necessary data for actors to interact and process the output within the workflow based on the legal requirements. If any information is missing or deemed inadequate, the interaction can be modified to streamline the process. API is then developed using the use case scenario as the (guide) for the input and output for each process.

Use case scenario in this study is used to captures the interactions between processes. The scenario outlines specific sequences of actions that each user undertakes within the workflow. This approach ensures that the API meets the functional requirements of all actors, enhancing the overall efficiency and reliability of the process.

2.6. Application Programming Interface

The common definition of API is a set of rules and protocols that define how different software applications interact with each other. API allow different systems to communicate and exchange data. The Web API (API), a subtype of API, facilitate data exchange over the internet. The structure of an API typically includes endpoints, request methods, and data formats, which facilitate the retrieval and submission of information. Understanding the structure is crucial for ensuring that different systems can exchange land-related data efficiently and accurately.

API is flexible, depends on the purpose and functionality, it can be structured in various ways. The design of API usually follows principles of Representational State Transfer (REST), utilizing HTTP methods such as GET, POST, PUT, and DELETE for data manipulation(R. T. Fielding & Taylor, 2002). Using API as implementations for data models is not something new. In data analysis software and system field, the data model implementation process uses a layered approach. The bottom layer provides a standard API to multiple file formats, the middle layer adds "meaning" to the data objects so that applications can be designed easily, and the top layer consists of actual tools and applications(Herrero et al., 1997). The intention is to make the system understand and correctly recall which fields in the data model corelates with the process. The latest version of API, REST-API, enables the public to be exposed to relevant information in simple JSON objects. It accesses a database system using middleware to generate JSON objects based on template files that call each field described in the data model and prints their content in a predefined structure (Wohner et al., 2022). Although, on this research the API is not intended to be publicly available. In this case, an additional layer would be needed to add ruling to the API so that only designates user with proper authentication can do the process.

The main idea of this study is to develop an API that ensures data related to land administration is comprehensible and usable by actors. This objective is achieved by designing an endpoint that is meaningful and directly useful to these actors. The endpoint is structured to facilitate both input and output functions: it allows stakeholders to submit requests and receive standardized responses that are easily interpretable and actionable. This is achieved by implementing RESTful principles in the design. As outlined by R. Fielding (2000) the use of RESTful principles in API design enhances scalability, interoperability, and the efficient management of interactions between clients and servers. The API adopt Land Administration Domain Model (ISO 19152:2012). The adoption of the standards is to ensure that the data exchanged through API is consistent. The endpoint is structured to facilitate both input and output functions: it allows actor to submit requests and receive standardized responses that are easily interpretable and actionable. Therefore, guide the interaction of actor and actor within a workflow via the system with the aim of actor can effectively engage with and utilize the API for comprehensive land administration tasks.

2.7. Research Approach

A research approach has been devised for this study to meet the research objectives. The overview of the research approach can be seen in Figure 4. Initially, a literature review was conducted to gain background knowledge on the existing land administration processes in the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN) in Indonesia. This review also included an examination of the current state-of-the-art land administration systems and processes in Indonesia to identify opportunities for improvement in the certificate issuance workflow at ATR/BPN.

Following the literature review, the study identified opportunities for improvement within the current land administration system. This involved a thorough analysis of the existing workflows, data management practices, and interoperability challenges. The next step was to identify the interactions between different actors within the certificate issuance process. This was achieved by analysing the inputs and outputs of each process, which were then mapped into use case scenarios. These use case scenarios provided a detailed depiction of the specific interactions and data exchanges required at each stage, facilitating a comprehensive understanding of the workflow and work as the basis for the subsequent redesign efforts.

Following the identification of actor interactions, the workflow for certificate issuance was redesigned. This redesign aimed providing mechanism for process to interact (exchange data) to facilitate smoother interactions among actors. The redesigned workflow sought to enhance data interoperability.

To support the redesigned workflow, the interaction requirements were determined. This involved specifying the data inputs and outputs for each step of the process, ensuring that these requirements were aligned with the overall objectives of the system. Clear and precise interaction requirements are fundamental for the successful implementation of the redesigned workflow.

Then, a data model was devised to standardize the data in the certificate issuance process. This model was based on the LADM (Land Administration Domain Model) country profile that Indonesia has adopted. Adjustments were made to ensure the model accurately reflected the specific requirements and nuances of workflows that this study devises. The data model provides attributes and data type for the Certificate Issuance API to work with.

Next, the API endpoints were created to facilitate seamless interactions between different components of the land administration system. The API endpoints were designed to ensure they could handle the data transactions required at each step of the certificate issuance. This involved specifying the structure of the requests and responses, ensuring that each endpoint could effectively facilitate the necessary interactions within the land administration system.

To support the API, a response body designed, outlining the data format and content that each endpoint should return. This response body includes all necessary data elements to ensure clarity and completeness in the data exchange, thus facilitating accurate processing and communication within the workflow.

To finalize this, a simple API endpoint test was conducted to check that the endpoints handle the requests properly. These tests involved sending requests to the API and verifying that the responses met the defined criteria, ensuring that the system performed as expected.

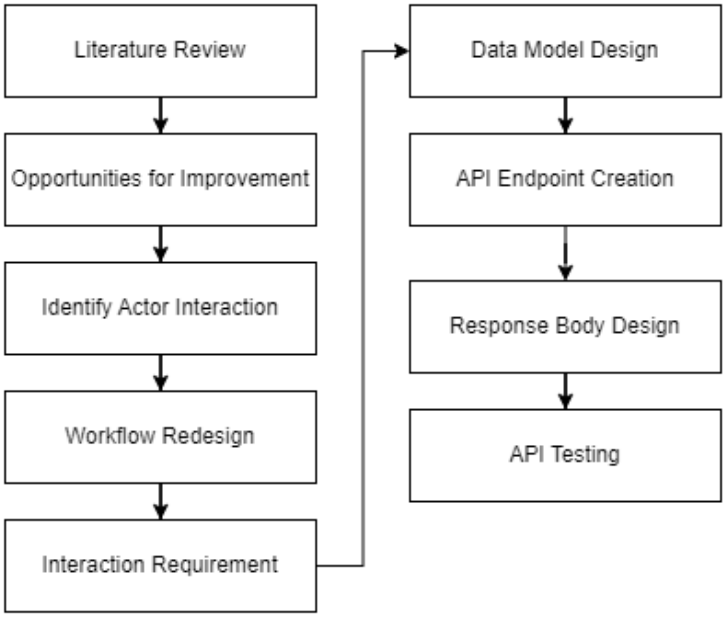


Figure 3. Overview of Research Approach

3. REDESIGNING INDONESIA'S CERTIFICATE ISSUANCE WORKFLOW

This chapter illustrates the approach that was carried out to develop the Application Programming Interface (API) for issuing digital land certificates in Indonesia. The structure of this chapter was based on the overview of the current workflow of the land administration system in the ministry. The study was based on reviewing and collecting information about the land administration's land policy, laws, and regulations in Indonesia. The chapter identified the actor, process, and data to determine how the potential API should be developed. These criteria are derived from Indonesia's legal frameworks. This chapter structured in a way to answer the 2nd objective of this research.

3.1. Indonesia's Certificate Issuance Workflow

Identifying how actors cooperate and re-designing the certificate was a priority to ensure the usability of the API that will be developed. This was done through reviewing regulation related to certificate issuance workflow. By thoroughly analysing these regulations, this study identified several key processes and redefine them to optimize the workflow.

The literature review revealed at least 22 laws and policies related to the certificate issuance workflow. The full list of these laws and policies is provided in Appendix C. For the process definition, this study identified five fundamental regulations:

1. **Ministry Regulation Number 3 of 1997**: This regulation is the cornerstone of the certificate issuance workflow in Indonesia. It establishes the basic procedures for issuing land certificates, including the necessary documentation and verification steps.
2. **Ministry Regulation Number 7 of 2019**: An amendment to Regulation Number 3 of 1997, this regulation introduces modernisation on the measurement (survey) techniques.
3. **Ministry Regulation Number 16 of 2021**: This third amendment to Regulation Number 3 of 1997 further elaborates on the procedures, particularly focusing on integrating digital solution to streamline the workflow.
4. **Ministry Regulation Number 18 of 2021**: This regulation outlines the roles and responsibilities of various actors involved in the land certificate issuance process, ensuring clearer accountability and coordination among them.
5. **Ministry Regulation Number 3 of 2023**: This recent regulation introduces the digital system for land certificate issuance. It adds new responsibilities for the front office, reintroduces processes such as Spatial Data Collection and Juridical Data Collection, and emphasizes the use of digital tools to enhance efficiency.

As outlined in the Regulation, the land certificate issuance process in Indonesia includes several key steps:

1. **Application Retrieval:** The applicant submits a formal request and original documents proving land rights.
2. **Measurement and Mapping:** Surveys are conducted to determine land boundaries and dimensions, producing a Measurement Form and a Parcel Identifier Number, which are integrated into national maps.
3. **Juridical Data Examination:** Juridical data is examined to confirm the land's legal status, addressing any issues as necessary.
4. **Recording in Land Register and Issuance of Land Certificate:** Verified land information is recorded in the land register. As soon as the land information recorded a certificate is issued to complete the registration process.

The steps outlined above represent the key phases of the land certificate issuance process, each playing a crucial role in ensuring the accuracy, legality, and efficiency of land registration. These steps, from application retrieval to the issuance of the final land certificate, form the backbone of Land Certificate Issuance workflow. According to the Ministry Regulation No.3 of 1997, Indonesia has at least 3 workflows related to land certificate issuance, including First-time Land Registration in Sporadic Project, First-time Land Registration in Systematic Project, and Land Registry Maintenance.

First-time Land Registration in Sporadic Project

The First-time Land Registration in Sporadic Project workflow in Indonesia follows a generic sequential step as depicted in Figure 4. The process begins with the applicant submitting a formal request for land registration. This initiates the certificate issuance workflow. Next, the land undergoes a thorough survey to determine its boundaries and dimensions. Following this, juridical data related to the land is collected and examined to verify its legal status, ensuring no disputes or issues could hinder registration. This step involves comparing land records, ownership documents, and other relevant legal data to the data obtained from the survey. This step also involves announcing the survey and mapping result with the juridical data to amass objection from related party. After verifying the juridical data, the information is recorded in the land register, officially recognising, and documenting the land in the registry. Subsequently, a land certificate is issued to the applicant, completing the registration process. These steps are the daily operation in the land office of ATR/ BPN.

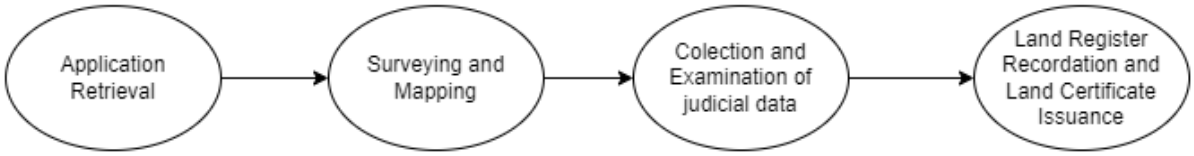


Figure 4. Generic First-time Land Registration in Sporadic Project workflow

First-time Land Registration in Systematic Project

The next workflow is the First-time Land Registration in a Systematic Project. Unlike the Sporadic Project, this workflow begins with project preparation and is initiated by ATR/BPN rather than by the applicant. An example of this workflow's implementation is the current PTSL. Following the initial preparation phase, which includes steps like location determination, preparation, and task force formation, the subsequent steps are similar to those in the Sporadic Project. It's crucial to note that, in the systematic approach, certificates are processed in a bundle, typically within an administrative area. After the certificates are issued, it is imperative to document the results and outcomes of the project meticulously. This documentation ensures transparency, traceability, and serves as a vital reference for future governance and administrative purposes, thereby enhancing the overall efficiency and reliability of the land administration system. These steps can be visualized in Figure 5.

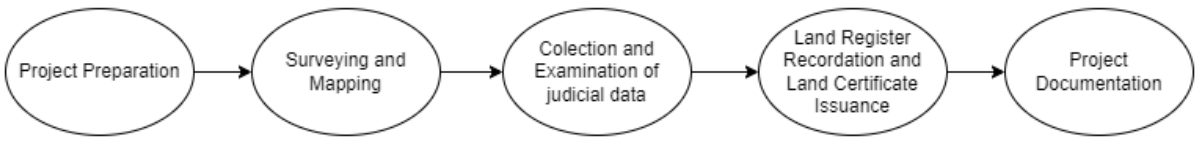


Figure 5. Generic First-time Land Registration in Systematic Project workflow

Land Registry Maintenance

The third workflow is the Land Registry Maintenance. Similar to the First-time Land Registration in Sporadic Project, this workflow begins with Application Retrieval, where the applicant submits a formal request. However, the applicant must also provide a deed that legalizes any changes in the land, triggering

a change in the land registry. This necessitates an additional step, Registration Transfer of Right, where the deed must be validated before it can be used as the basis of change in the land registry. Following this, the land undergoes Surveying and Mapping to update any changes in boundaries and dimensions, reflecting the current state of the property. The next step, Collection and Examination of Judicial Data, involves verifying the legal status of the land by comparing land records, ownership documents, and other relevant legal data to the updated survey information. After confirming the juridical data, the updated information is recorded in the Land Register. The final step is the Land Certificate Issuance, where a new or updated land certificate is issued to the rightful owner, completing the maintenance process. This systematic approach ensures that the land registry remains current, accurate, and reliable, thereby enhancing the efficiency of land administration and providing up-to-date records for future reference and governance. These steps are depicted in Figure 6.

Figure 6. Generic Land Registry Maintenance workflow

In summary, these workflows for land certificate issuance, including the First-time Land Registration in Sporadic and Systematic Projects, as well as Land Registry Maintenance, form the cornerstone of land tenure functions in Indonesia. It is also important to highlight that other than the systematic land registration, all of the certificate issuance workflow starts with retrieval of applications and includes the key steps such as surveying and mapping, the collection and examination of judicial data, and the formal recording of information in the land register. These workflows ensure that the land registry remains up-to-date, accurate, and legally sound. Mapping these processes as workflows is essential to understanding the interactions between various actors involved to ensure seamless communication and coordination.

3.2. Actor Interaction

Having established the workflows for land certificate issuance, the next step is to examine the interactions between the actors within these workflows. According to Ministry Regulation 3 of 1997, these actors interact using standardized physical documents to ensure consistency and compliance with legal requirements. This section analyses these interactions by examining the standardized physical documents, checking the outputs of each process, and understanding what data and information are used in subsequent processes.

The first interaction to be observed is between the Application Retrieval stage and the Measurement stage. According to Ministry Regulation 3 of 2023, the front office processes data provided by the applicant, including personal identification, proof of ownership, and application details. This data is digitized and checked for completeness, creating a digital record. However, according to Ministry Regulation 3 of 1997 surveyor only needs to have the personal identification of the applicant and application details during the Measurement stage to conduct physical measurements of the land. This interaction is illustrated in Figure 7.

The next interaction to be examined is between the Survey and Measurement process and the Juridical Data Inspection stage. According to Ministry Regulation 3 of 1997, the surveyor needs to provide the

measurement form (gambar ukur) to the Mapping Officer to have the parcel mapped to *Peta Pendaftaran* (Cadastral Map) or *Peta Bidang Tanah* (Parcel Map). Measurement form contains physical measurements of the parcel, which identified by a unique parcel number. This mapped data is then used in the Juridical Data Collection and Examination stage to verify the legal status of the land. There is no clear indication how the data is actually used to clarify. However, it states that the output of Juridical Data Collection and Examination is a *Berita Acara Pengesahan Data Fisik dan Data Yuridis* (Minutes of Physical and Juridical Data Validation) which contain the parcel and the parcel identifier number. These interactions visualised in Figure 8.

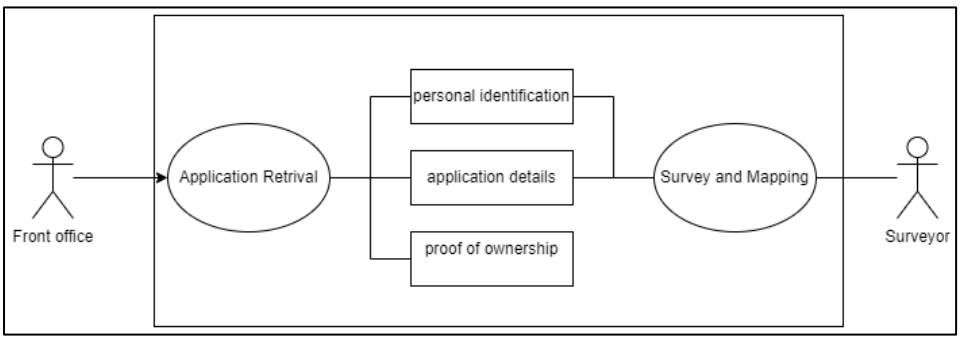


Figure 7. Interaction between Application Retrieval and Survey and Mapping

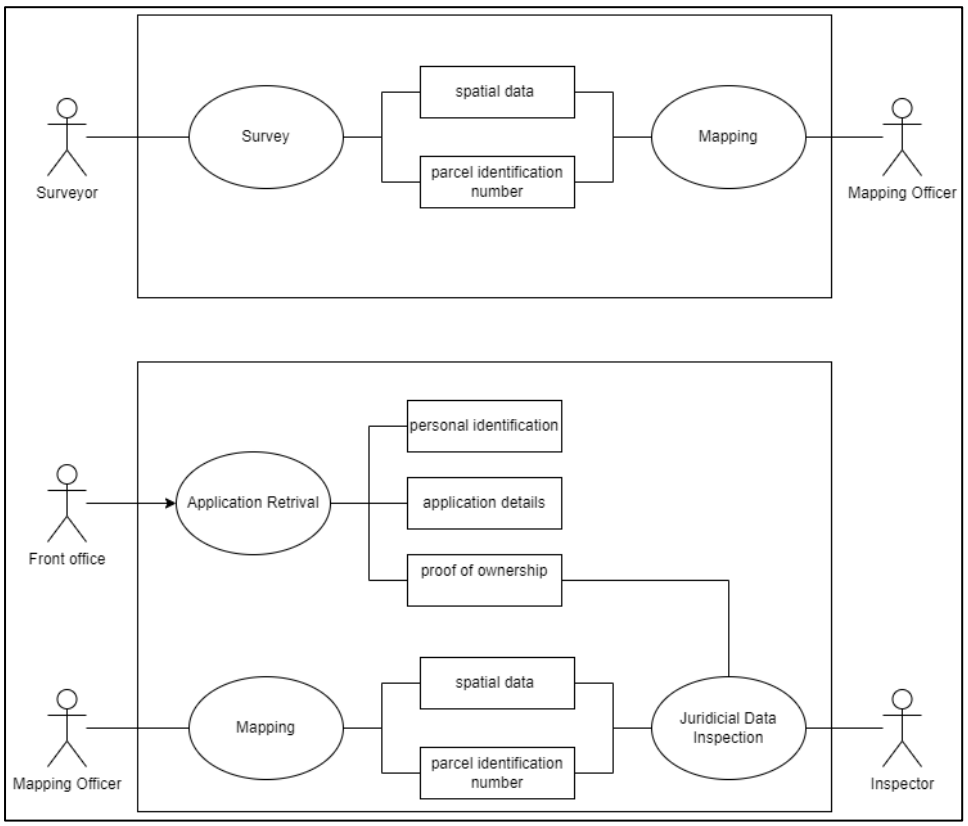


Figure 8. Interaction between survey and mapping (top); Interaction between Mapping and Judicial Data Inspection (bottom)

According to the Ministry Regulation upon validation, a snippet of the parcel from Cadastre Map and the conclusion of Judicial Data Inspection is passed to land officer that responsible for land register, who formally record the validated entries in the land register. This record includes data such as the Parcel Identifier Number, area, Map Number, encumbrance status, and possession status. The entries is stored

along with the documents related to the identity and history of the rights, known as *warkah*. Therefore, providing a reliable reference for all future transactions and claims related to the land parcels. The interaction between Juridical Data Inspection and Land Register Recordation can be visualised in Figure 9.

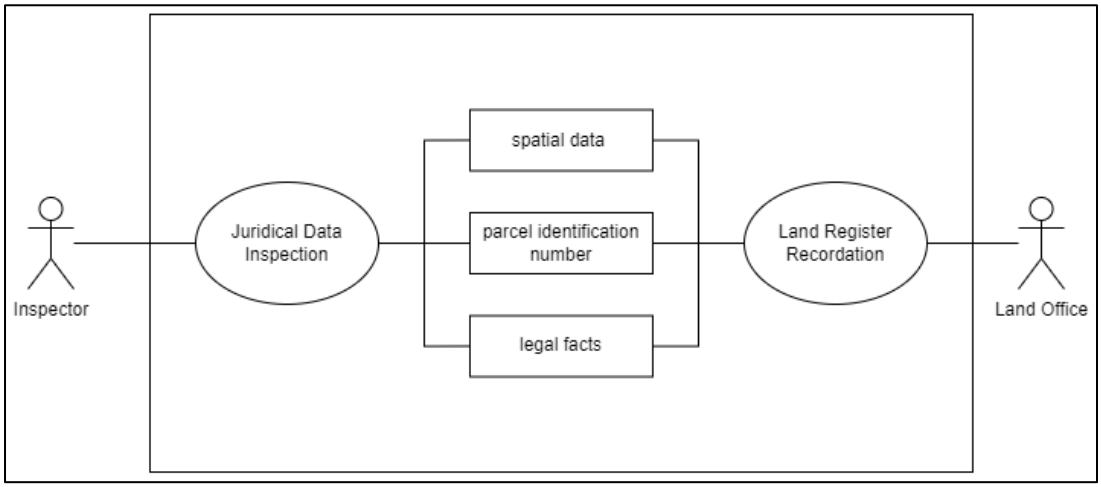


Figure 9. Interaction between Juridical Data Inspection and Land Register Recordation

Finally, in the Issuance of the Land Certificate stage, the head of the land office uses the information from the land register to issue a new land certificate. Land certificate is seen as a summary of the land record, consolidating all verified spatial and juridical data into one official document. This certificate provides the landowner with clear and undisputed proof of ownership, reflecting the comprehensive validation and accurate recording of all relevant data throughout the preceding stages. The interaction is depicted in Figure 10.

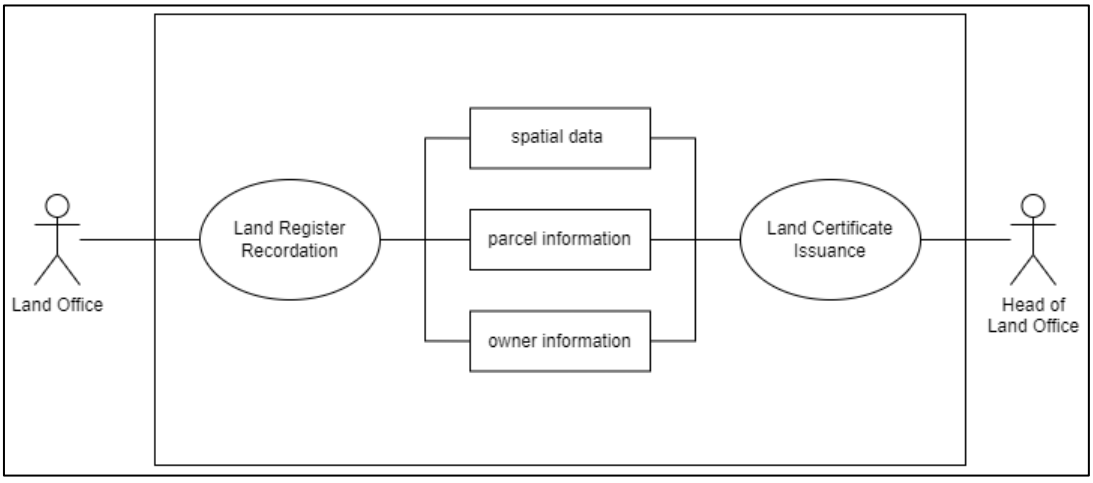


Figure 10. Interaction between Juridical Data Inspection and Land Register Recordation

Through careful examination of each interaction within the current land certificate issuance process, several potential inefficiencies and areas for improvement have been identified. The lack of clarity regarding when spatial data and juridical data are joined may arise from overlapping responsibilities between the Juridical Data Examination and the Recording in the Land Register stages. Additionally, the absence of a formal mechanism to manage applications and assign tasks within the workflow may contributes to bottlenecks and inconsistencies in the land certificate issuance workflow. These observations underscore the need for a more streamlined and integrated approach to the land certificate

issuance process, ensuring clear roles and responsibilities, and a cohesive management system to enhance the effectiveness of land administration.

3.3. Redesigned Indonesia's Certificate Issuance Workflow

As part of this study, several significant changes have been proposed to enhance the land certificate issuance process in Indonesia. These modifications address the observations and identified challenges in Section 3.2:

1. **Change to Survey and Mapping**
    - The Survey and Mapping process is transformed into a spatial data collection process.
    - This process now can be done by Surveyor.
2. **Change to Juridical Data Inspection**:
    - The Juridical Data Examination process is transformed into a prequalification process.
    - This process now not only examines the legal status of the land but also prepares it as a rights register, ensuring a thorough legal check early in the process.
    - The process of registering deeds (registration transfer of right) is included in the prequalification process.
3. **Integration of Parcel and Juridical Data**:
    - The Recording in Land Register process now focuses on integrating the parcel and juridical data.
    - With the verification of rights moved to the prequalification stage, the data recording step becomes more streamlined and accurate, involving the creation of a Land Register where the Cadastral Map and the Rights Register are joined.
4. **Introduction of Application Management**:
    - An Application Management process is introduced, providing an additional phase for the front office to manage the application.
    - This ensures that the application complies with regulations before moving forward.
5. **Introduction of Assignment Task Process**:
    - An Assignment Task process is added, involving the assignment of the checked application to the appropriate process.
    - This aims to further clarify roles and improve the overall management of the land certificate issuance process.
6. **Parallel Processing of Surveying and Prequalification**:
    - It is suggested that the Surveying and Prequalification processes become parallel activities.
    - This allows for the simultaneous gathering of spatial data and the legal verification of land, reducing the overall processing time and improving efficiency.

These changes are suggested with the development of the API in mind. The changes also include applying the API as the interface between the processes, facilitating seamless data exchange and integration. The redesigned workflow, illustrated in the diagram 11, begins with **Application Retrieval**, where applicants submit their requests. This is followed by the **Application Management** phase, where the front office reviews and ensures compliance with regulations. Once the application is managed, it moves to **Assignment Management**, where tasks are assigned to the appropriate processes. From here, two parallel activities commence: **Prequalification** and **Spatial Data Collection**. Prequalification involves the legal verification of land, transforming juridical data into a rights register. Simultaneously, Surveyors collect spatial data, streamlining the Survey and Mapping process. Both prequalified juridical data and spatial data are then integrated in the **Land Register Management** phase, where a unified Land Register is created, combining the Cadastral Map and the Rights Register. Finally, this comprehensive and verified data leads to the **Land Certificate Issuance**, where a new land certificate is issued, consolidating all verified information into one official document.

This workflow is also capable of running the Land Registry Maintenance despite being developed as a single workflow. This is achieved by the Assignment Manager, who has the authority to decide which tasks need to be assigned based on the nature and requirements of the maintenance activities. The Job Manager in **Application Management** phase can determine the appropriate steps for processing the application, changing the workflow instances by determine which phase is the next …. For example, a Land Registry Maintenance (Updates) due to legal activities might not need to be surveyed. So that the application will be sent to the prequalification to update the right register, subsequently to the registrar to update the land register. Meanwhile, an update due to changes in boundary changes shall not need the prequalification since it only needs to update the Cadastral Map, subsequently the land register. This hypothetical workflow instances is visualized in Figure 12 and 13.

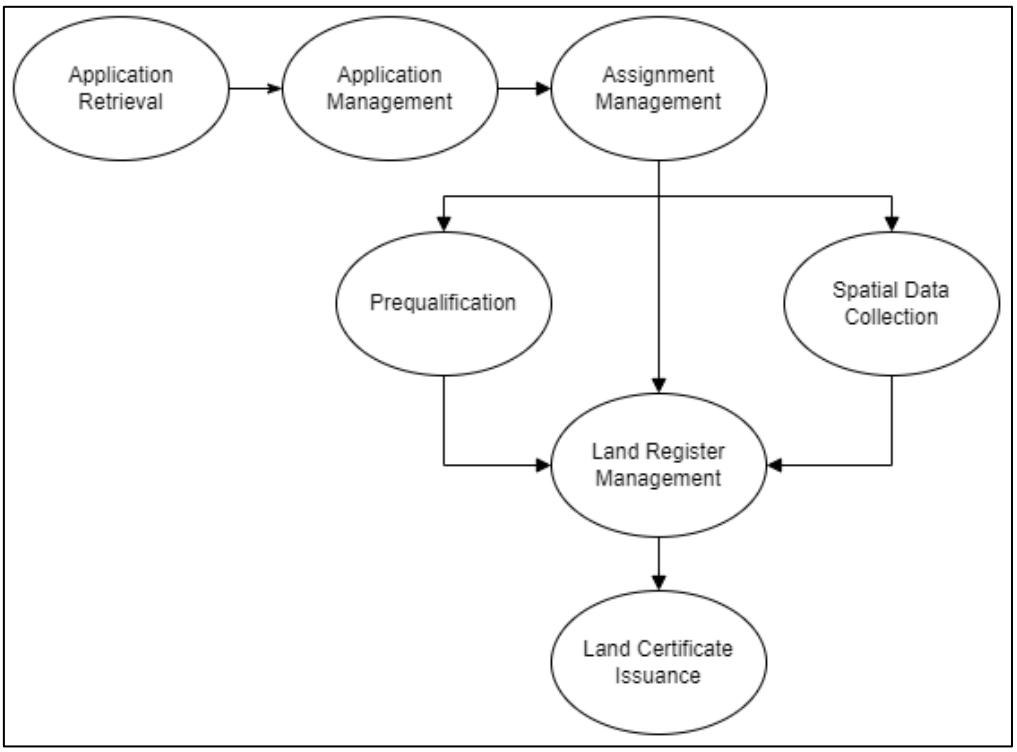
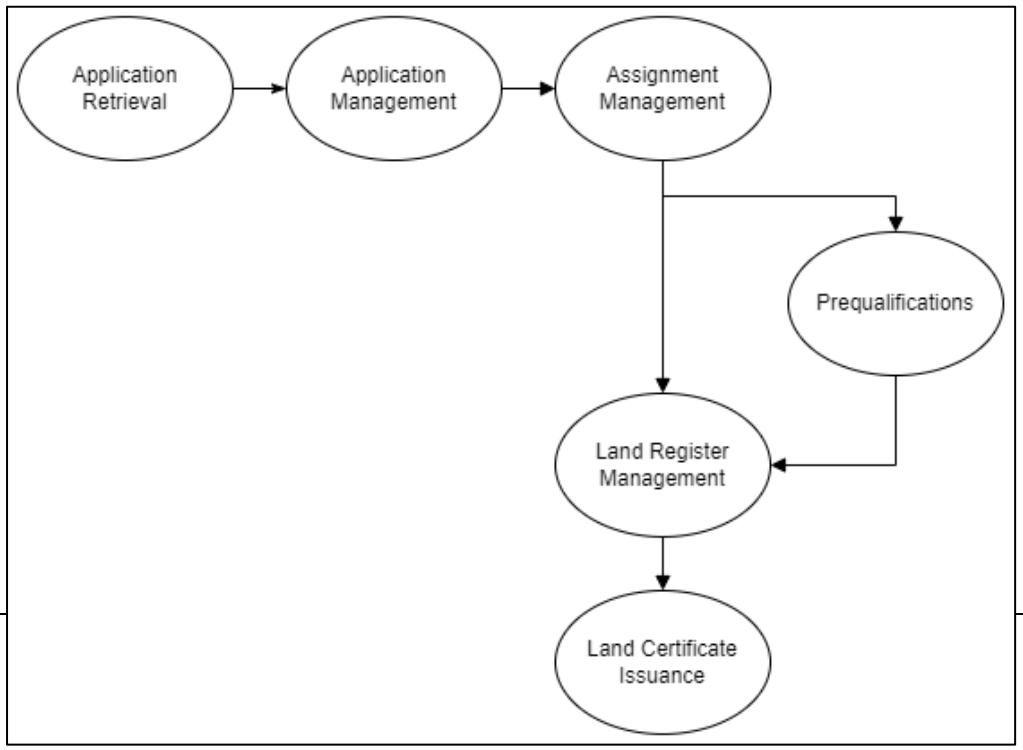


Figure 11. Redesigned Indonesia's Certificate Issuance Workflow



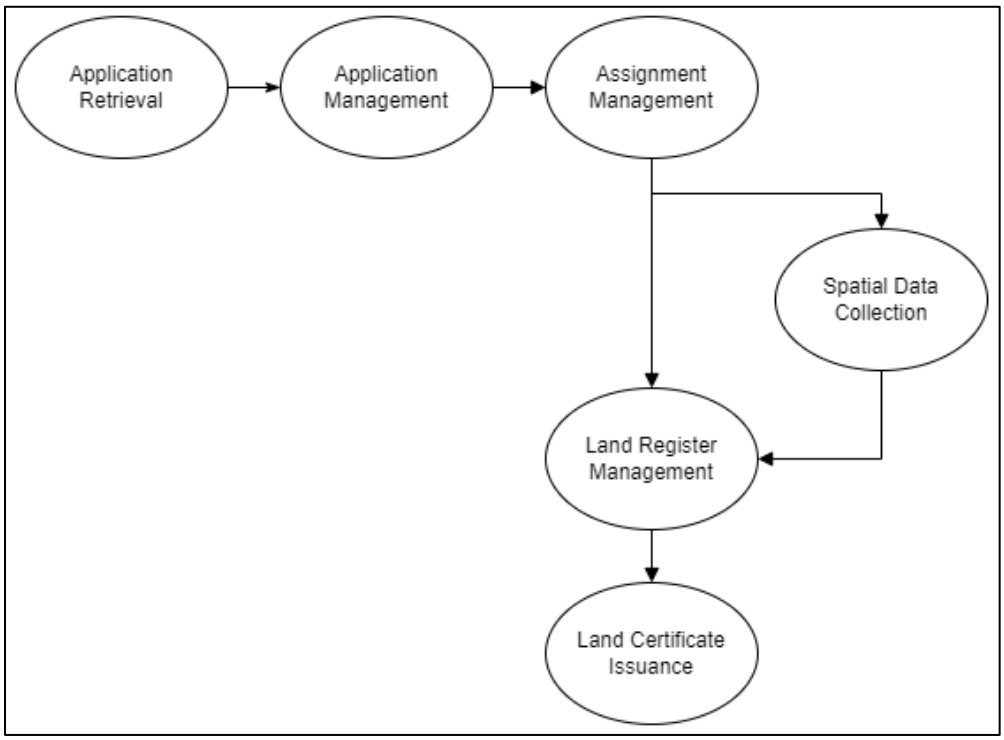


Figure 12. Redesigned Workflow for updating land register due to legal activities

Figure 13. Workflow for updating land register due to boundary changes

3.4. Requirements for Interaction

To ensure the API works as intended, it is essential to define the requirements for interaction between the various actors and processes involved in the land certificate issuance workflow. The prerequisites and conditions necessary for the functioning and seamless data exchange among these processes are detailed as requirements. Each step in the process will have a dedicated requirement that specifies the data being transferred. By aligning with the relevant Ministry Regulations, the workflow ensures compliance with the legal framework.

The process of land certificate issuance is structured into several distinct use cases to ensure clarity and compliance with Ministry Regulations. Each use case represents a specific step in the workflow, detailing the necessary inputs and outputs, as well as referencing the relevant regulations that govern these activities. For instance, the Application Retrieval use case involves the submission and retrieval of documents by the applicant, guided by Ministerial Regulation No. 3 of 1997, Act 73. The Application Management use case ensures the application complies with regulatory standards, as stipulated in Ministerial Regulation No. 3 of 2023, Acts 7–10. The Job Assignment phase, newly introduced to bridge the gap between application management and subsequent processes, involves the job manager assigning the appropriate department for further processing without violating any existing regulations. In the Spatial Data Collection use case, surveyors conduct site visits and gather necessary data, as mandated by Ministerial Regulation No. 3 of 1997, Acts 24–30 and 77–81, and Ministerial Regulation No. 3 of 2023, Acts 11–13. The Prequalification use case, also a new process introduced to closely resemble the Juridical Data Examination, involves examining the legal status of the land, guided by Ministerial Regulation No. 3 of 1997, Acts 86–88. The Recording in Land Register use case integrates parcel and juridical data into the

official register, following Ministerial Regulation No. 3 of 2023, Acts 89–90, and Ministry Regulation No. 18 of 2021. Finally, the Issuance of Land Certificate marks the conclusion of the process, with the issuance of the land certificate to the applicant, as directed by Ministry Regulation No. 3 of 2023, Acts 91–93. The considerations of these regulations are incorporated into the requirements. However, this study focuses on the inputs and outputs of each use case.

Requirement 1 for Application Retrieval Use Case

- **Description:** The process of retrieving and submitting documents
- **Input:**
  - **Requirement 1.1** Applicant can submit at least 3 documents, including: personal identification, application details, and proof of ownership.
- **Output:**
  - **Requirement 1.2** Front office retrieves the application documents.

Requirement 2 for Application Management Use Case

- **Description:** The process that ensure the application complies to the regulation
- **Input:**
  - **Requirement 2.1** Front office can access the application documents.
  - **Requirement 2.2** Applicant or Front office can update the application documents.
- **Output:**
  - **Requirement 2.3** if checked complete, the front office submit the checked documents to the job manager.

Requirement 3 for Job Assignment Use Case

- **Description:** A process that assigns the checked application to the appropriate subsequent process.
- **Input:**
  - **Requirement 3.1** Job Manager can access the checked documents.
- **Output:**
  - **Requirement 3.2** Job Manager can decide the appropriate step (department) and actor for further processing and send the job assignment with the apropriate application information.

Requirement 4 for Spatial Data Collection Use Case

- **Description:** The process of surveying, where surveyor of land office or licensed surveyor visit the site.
- **Input:**
  - **Requirement 4.1** Surveyor can receive job assignment.
  - **Requirement 4.2** Surveyor can access the application details, and applicant personal information.
- **Output:**
  - **Requirement 4.3** Surveyor can submit the completed survey data and measurements, including parcel identification number, parcel boundaries and measurement point.
  - **Requirement 4.4** Surveyor can update the parcel to the cadastre map.

Requirement 5 for Prequalification Use Case

- **Description:** The process that examines the legal status of the land
- **Input:**

  - **Requirement 5.1** Inspector can receive job assignment.
  - **Requirement 5.2** Inspector can access application details, applicant personal information, and proof of ownership.
- **Output:**
  - **Requirement 5.3** Inspector can validate the legal information.
  - **Requirement 5.4** Inspector can create the right register.

Requirement 6 for Recording in Land Register Use Case

- **Description:** The process that integrate parcel and juridical data into Land Register
- **Input:**
  - **Requirement 6.1** Registrar receives job assignment.
  - **Requirement 6.2** Registrar can access application details, applicant personal information, and proof of ownership.
  - **Requirement 6.3** Registrar can access the prequalification.
  - **Requirement 6.4** Registrar can access the measurement files.
- **Output:**
  - **Requirement 6.3** Registrar can access the right register and link it to the cadastre map.
  - **Requirement 6.4** Registrar can submit the new and updated land register.

Requirement 7 for Land Certificate Issuance

- **Description:** The process that marks the end of the application
- **Input:**
  - **Requirement 7.1** Head of the land office able to access the land register.
- **Output:**
  - **Requirement 7.2** Head of the land office issue the land certificate to the applicant.

4. API DEVELOPMENT

This chapter discusses the implementation of the API structure for the land certificate issuance process in ATR/BPN, Indonesia. In Chapter 4, workflows were created to describe the certificate issuance process in ATR/BPN. This chapter focuses on the development of the API, detailing the data model of the land certificate issuance to provide the API with the necessary structure for data transfer. The requirements established in Section 3.4 serve as guidelines for developing the API.

4.1. Data Model

A data model was devised to provide structure to the API before defining the endpoints. This data model references the Land Administration Domain Model (LADM), with modifications to satisfy the specific requirements of the involved stakeholders. It is important to highlight that Indonesia has its own country profile in the LADM (Indrajit et al., 2020). However, the country profile of Indonesia lacks a defined spatial unit. To address this gap, the data model also draws inspiration from the Ministry Regulation Number 3 of 1997. This approach is also intended to ease the integration of existing land records in Indonesia into the system, ensuring compatibility and continuity without disrupting the current processes.

The diagram of the data model is provided in Figure 13. It describes the relationship between entities such as "Party", "Application", "AdministrativeSource", "Deed", "AssignmentDocument", "Right", "Mortgage", "Parcel", "MeasurementFile", and "MeasurementPoint". Each entity is defined with attributes that capture the necessary information for the API to function effectively.

The first entity is "Party". This entity includes attributes like 'partyName', 'partyIdNumber', 'partyIdType', and 'partyRoleType'. This entity models the person involved in the process. For example, an Applicant will have need to give his/her name, ID number, and ID type. As an applicant it will also have the role type of Applicant.

The design of the Party entity is derived from Ministerial Regulation Number 3 of 1997, Articles 171-172 about *daftar nama* (holder name list), especially Article 172, which states:
(1) *The name of the right holder and their date of birth or the number/date of their founding deed is written according to the name and date of birth or number/date of the founding deed written in the first land book that forms the basis for creating the name card.*

Next, the "Application" has attributes such as 'applicationNumber', 'applicationType', 'applicationStatus', 'applicationRetrivalDate', 'applicationCompletionDate', and 'applicationVerificationDate' as its attributes. These attributes ensure comprehensive tracking of each application from submission to completion and verification. The 'applicationRetrivalDate' denotes the precise date on which the Applicant submits the application. Meanwhile, the 'applicationCompletionDate' signifies the date when the Front Office officially records the application as completed. Additionally, the 'applicationVerificationDate' indicates the date on which the Front Office forwards the application to the Job Manager for further processing.

The design of the Application entity is derived from Ministerial Regulation Number 3 of 1997, Articles 181-183 about *daftar permohonan* (the application list) and *daftar penyelesaian pekerjaan*(job submission list), especially Article 183, which states:
(1) The list of job submission results contains data regarding the date of submission or retrieval of the activity results, the name and address of the applicant, the application list number, the results of the work received, the name and identity of the recipient's address, the recipient's signature, and a remarks column.

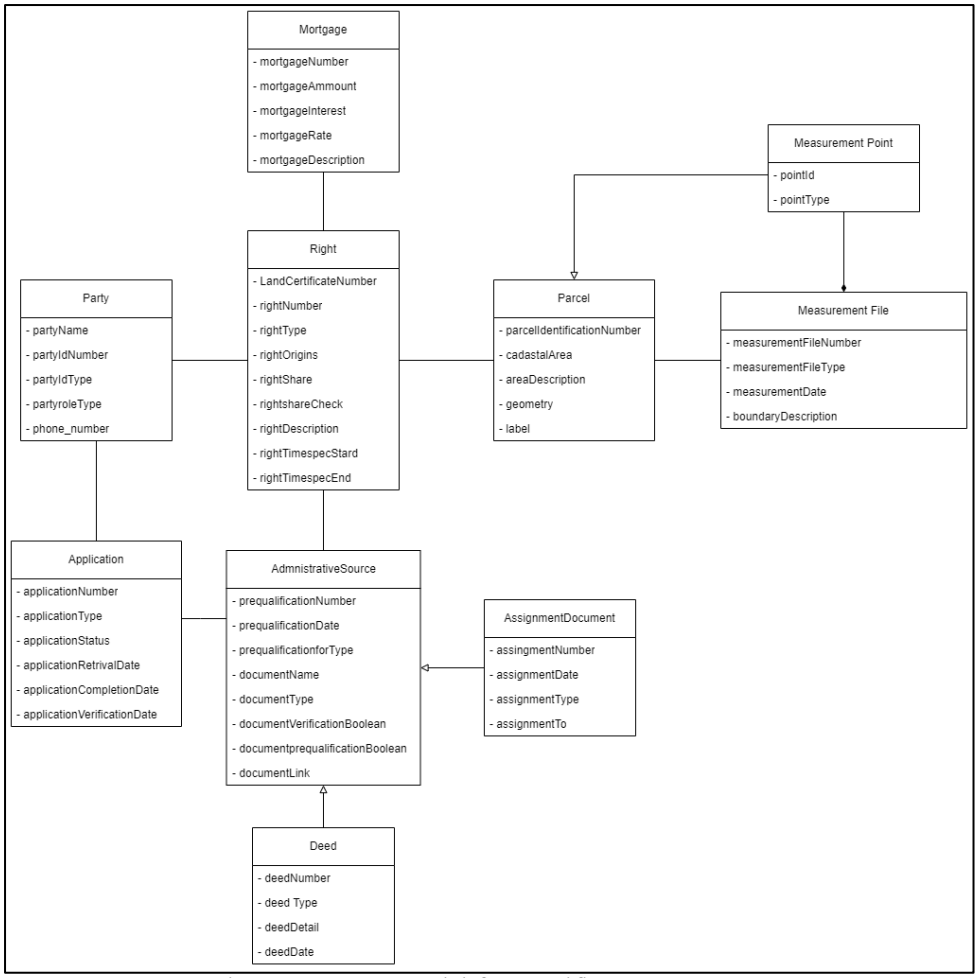


Figure 13. Data Model for Certificate Issuance

Furthermore, the "AdministrativeSource" entity entity comprises attributes like 'documentName', 'documentType', 'documentVerificationBoolean', 'documentLink', 'prequalificationNumber', 'prequalificationDate' and 'documentprequalificationBoolean'. This entity captures the administrative documents and legal references that support the land registration process. Additionally, this entity ensures that each application is accompanied by the necessary documents, which are then checked and verified by the Front Officer. In the later stages of the land registration process, these documents are prequalified by the Inspector to confirm their validity and relevance, ensuring they meet the required standards before the application will be used as information to updates the land register.

Within the "AdministrativeSource" entity, there is a specific type of document called "AssignmentDocument". This document involves attributes such as 'assignmentNumber', 'assignmentDate', 'assignmentType' and 'assignmentTo'. The "AssignmentDocument" captures all necessary details related to the task assignments within the land registration process. It ensures that every assignment is documented, specifying who is responsible for each task and when it was assigned.

Another specific document within the "AdministrativeSource" entity is "deeds" entity. This entity contains attributes such as 'deedNumber', 'deedType', 'deedDetail', and 'deedDate'. Looking at the design of API endpoints in section 5.1 there is no indication of using deeds in a use case. However, according to the regulations for issuing land certificates, land deeds are essential for legal compliance. This is because

applications for updates necessitate deeds to legally bind the activities. Therefore, the document deed is included within the "AdministrativeSource" entity to ensure comprehensive data coverage.

Moreover, the "Right" entity is designed to capture the rights, responsibilities, and restrictions associated with a land parcel. Its attributes include 'LandCertificateNumber', 'rightNumber', 'rightType', 'rightOrigins', 'rightShare', 'rightShareCheck', 'rightDescription', 'rightTimespecStart', and 'rightTimespecEnd'. This entity documents legal information as part of the land registers. Simplification was made to include'LandCertificateNumber', as per regulations, each right correlates with one certificate. This entity corresponds to the RRR (Rights, Responsibilities, and Restrictions) in LADM, which describes the legal and administrative relationship between parties and spatial units.

The design of the Right entity is derived from Ministerial Regulation Number 3 of 1997, Article 180 about the *daftar hak* (right list), which states:
(2) *The right list is made for each type of right and contains data on the right number, Land Parcel Identification Number (NIB), date of registration, date of certificate issuance, and other information.*

Within "Rights" there is entity called "Mortgage". It incorporates attributes like 'mortgageNumber', 'mortgageAmmount', 'mortgageInterest', 'mortgageRate', and 'mortgageDescription'. This entity registers encumbrances associated with the land parcel. It also does not have any endpoints related to the operational workflow but is captured to provide a complete picture of the land administration system in Indonesia.

Following that, the "Parcel" entity represents the physical land units. In Indonesia, the parcel is the only unit of registration. It includes attributes such as 'parcelIdentificationNumber', 'cadastralArea', 'geometry', 'label'. These attributes are essential for identifying and describing the land parcels accurately, ensuring that each unit is uniquely registered and clearly defined within the land administration system. This entity corresponds to the spatialunits in LADM.

The design of the "Parcel" entity is derived from Ministerial Regulation Number 3 of 1997, Article 146 – 154 about the *daftar tanah* (parcel list), especially article 147 and 148 which states:
Article 147 (1) : In column 1 of the parcel list, the Land Parcel Identification Number (NIB) is written.
Article 148 : In column 2 of the parcel list, the area of the concerned land parcel in square meters is recorded.

Next, The "MeasurementFile", entity stores data related to Survey and includes attributes like 'measurementfileNumber', 'measurementfileType', 'measurementDate', and 'boundaryDescription'. These attributes are crucial for documenting the specifics of spatial data collection, ensuring that all measurement activities are recorded and properly referenced within the land administration system.

Lastly, the "MeasurementPoint" entity captures specific data points from the Survey. Attributes include 'pointID' and 'pointType'. "MeasurementPoint" is a component of the "Parcel" entity and is associated with the "MeasurementFile" entity. Essentially, "MeasurementFile" contains "MeasurementPoints" which are used to create and define the "Parcel".

Looking back to the requirements outlined in Section 3.4 reveals that nearly all necessitate three critical pieces of information: Applicant Data, Legal Information, and Spatial Data. These elements correspond directly with the Land Administration Domain Model's (LADM) Party, Right, and Spatial Unit components. This alignment underscores the rationale for adopting LADM as the foundational data model for this study. Additionally, it is imperative to consider the stipulations set forth in the Ministry

Regulation Number 3 of 1997, which this study references to ensure the legal compliance of the land certificate API.

4.2. API Endpoint Structure

The Certificate Issuance API facilitates seamless communication and data exchange between the various actors involved in the land certificate issuance process within ATR/BPN, Indonesia, via Hypertext Transfer Protocol (HTTP). Developed using the Open API specification and adhering to REST principles, this API enables effective communication between different processes by providing endpoints throughout the workflow. The actors are intended to input data and receive output via these endpoints. The overall workflow and endpoint structure of the Certificate Issuance API are visualized in Figure 14.

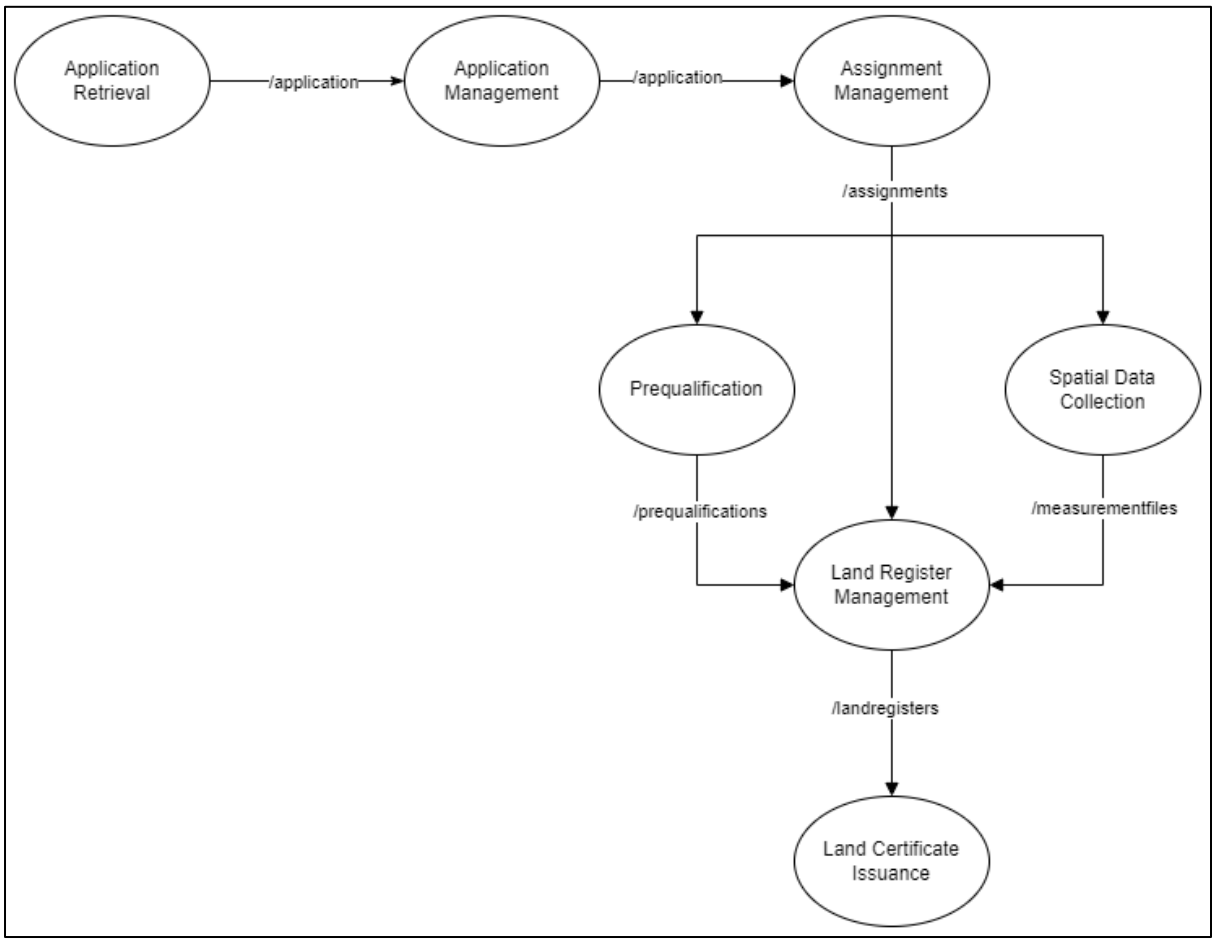


Figure 14. The certificate issuance workflow with endpoints

The actors interact with the endpoints, which are designed using the requirements specified in section 3.4, serving as the rules that govern inputs and outputs. Adhering to these requirements ensures that each interaction conforms to the standardized processes and data formats necessary for seamless communication. For each of the endpoints, a specific HTTP method is designated to handle the corresponding actions, such as GET for retrieving data, POST for submitting data, PUT for updating existing records, and DELETE for removing entries.

The API endpoints facilitate different stages of the workflow. Below is an explanation of each endpoint and its role in the process, along with the associated requirements:

1. **Endpoint /applications**
   - **Description:** Connects Application Submission, Application Retrieval, and Application Management.
   - **Requirements:**
     - *Requirement 1.1:* Applicant can submit at least 3 documents, including personal identification, application details, and proof of ownership.
     - *Requirement 1.2:* Front office retrieves the application documents.
     - *Requirement 2.1:* Front office can access the application documents.
     - *Requirement 2.2:* Applicant or Front office can update the application documents.
     - *Requirement 2.3:* If checked complete, the front office submits the checked documents to the job manager.
     - *Requirement 3.1:* Job Manager can access the checked documents.
   - **Endpoints:**
     - **GET /applications:** Retrieve all application documents.
     - **POST /applications:** Submit new application documents.
     - **GET /applications/{applicationNumber}:** Retrieve specific application details.
     - **PUT /applications/{applicationNumber}:** Update specific application details.

2. **Endpoint /applications**
   - **Description:** Connects Application Management to Prequalification, Spatial Data Collection, and Land Register Management
   - **Requirements:**
     - *Requirement 3.2:* Job Manager can decide the appropriate step (department) and actor for further processing and send the job assignment with the apropriate application information.
     - *Requirement 4.1:* Surveyor can receive job assignment.
     - *Requirement 4.2:* Surveyor can access the application details, and applicant personal information.
     - *Requirement 5.1:* Inspector can receive job assignment.
     - *Requirement 5.2:* Inspector can access application details, applicant personal information, and proof of ownership.
     - *Requirement 6.1:* Registrar receives job assignment.
   - **Endpoints:**
     - **POST /assignments:** Create a new job assignment.
     - **GET /assignments/{assignmentType}:** Retrieve assignments by type.
     - **GET /assignments/{assignmentType}/{assignmentNumber}:** Retrieve specific assignment details.

3. **Endpoint /prequalifications**
   - **Description:** Connects Application Management to Prequalification and Land Register Management
   - **Requirements:**
     - *Requirement 5.3:* Inspector can validate the legal information.
     - *Requirement 5.4:* Inspector can create the right register.
     - *Requirement 6.3:* Registrar can access the prequalification.
   - **Endpoints:**
     - **GET /prequalifications:** Retrieve all prequalification records.
     - **POST /prequalifications:** Submit new prequalification records.
     - **GET /prequalifications/{prequalificationType}:** Retrieve prequalifications by type.
     - **GET /prequalifications/{prequalificationType}/{prequalificationNumber}:** Retrieve specific prequalification details.

4. **Endpoint /measurementfiles**
   - **Description:** Connects Spatial Data Collection to Prequalification and Land Register Management

- **Requirements:**
  - *Requirement 4.3:* Surveyor can submit the completed survey data and measurements, including parcel identification number, parcel boundaries and measurement point.
  - *Requirement 4.4:* Surveyor can update the parcel to the cadastre map.
  - *Requirement 6.2:* Registrar can access the measurement files.
- **Endpoints:**
  - **GET /measurementfiles:** Retrieve all measurement files.
  - **POST /measurementfiles:** Submit new measurement files.
  - **GET /measurementfiles/{measurementfileNumber}:** Retrieve specific measurement file details.
  - **GET /measurementfiles/{measurementfileNumber}/points/:** Retrieve all points in a measurement file.
  - **GET /measurementfiles/{measurementfileNumber}/points/{pointID}:** Retrieve specific point details.

5. **Endpoint /land register**
   - **Description:** Connects Application Management to Prequalification and Land Register Management
   - **Requirements:**
     - *Requirement 6.3:* Registrar can access the right register and link it to the cadastre map.
     - *Requirement 6.4:* Registrar can submit the new and updated land register.
     - *Requirement 6.5:* Registrar can delete entries in land register
     - *Requirement 7.1:* Head of the land office able to access the land register.
     - *Requirement 7.2:* Head of the land office issue the land certificate to the applicant.
   - **Endpoints:**
     - **GET /landregisters/:** Retrieve all land registers.
     - **POST /landregisters/:** Submit new land registers.
     - **PUT /landregisters/{landCertificateNumber}:** Update specific land register details.
     - **DELETE /landregisters/{landCertificateNumber}:** Delete specific land register entries.

These endpoints were designed based on the specified requirements to ensure that all operations are performed consistently and efficiently across the API. Each HTTP method is designated to handle specific actions such as retrieving (GET), submitting (POST), and updating (PUT) data, facilitating clear and effective communication between the various actors involved.

Additionally, several other endpoints are designed to handle specific tasks within the process. For example:

- **/parcels** : Used to visualize points within measurement files as parcel.
- **/invitations** : Provides invitations for applicants during the spatial data collection phase.
- **/deeds** : Manages deed records.
- **/mortgages** : Manages mortgage records.

The full structure of the API can be found in Table 3.

Table 3. API Endpoint Structure

Certificate Issuance API
Application Submission and Managing Application
• `GET /applications` • `POST /applications` • `GET / applications/{applicationNumber}` • `PUT /applications/{applicationNumber}`
Assignment Management
• `POST /assignments` • `GET /assignments/{assignmentType}` • `GET /assignments/{assignmentType}/{assignmentNumber}`
Spatial Data Collection
• `GET /measurementfiles` • `POST /measurementfiles` • `GET /measurementfiles/{measurementfileNumber}` • `GET /measurementfiles/{measurementfileNumber}/points/` • `GET /measurementfiles/{measurementfileNumber}/points/{pointID}` • `GET /parcels` • `POST /parcels` • `GET /parcels/{parcelidentificationNumber}` • `PUT /parcels/{parcelidentificationNumber}`
Juridical Data Inspection
• `GET /prequalifications` • `POST /prequalifications` • `GET /prequalifications/{prequalificationType}` • `GET /prequalifications/{prequalificationType} /{prequalificationNumber}`
Land Register Management
• `GET /landregisters/` • `POST /landregisters/` • `PUT /landregisters/{landCertificateNumber}` • `DELETE /landregisters/{landCertificateNumber}`
Additional Endpoint
• `GET /mortgages/` • `POST /mortgages/` • `PUT /mortgages/{mortgagesNumber}` • `DELETE /mortgages/{mortgagesNumber}` • `GET /deeds/` • `POST /deeds/` • `PUT /deeds/{deedsNumber}` • `DELETE /deeds/{deedsNumber}` • `GET /invitations/` • `POST /invitations/` • `PUT /invitations/{invitationNumber}`

4.3. Response formats for Certificate Issuance API

The response format for the Certificate Issuance API is designed to ensure clarity, consistency, and completeness of the data exchanged between the various actors involved in the process. Each API response is structured in a standardized JSON format, providing a uniform way to represent data. When an endpoint is accessed, such as /applications or /assignments, the server returns a JSON response that includes key-value pairs representing the requested data fields. For this study, the endpoints such as /applications, /assignments, /measurementfiles, /prequalifications, and /landregisters are structured to provide detailed information relevant to their specific functions.

The JSON responses from these endpoints contain data fields pertinent to the application process, assignment details, measurement files, prequalification information, and land register entries, respectively. Each response also includes relevant links to other resources, facilitating easy navigation and integration between different stages of the workflow. This linkage is crucial for maintaining the flow of information and ensuring that each actor involved in the process can access the necessary data efficiently.

The requirements specified in section 3.4 helped identify the necessary data fields and the type of information that needs to be exchanged between different actors in the land certificate issuance process. The response formats for each endpoint can be found in Appendix D.

5. API IMPLEMENTATION

This chapter present the results that show how the API implementation in land certificate issuance in ATR/BPN. It details the technological framework used and describe the process of handling the request. It chooses a scenario to show how the API can handle data submission, data retrieval and updating operation.

5.1. Technological Overview

The prototype utilises Node.js as the foundational coding platform, with Express.js facilitating back-end development for the web application. The API begins with the client, which could be a user or a front-end application, sending a request to the server. This includes services for creating, retrieving, and updating applications. This request is directed to the Express server, which is the middleware layer responsible for handling routing and processing incoming requests. The Express server operates within the Node.js, serving as the middleware that manages these operations. Upon receiving the request, Node.js interacts with various database tables to fetch or update the required data from the table. This technological overview is summarized in Figure 15.

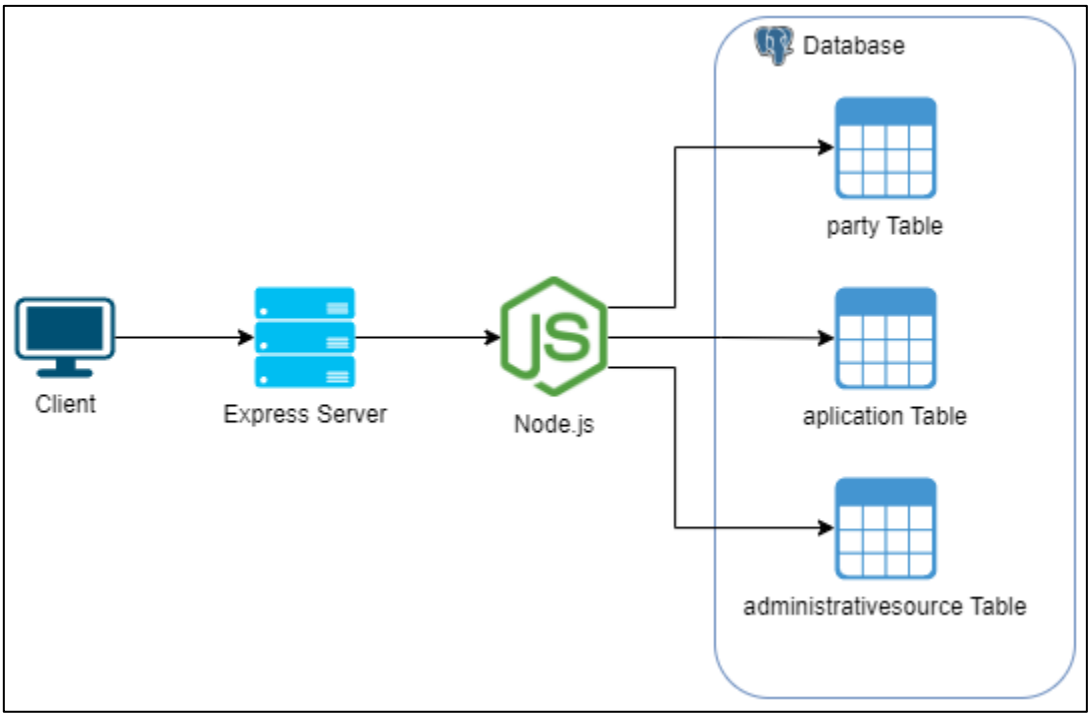


Figure 15. Technological Framework

The interaction between Node.js and the database is facilitated by the PostgreSQL database management system, connected via the pg module. Within the Node.js environment, a custom database module defines the structure for querying and updating data in the database. This module establishes a connection pool to efficiently manage database connections, ensuring optimal performance and scalability for handling concurrent user requests. Queries are executed asynchronously using async/await syntax, allowing non-blocking operations, and enhancing responsiveness in handling multiple client interactions simultaneously.

In addition to database interactions, the API employs middleware functions within Express.js to enhance functionality and security. Middleware such as express.json() parses incoming JSON data from client requests, enabling seamless integration with the application's data processing logic. A simple error handling mechanisms are integrated throughout the middleware layers and database operations, ensuring robustness by catching and appropriately responding to exceptions. This approach not only improves the reliability of the application but also provides informative error messages to users or client applications in case of unexpected events.

The architecture also incorporates RESTful principles, defining clear and predictable endpoints for different operations such as creating, retrieving, updating, and deleting application data. Each endpoint corresponds to specific HTTP methods (e.g., POST, GET, PUT) that define the type of operation being performed. This standardized approach simplifies API usage and promises interoperability with various client applications or third-party services that consume the API.

5.2. Scenario: Seamless Data Integration between Application Retrieval and Managing Application

To test the seamless data integration between the Application and Retrieval and Managing Application system, this study implementeded the `/Applications` endpoint of the API. This process involves several steps:

1. **Submission of Applications**: This Study has implemented the `POST /Applications` endpoint to allow applicants to submit their applications. This endpoint accepts the application data and stores it within the system.
2. **Accessing the Application:** The output from the Application Retrieval process, which is generated when an applicant submits an application, is used as the input for the Managing Application system. In this scenario, the front office staff can access specific applications using the `GET /Application/{applicationNumber}` endpoint. By providing the application number, they can retrieve all relevant details about a particular application, ensuring they have the information needed to proceed with processing.
3. **Application Management Output:** Once an application has been reviewed and completed, the front office can update its status by providing a checked date using the `PUT /Application/{applicationNumber}` endpoint. This marks the application as reviewed and completed, updating the system accordingly.
4. **Job Manager Integration**: The job manager needs to have the *application checked* to complete the Assignment Management process. The Job Manager can utilise the `GET /Application/{applicationNumber}` endpoint in this scenario. This allows the Job Manager to access specific applications, ensuring that all relevant personnel in the next step have the necessary data to continue the Certificate Issuance Workflow.

5.2.1. Verification using API Client

To verify the developed API, the operations described in Section 5.2 were performed using the API client, Requests, followed by verification in pgAdmin to ensure data integrity and correct operation. As shown in Figure 16, a POST request was submitted using Insomnia to the endpoint http://localhost:8000/application/. The request included a JSON body, as described in Section 4.3. Upon successful submission, the server responded with a status message indicating "Application submitted" and a status code of 200 OK, confirming the request was processed correctly. This can be seen as an applicant submitting the application through a user interface that interacts with the endpoint. Then, the application is stored in the database.

In this scenario, the endpoint interacts with the database using the data model described in Section 4.1. The application itself contains information for the schema applicant, application, and administrative source. In this interaction, the request updates the database accordingly, ensuring that all related data is processed and stored as intended. Figures 17 - 19 present the result of the request from the operation within pgAdmin tables.

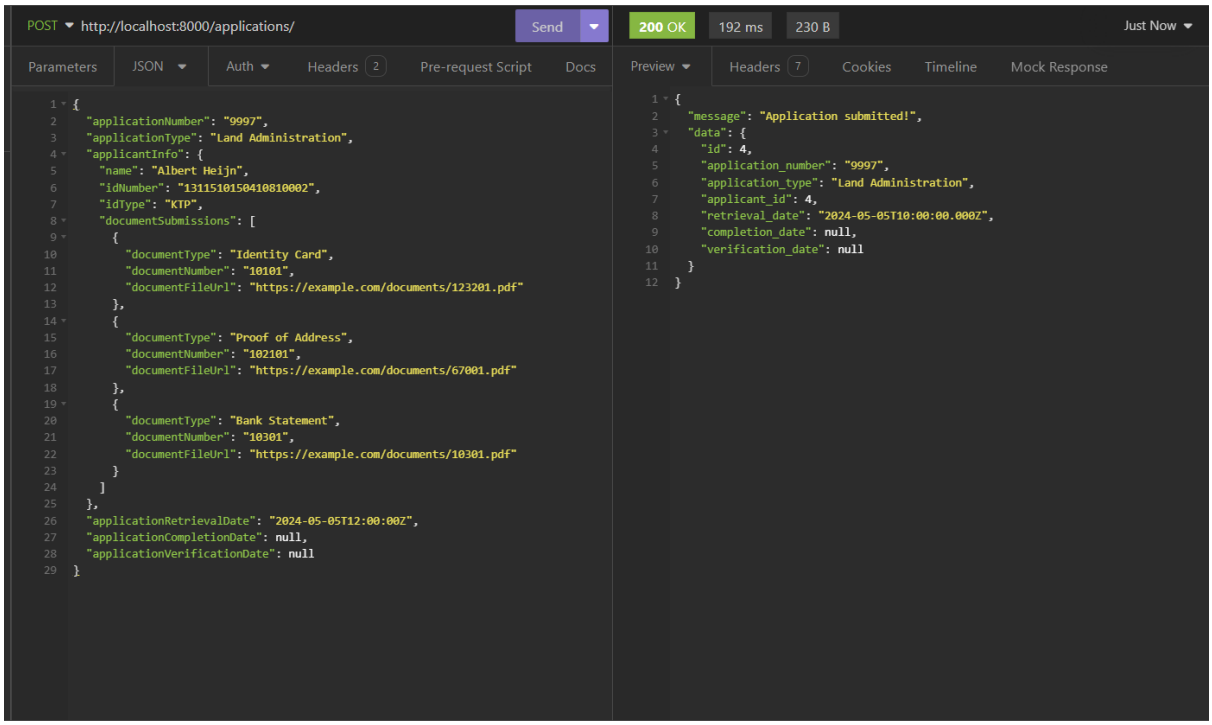


Figure 16. POST operation in Insomnia

	id [PK] integer	application_number character varying (255)	application_type character varying (255)	applicant_id integer	retrieval_date timestamp without time zone	completion_date timestamp without time zone	verification_date timestamp without time zone
1	1	9999	First Registration	1	2024-05-06 06:00:00	[null]	[null]
2	2	9998	First Registration	2	2024-05-06 10:00:00	2024-05-06 10:00:00	[null]
3	4	9997	Land Administration	4	2024-05-05 12:00:00	[null]	[null]

Figure 17. Verification of Application Schema in PgAdmin

	id [PK] integer	document_type character varying (255)	document_number character varying (50)	document_file_url text	application_id integer
1	11	Passport	ABC123456	https://example.com/documents/passport_abc123456.pdf	2
2	12	Driver's License	XYZ987654	https://example.com/documents/driver_license_xyz987654.p...	2
3	13	Passport	789879564	https://example.com/documents/passport_9879798.pdf	1
4	14	Driver's License	7897987979	https://example.com/documents/driver_license_78979879.pdf	1
5	15	Identity Card	10101	https://example.com/documents/123201.pdf	4
6	16	Proof of Address	102101	https://example.com/documents/67001.pdf	4
7	17	Bank Statement	10301	https://example.com/documents/10301.pdf	4

Figure 18. Verification of administrativesource schema in PgAdmin

	id [PK] integer	name character varying (255)	id_number character varying (255)	id_type character varying (50)
1	1	Kayuza Miasma	1311510150410810007	KTP
2	2	Jim Mishima	1311510150410810006	KTP
3	4	Albert Heijn	1311510150410810002	KTP

Figure 19. Verification of applicant schema in PgAdmin

Next, a GET request was executed to retrieve the details of the submitted application. The request was directed to the endpoint http://localhost:8000/applications/9997, as shown in Figure 20. The server responded with a JSON object containing information from the database.

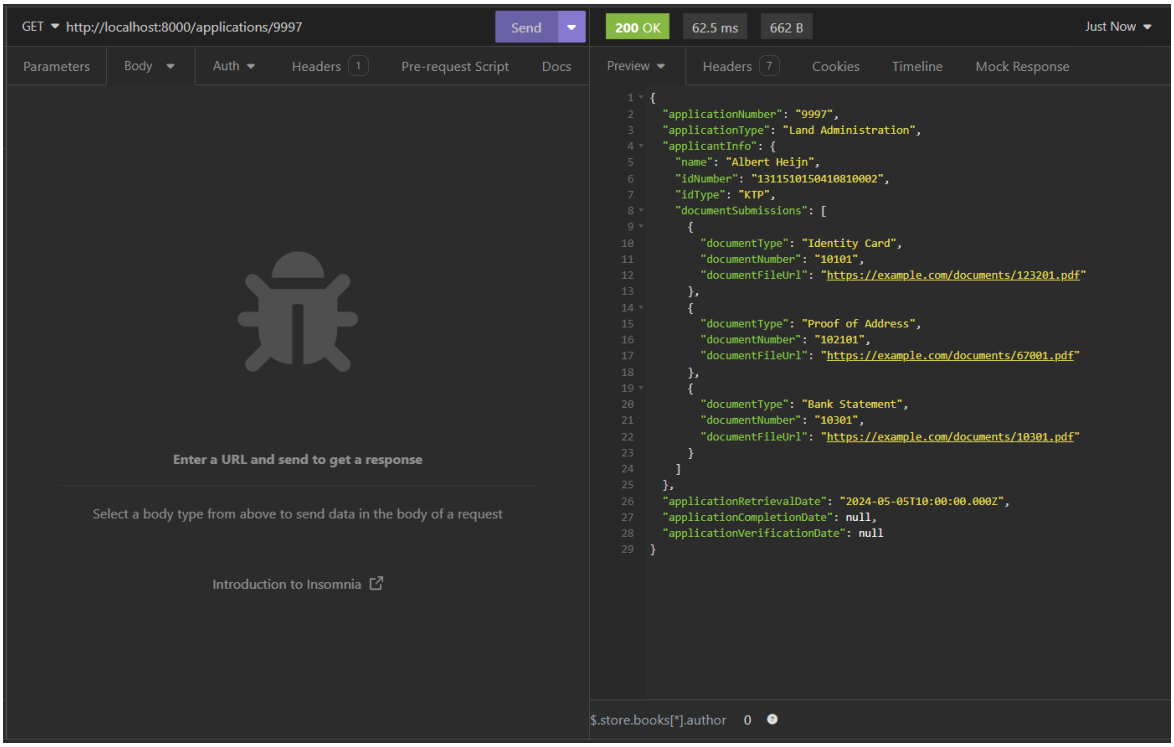


Figure 20. GET operation in insomnia

In this example, the request was for applicationNumber "9997". The response includes the applicationType "Land Administration". It also provides the applicant's information, such as the name "Albert Heijn" and identityNumber "1311510510418010002". Additionally, the documentSubmissions array lists the documents submitted: an "Identity Card", "Proof of Address", and "Bank Statement", each with their respective document numbers and URLs. The applicationRetrievalDate is "2024-05-05T10:00:00.000Z", while the applicationCompletionDate and applicationVerificationDate are null, indicating these steps are yet to be completed. This step mimics the scenario when the front office wants to retrieve information about application number "9997" to perform a check. The next operation involves the front office completing their process.

The next step involved performing a PUT request to update the application details. The request was made to the endpoint http://localhost:8000/applications/9997, as shown in Figure 21. Similar to before, a request body was included with the request. The server responded with a message "Application updated successfully" and a status code of 200 OK, indicating that the update was processed correctly. This step

simulates the scenario where the front office marks the application as complete and ready to be sent to the job manager.

To verify the update, the database schema was checked using pgAdmin. The corresponding record in the database was examined to confirm that the completion_date and verification_date fields were updated accurately. The data in pgAdmin showed the application_number "9997" and application_type "Land Administration" with the updated timestamps for completion_date and verification_date, validating that the PUT request effectively updated the application data in the database. The result within the pgAdmin tables can be seen in Figure 22.

The last step involves integrating with another actor. In this scenario, the actor can utilise the GET /Application/{applicationNumber} endpoint, as shown in Figure 20. This scenario can be reimagined as the Job Manager needs access to the checked application to proceed with the Assignment Management process. This endpoint allows the Job Manager to access specific applications, ensuring that all relevant personnel in the next step have the necessary data to continue the Certificate Issuance Workflow.

By executing a GET request to http://localhost:8000/applications/9997, the Job Manager can retrieve comprehensive details of the application, including the applicationNumber, applicationType, applicant information, and document submissions. The JSON response provides a structured view of the application's current state. This ensures that the Job Manager can efficiently manage assignments and maintain the workflow's integrity by having up-to-date information on each application. This request is shown in Figure 23.

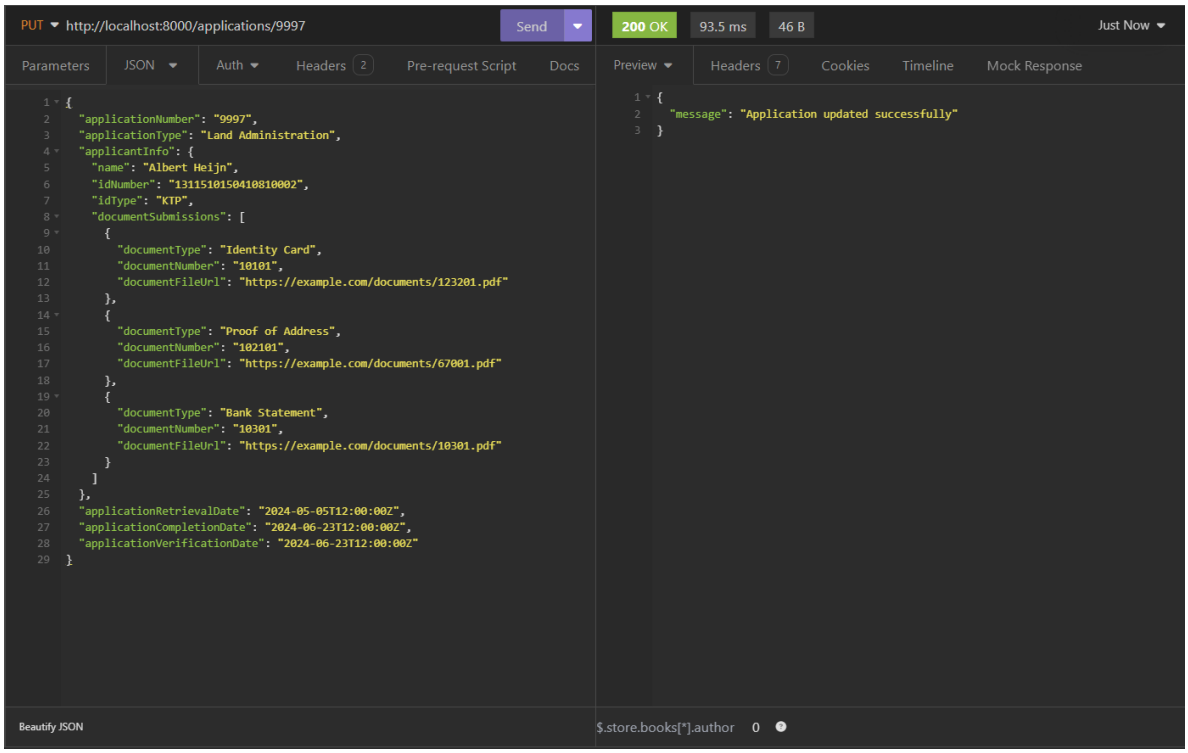


Figure 21. PUT operation in insomnia

	id [PK] integer	application_number character varying (255)	application_type character varying (255)	applicant_id integer	retrieval_date timestamp without time zone	completion_date timestamp without time zone	verification_date timestamp without time zone
1	1	9999	First Registration	1	2024-05-06 06:00:00	[null]	[null]
2	2	9998	First Registration	2	2024-05-06 10:00:00	2024-05-06 10:00:00	[null]
3	4	9997	Land Administration	4	2024-05-05 12:00:00	2024-06-23 12:00:00	2024-06-23 12:00:00

Figure 22. Verification of application schema in PgAdmin

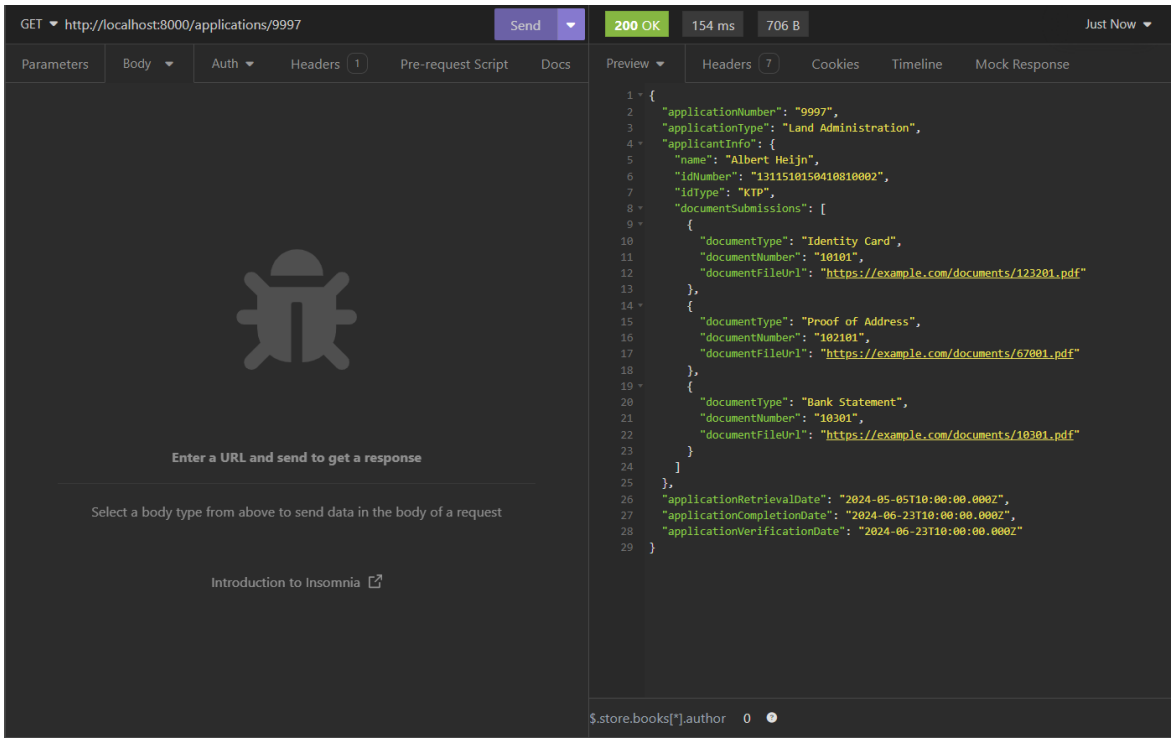


Figure 23. Post operation in Insomnia

6. DISCUSSION

This chapter contains discussion regarding what is the implication of this study and highlights the assumptions made during the research.

6.1. Indonesia's Land Administration Process Problem

In Chapter 2, the literature review sets the foundation by examining the existing land administration systems and their operational frameworks in Indonesia. From the literature review it can be concluded that Indonesia has rigid regulatory structure for the certificate issuance workflow that does not align with technological capabilities. This regulatory framework relies heavily on documented processes for input and output, necessitating meticulous handling of physical documents at each step. These documents serve as the primary means of data transfer between different stages of the process, from application submission to certificate issuance. This reliance on paper-based methods introduces an invisible step where the output documents need to be manually processed before use as input for subsequent processes.

In reality, it is hard to gauge this as a problem, since the current processes have been in place for many years and are deeply embedded in the institutional practices of ATR/BPN. However, with the ongoing digital transformation, the limitations of the existing framework need to be assessed further. The manual processing of documents not only introduces delays and potential errors but also hinders the ability to respond swiftly to changes and updates in land records.

6.2. Redesigning the Indonesia Certificate Issuance Workflow

The approach undertaken to redesigning the Indonesia certificate issuance workflow is described in chapter 3. It starts with identifying the current workflow and lays out the interaction between process inside of the workflow. This foundational understanding of the existing procedures allows for a comprehensive mapping of where and how improvements can be made.

These changes are designed with the development of the API in mind. The API serves as the interface between processes, facilitating seamless data exchange and integration. The API serves as the interface between different processes, facilitating seamless data exchange and integration. This intended to replace paper-based document handling with a more digital environment.

The redesigned workflow begins with the Application Retrieval phase, where applicants submit their requests. This is followed by an Application Management phase, where the front office manages and ensures the compliance of applications before they proceed further. Next is the Assignment Management phase, which assigns checked applications to the appropriate next steps, improving the overall management of the land certificate issuance process.

The workflow then proceeds with parallel processes of Prequalification (Juridical Data Examination) and Spatial Data Collection (Survey and Mapping). These parallel processes allow for the simultaneous gathering of spatial data and the legal verification of land, significantly reducing overall processing time. The integration of data from these parallel processes in the Land Register Management phase ensures a unified and verified land register, leading to the final stage of Land Certificate Issuance.

This workflow also taking accounts for land registry maintenance (updates), by allowing for updates due to legal activities or boundary changes without needing to restart the entire process. This flexibility

ensures that the workflow can adapt to various scenarios where it necessitates to update the land registry. These changes are intended to prepare the system for further development and technological implementation.

Based on the new workflow, a set of requirements for interaction is made as a guide to standardize the input and output between processes. These requirements also take into account existing regulations, ensuring that the redesigned workflow remains compliant with current legal frameworks. These requirements serve as the basis for the API development, ensuring that data exchanges are seamless and efficient.

6.3. API Development

Perhaps the hardest part of this study is how to effectively define the certificate issuance workflow into an API. In Chapter 4, the decision was made to realise the workflow through implementing a Data Model, API Endpoints, and the API Response Body. The data model is developed based on the Land Administration Domain Model (LADM) and modified to meet the specific requirements of the actors involved. This model ensures that all relevant data elements are captured and standardised, facilitating seamless data exchange between different components of the system. The API endpoint is designed using RESTful principles to ensure scalability and ease of use. Another standardisation like OGC API also implemented where necessary. Endpoints are defined for each process in the certificate issuance workflow, with clear input and output format specifications. This structure ensures that each actor can interact with the system efficiently, submitting requests and consistently receiving responses. The response formats for the API are defined using JSON, a widely supported and easily parse able format. This choice enhances the potency interoperability of the system by ensuring that data can be exchanged accurately and efficiently between different components and actors.

6.4. API Implementation

The intent of the Certificate Issuance API is to provide a mechanism for data sharing between processes in the certificate issuance workflow within ATR/BPN. Each process within this workflow inherently handles specific inputs, performs essential operations, and generates corresponding outputs. The coordination of these inputs and outputs is crucial for maintaining an efficient and streamlined process. Therefore, by leveraging interoperable API, the Certificate Issuance API connects the inputs and outputs of each process, enabling smooth communication between the process. This mechanism allows actors in each process to access data for the inputs and submit data for the outputs through the API. This interaction can be visualised in into Figure 24.

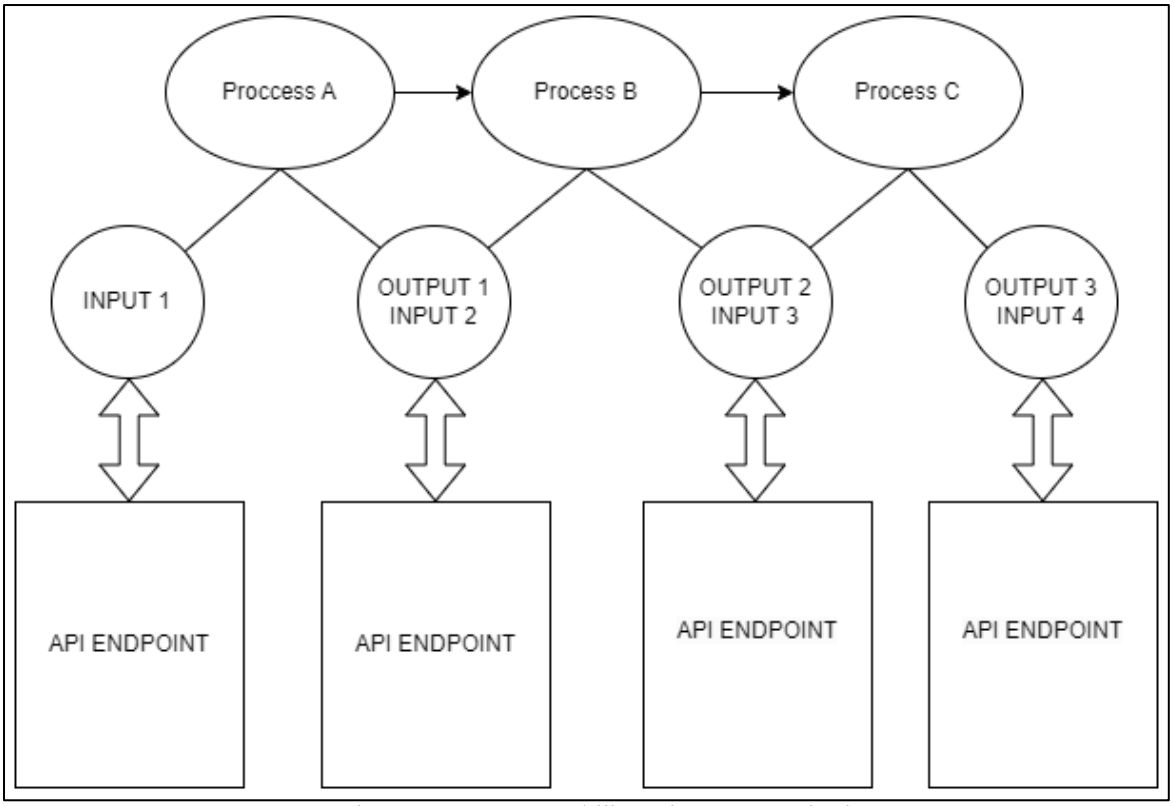


Figure 24. Interoperability using API Endpoint

In the end, the successful POST, GET, and PUT requests indicate that the API functions effectively as a mechanism for data exchange, streamlining both output and input processes. This ensures that the integration of output into subsequent processes can occur without the need for direct actor intervention. As a result, the data from the document can be seamlessly communicated between processes, making the actor independent of the workflow. This independence enhances the system's interoperability, as it provides a mechanism where the data from another process can be exchanged and used without extra step.

7. CONCLUSION AND RECOMMENDATIONS

In this chapter, we conclude the findings from the API implementation for land certificate issuance in ATR/BPN. It summarizes the key outcomes, insights, and lessons learned from the study. This chapter also provides recommendations based on the results, suggesting potential improvements and future directions for enhancing the system.

7.1. Conclusion

7.1.1. Objective 1: To investigate the network of interaction between actors within the process of land administration for the case of ATR/ BPN

Based on the literature review conducted in this study, it is evident that actors in land administration in Indonesia interact through a structured process. This process is segmented into specific land administration functions, akin to those described by Enemark (2005): Land Tenure, Land Value, Land Use, and Land Development. Each function in Indonesia is managed by a different directorate general.

The land certificate issuance is the main process of land tenure in ATR/BPN, Indonesia. It involves several key steps: Application Submission, Measurement and Mapping, Juridical Data Examination, and Certificate Issuance. The requirements for these steps are outlined in various policies and regulatory frameworks, notably Ministerial Regulation No. 3/1997, which provides implementation provisions for Government Regulation Number 24 of 1997. The interaction of actors in this process is described for each step.

Despite the technological advancements and digitalization efforts in Indonesia, the interaction between actors within the process is still predominantly facilitated by standardized paper-based documents. This situation creates difficulties in exchanging data between subsequent processes, leading to inefficiencies and delays. This situation prompts the need for improvement for land issuance certificate progress to streamline data exchange.

7.1.2. Objective 2: To establish an approach to implement the technology for land administration in Indonesia

The approach to implementing technology for land administration in Indonesia, as detailed in Chapters 3 and 4, begins with redesigning the workflow to align with digital processes. The redesigning process involving a thorough review of the regulation to map out the existing certificate issuance workflow. Then, the interactions between processes are analysed to understand how the actors interact with each other. The insights gained from this analysis are then used as the basis for redesigning the workflow, ensuring that the new digital processes are streamlined and optimized for seamless data exchange. A set of interaction requirement is devised to rule the input and the output of each process from the ministry regulation as a form of regulatory compliance.

Based on this understanding, a data model was developed using the Land Administration Domain Model (LADM), adapted to fit the specific requirements of Indonesia. This model ensures consistency and completeness in data exchange between actors. To facilitate seamless communication, an API was developed adhering to REST principles and the Open API specification. This API manages specific actions such as retrieving, submitting, and updating data, ensuring standardized interactions. Legal compliance is maintained throughout the process, with each step governed by specific requirements derived from the reviewed regulations, ensuring that digital transformations uphold legal standards.

7.1.3. Objective 3: To develop API implementation that's meets with the requirements to provide interoperability for land administration actors in Indonesia

The results of this study, as summarized in Chapter 5, demonstrate the successful implementation of an API designed to ensure interoperability among land administration actors in Indonesia. The API was developed using Node.js and Express.js for backend functionality, with PostgreSQL as the database management system. The implementation focused on the scenario of seamless data integration between the application retrieval and application management processes.

The API facilitated the submission of applications through the POST /applications endpoint, which accepted application data and stored it within the system. The GET /applications/{applicationNumber} endpoint allowed front office staff to retrieve specific application details, ensuring they had the necessary information to proceed with processing. Once an application was reviewed, the PUT /applications/{applicationNumber} endpoint was used to update its status, marking it as reviewed and completed. This update ensured that the application was ready for the next steps, assignment management, where the Job Manager could access the necessary data to continue the workflow.

The validation of the requirement is demonstrated by showing that the data already stored and updated by the front office can be accessed through the API seamlessly. This proves that the system can handle the interaction between these processes.

7.2. Limitations of the Research

There are several limitations that should be acknowledged in this study. First, while determining the system requirements for this API to work, this study adhered closely to the legal requirements and tried to align the needs of the system with the regulations. This was done due to the existence of established land management procedures in Indonesian regulations. However, there are other ways to determine system requirements, such as interviewing the actors involved to understand their practical needs and challenges better. Doing interview arguably could provide a more comprehensive view of the system requirements beyond what is prescribed by regulations, ensuring that the API addresses all practical and operational aspects of the land administration processes.

Second, the scope of the API implementation is narrowed to interaction between application submission, application management, and assignment management, which does not cover all possible interactions within the land administration system as observed in Section 3.1. Perhaps it's might be more interesting to see the interactions between Spatial Data Collection, Judicial Data Inspection, and Land Registry Management since it also involves access to spatial data. Nevertheless, this study believes that the same replication can be applied to other processes within the land administration system to achieve comprehensive interoperability.

Third, the implemented API does not consider security and API keys. While the current implementation focuses on functionality and interoperability, it lacks mechanisms for secure data access and authentication. Incorporating security measures such as API keys, authentication protocols, and encryption is part of the API Structure and crucial for protecting sensitive land administration data from unauthorized access.

7.3. Recommendations

7.3.1. Short-term Recommendations

Out of the limitations identified above, here are some short-term recommendations to address and improve the solution in future studies and steps required to implement API in the Land Certificate Issuance Workflow:

1. **Further investigate the System Requirements with key-informants Interviews**: Conducting interviews with various actors involved in the land administration process could provide valuable insights and validate the API's functionality and relevance. These interviews can help clarify ambiguities in the requirements obtained from the regulations, identify practical needs, and address challenges to ensure that the API effectively meets all operational aspects.
2. **Expand API Implementation to Other Land Administration Functions**: Expanding the scope of the API to cover additional land administration functions, such as land valuation, land use and land development will help create a holistic and scalable solution. Addressing these additional functions will enhance the overall interoperability and effectiveness of the land administration system in Indonesia.

7.3.2. Areas for Further Research

This study serves as an entrance for API integration in land administration. To further enhance this initiative, it suggests the following areas for future research:

1. **Interoperability with External Systems**: Explore the interoperability of the API with external systems used by other government agencies and private entities involved in land management. This includes integration with other relevant databases to ensure seamless data exchange and collaboration.
2. **Impact Assessment of API on Land Administration Efficiency**: Conduct studies to assess the impact of the API implementation on the overall efficiency and effectiveness of land administration processes. This includes measuring improvements in processing times, error rates, and user satisfaction compared to traditional methods, thereby validating the benefits, and identifying areas for further optimization.
3. **Legal and Regulatory Adaptation**: Examine how changes in legal and regulatory frameworks impact the API implementation and vice-versa. Future research should focus on creating adaptable models that can easily be updated to comply with new regulations without requiring extensive system overhauls, ensuring long-term sustainability and compliance. Additionally, understanding the effects of technological improvements on the process is crucial for continuous development and optimization.

8. ETHICAL CONSIDERATIONS

It is important to note that there are no significant ethical concerns to address. This is because the process does not involve direct human interaction or the use of personal data. The implementation is designed using dummy data to ensure that no real or sensitive information is used during the development and testing phases.

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APPENDIX A: SERVER.JS

```
const express = require('express');
const app = express();
const port = 8000; // Port to listen on

const db = require('./db');

// Sample data - for demonstration purposes
let applications = [];

// Middleware to parse JSON request bodies
app.use(express.json());

// POST /applications route - Create a new application
app.post('/applications', async (req, res) => {
    const newApplication = req.body;

    // Validation logic (e.g., check if all required fields are present)
    if (!newApplication.applicationNumber || !newApplication.applicantInfo ||
!newApplication.applicantInfo.documentSubmissions) {
      return res.status(400).json({ error: 'Bad Request. Application is not
completed' });
    }

    try {
      // Insert the applicant data into the applicants table in the lite schema
      const { name, idNumber, idType } = newApplication.applicantInfo;
      const applicantQuery = 'INSERT INTO lite.applicants(name, id_number,
id_type) VALUES($1, $2, $3) RETURNING id';
      const applicantValues = [name, idNumber, idType];
      const { rows: applicantRows } = await db.query(applicantQuery,
applicantValues);
      const applicantId = applicantRows[0].id;

      // Insert the application data into the applications table in the lite
schema
      const applicationQuery = 'INSERT INTO lite.applications(application_number,
application_type, applicant_id, retrieval_date, completion_date,
verification_date) VALUES($1, $2, $3, $4, $5, $6) RETURNING *';
      const applicationValues = [
        newApplication.applicationNumber,
        newApplication.applicationType,
        applicantId,
        newApplication.applicationRetrievalDate,
        newApplication.applicationCompletionDate,
        newApplication.applicationVerificationDate
      ];
      const { rows: applicationRows } = await db.query(applicationQuery,
applicationValues);
      const applicationData = applicationRows[0];

      // Insert document submissions into the AdministrativeSource table in the
lite schema
```

```
      for (const docSubmission of
newApplication.applicantInfo.documentSubmissions) {
        const { documentType, documentNumber, documentFileUrl } = docSubmission;
        const docSubmissionQuery = 'INSERT INTO
lite.AdministrativeSource(document_type, document_number, document_file_url,
application_id) VALUES($1, $2, $3, $4)';
        const docSubmissionValues = [documentType, documentNumber,
documentFileUrl, applicationData.id];
        await db.query(docSubmissionQuery, docSubmissionValues);
      }

      return res.status(200).json({ message: 'Application submitted!', data:
applicationData });
    } catch (error) {
      console.error('Error creating application:', error);
      return res.status(500).json({ error: 'Internal Server Error' });
    }
  });

// GET /applications route - Retrieve all applications with the number of document
submissions
app.get('/applications', async (req, res) => {
    try {
      // Fetch all applications with the count of associated document submissions
from the lite schema
      const query = `
        SELECT
          applications.*,
          applicants.name AS applicant_name,
          applicants.id_number AS applicant_id_number,
          applicants.id_type AS applicant_id_type,
          COUNT(AdministrativeSource.id) AS document_submission_count
        FROM lite.applications
        INNER JOIN lite.applicants ON applications.applicant_id = applicants.id
        LEFT JOIN lite.AdministrativeSource ON applications.id =
AdministrativeSource.application_id
        GROUP BY applications.id, applicants.name, applicants.id_number,
applicants.id_type
      `;
      const { rows } = await db.query(query);
      return res.status(200).json(rows);
    } catch (error) {
      console.error('Error fetching applications:', error);
      return res.status(500).json({ error: 'Internal Server Error' });
    }
  });

  app.get('/applications/:applicationNumber', async (req, res) => {
    const applicationNumber = req.params.applicationNumber;
    try {
      // Fetch application with associated applicant info and document submissions
from the lite schema
      const query = `
        SELECT
          applications.*,
          applicants.name AS applicant_name,
```

```
          applicants.id_number AS applicant_id_number,
          applicants.id_type AS applicant_id_type,
          AdministrativeSource.document_type AS document_type,
          AdministrativeSource.document_number AS document_number,
          AdministrativeSource.document_file_url AS document_file_url
        FROM lite.applications
        INNER JOIN lite.applicants ON applications.applicant_id = applicants.id
        LEFT JOIN lite.AdministrativeSource ON applications.id =
AdministrativeSource.application_id
        WHERE applications.application_number = $1
      `;
      const { rows } = await db.query(query, [applicationNumber]);
      if (rows.length === 0) {
        return res.status(404).json({ error: 'Data Not Found. Application not
found' });
      }

      // Organize document submissions into an array
      const documentSubmissions = rows.map(row => ({
        documentType: row.document_type,
        documentNumber: row.document_number,
        documentFileUrl: row.document_file_url
      }));

      // Construct the response object
      const responseObject = {
        applicationNumber: rows[0].application_number,
        applicationType: rows[0].application_type,
        applicantInfo: {
          name: rows[0].applicant_name,
          idNumber: rows[0].applicant_id_number,
          idType: rows[0].applicant_id_type,
          documentSubmissions: documentSubmissions.filter(submission =>
submission.documentType)
        },
        applicationRetrievalDate: rows[0].retrieval_date,
        applicationCompletionDate: rows[0].completion_date,
        applicationVerificationDate: rows[0].verification_date
      };

      return res.status(200).json(responseObject);
    } catch (error) {
      console.error('Error fetching application:', error);
      return res.status(500).json({ error: 'Internal Server Error' });
    }
  });


// PUT /applications/:applicationNumber route - Update an existing application by
applicationNumber
app.put('/applications/:applicationNumber', async (req, res) => {
    const applicationNumber = req.params.applicationNumber;
    const updatedApplication = req.body;

    try {
        // Begin a transaction
```

```
        await db.query('BEGIN');

        // Fetch existing application data from the database
        const existingApplicationQuery = 'SELECT * FROM lite.applications WHERE
application_number = $1';
        const { rows: [existingApplication] } = await
db.query(existingApplicationQuery, [applicationNumber]);
        if (!existingApplication) {
            return res.status(404).json({ error: 'Data Not Found. Application not
found' });
        }

        // Compare existing application data with updated application data
        // Update the applications table if necessary
        const updateApplicationQuery = `
            UPDATE lite.applications
            SET
                application_type = $1,
                retrieval_date = $2,
                completion_date = $3,
                verification_date = $4
            WHERE application_number = $5
        `;
        const updateApplicationValues = [
            updatedApplication.applicationType,
            updatedApplication.applicationRetrievalDate,
            updatedApplication.applicationCompletionDate,
            updatedApplication.applicationVerificationDate,
            applicationNumber
        ];
        await db.query(updateApplicationQuery, updateApplicationValues);

        // Update document submissions if they have changed
        // First delete existing document submissions
        const deleteDocSubmissionsQuery = 'DELETE FROM lite.AdministrativeSource
WHERE application_id = $1';
        await db.query(deleteDocSubmissionsQuery, [existingApplication.id]);

        // Insert updated document submissions
        for (const docSubmission of
updatedApplication.applicantInfo.documentSubmissions) {
            const { documentType, documentNumber, documentFileUrl } =
docSubmission;
            const insertDocSubmissionQuery = `
                INSERT INTO lite.AdministrativeSource(document_type,
document_number, document_file_url, application_id)
                VALUES($1, $2, $3, $4);
            `;
            const insertDocSubmissionValues = [documentType, documentNumber,
documentFileUrl, existingApplication.id];
            await db.query(insertDocSubmissionQuery, insertDocSubmissionValues);
        }

        // Commit the transaction
        await db.query('COMMIT');
```

```
        return res.status(200).json({ message: 'Application updated successfully'
});
    } catch (error) {
        // Rollback the transaction if an error occurs
        await db.query('ROLLBACK');
        console.error('Error updating application:', error);
        return res.status(500).json({ error: 'Internal Server Error' });
    }
});


// Start the server
app.listen(port, () => {
  console.log(`Server is running on port ${port}`);
});
```

APPENDIX B: DB.JS

```
const { Pool } = require('pg');

const pool = new Pool({
  user: 'postgres',
  host: 'localhost',
  database: 'postgres',
  password: '********',
  port: 5432, // Default PostgreSQL port
});

module.exports = {
  query: (text, params) => pool.query(text, params),
};
```

APPENDIX C: CERTIFICATE ISSUANCE REGULATION

Categories	Regulation
Basic Agrarian Law	• Law Number 5 of 1960 concerning Basic Agrarian Principles
Organisation and Structure	• Law Number 39 of 2008 concerning State Ministries.] • Presidential Regulation Number 47 of 2020 concerning the Ministry of Agrarian Affairs and Spatial Planning. • Presidential Regulation Number 48 of 2020 concerning the National Land Agency • Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 16 of 2020 concerning the Organization and Work Procedures of the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency • Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 17 of 2020 concerning the Organization and Work Procedures of the Regional Offices of the National Land Agency and Land Offices.
Business Process	• Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 29 of 2021 concerning the Business Process Map of the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency.
Land Tenure	• Government Regulation Number 40 of 1996 concerning Right to Cultivate, Building Use Right, and Right to Use Land. • Government Regulation Number 24 of 1997 Concerning Land Registration • Government Regulation Number 18 of 2021 concerning Management Rights, Land Rights, Condominium Units, and Land Registration. • Minister of Agrarian Affairs/ Head of the National Land Agency Regulation Number 3 Of 1997 Regarding the Implementation Provisions of Government Regulation Number 24 of 1997 • Minister of Agrarian Affairs/ Head of the National Land Agency Regulation Number 6 of 2018 Concerning Systematic Land Registration. • Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 7 of 2019 concerning the Second Amendment to the Minister of Agrarian Affairs/Head of the National Land Agency Regulation Number 3 of 1997 concerning the Implementation Provisions of Government Regulation Number 24 of 1997 concerning Land Registration. • Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 1 of 2021 concerning Electronic Certificates. • Minister of Agrarian Affairs/ Head of the National Land Agency Regulation Number 16 of 2021 concerning the Third Amendment to the Regulation of the Minister of Agrarian Affairs/Head of the National Land Agency Number 3 of 1997 concerning the Implementation Provisions of Government Regulation Number 24 of 1997 Regarding Registration. • Minister of Agrarian Affairs/ Head of the National Land Agency

	Regulation Number 18 of 2021 concerning Procedures for Establishing Management Rights and Land Rights • Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 3 of 2023 concerning the Issuance of Electronic Documents in Land Registration Activities
Omnibus Law	• Law Number 6 of 2023 concerning the Determination of Government Regulation in Lieu of Law Number 2 of 2022 concerning Job Creation as Law
Electronic Transaction	• Law (UU) Number 19 of 2016 concerning Amendments to Law Number 11 of 2008 concerning Electronic Information and Transactions. • Government Regulation Number 71 of 2019 concerning the Implementation of Electronic Systems and Transactions
Licensed Surveyor	• Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 8 of 2022 concerning Amendments to the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation Number 9 Year 2021 concerning Licensed Surveyors.
Land Deed Officer	• Government Regulation Number 37 of 1998 concerning the Regulation of the Position of Land Deed Officials.
Tariff	• Government Regulation Number 128 of 2015 concerning the Types and Rates of Non-Tax State Revenue Applicable to the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency.

APPENDIX D: JSON RESPONSE FORMAT EXAMPLE

Application (/Application)


```
[
  {
    "applicationNumber": "000001",
    "applicationType": "New",
    "applicantInformation": {
      "applicantName": "John Doe",
      "applicantIdNumber": "123456789",
      "applicantIdType": "Passport"
    },
    "applicationDocument": [
      {
        "applicationDocumentName": "ID Proof",
        "applicationDocumentLink": "https://example.com/doc/id_proof.pdf",
        "documentverification": true
      }
    ],
    "applicationstatus": "submitted to Job Manager"
  }
]
```


Assignments (/Assignments)


```
[
  {
    "assignmentNumber": "0001",
    "assignmentDate": "2023-06-15T00:00:00Z",
    "assignmentType": "survey",
    "assignmentTo": "Surveyor A",
    "applicationLink": "https://api.server.test/v1/applications/000001"
  }
]
```

Measurement Files (/measurementfiles)


```
[
  {
    "measurementFileNumber": "MF0001",
    "measurementFileType": "First Registration",
    "measurementDate": "2023-06-15",
    "surveyorIdentification": {
      "SurveyorName": "Surveyor A",
      "surveyorNumber": "SURV001",
      "surveyorType": "Licensed Surveyor"
    },
    "boundaryDescription": "North Boundary",
    "involvedName": [
      {
        "name": "Witness A",
        "role": "Neighbor"
      }
    ],
    "linktoAssignment": "https://api.server.test/v1/assignments/0001"
  }
]
```


Prequalifications (/prequalifications)


```
[
  {
    "prequalificationNumber": "PQ0001",
    "involvedparty": {
      "name": "Jane Smith",
      "identificationNumber": "987654321",
      "partyType": "individual"
    },
    "ownershipproof": [
      {
        "proofType": "Hak Milik",
        "documentOwner": "Jane Smith",
        "documentNumber": "DOC12345",
        "linktoproofDocument": "https://example.com/doc/ownership_proof.pdf"
      }
    ],
    "linktoAssignment": "https://api.server.test/v1/assignments/0001"
  }
]
```

Parcels (/parcels)


```
[
  {
    "cadastralArea": 500.5,
    "areaDescription": "Similiar with document",
    "parcelIdentificationNumber": "PID12345",
    "PronvinceName": "Province A",
    "geometry": {
      "type": "Polygon",
      "coordinates": [
        [
          [102.0, 0.5],
          [103.0, 1.5],
          [104.0, 0.5],
          [102.0, 0.5]
        ]
      ]
    },
    "linktoMeasurementFiles": "https://api.server.test/v1/measurementfiles/MF0001"
  }
]
```


Land registers (/landregisters)


```
[
  {
    "landCertificateNumber": "LCN0001",
    "parcelIdentificationNumber": "PID12345",
    "prequalificationNumber": "PQ0001",
    "rightType": "right of ownership",
    "rightNumber": 1,
    "mortgageStatus": false
  }
]
```

Mortgages (/mortgages)


```
[
  {
    "mortgageNumber": "MORT0001",
    "ammount": 1300000000.00,
    "creditorName": "Bank A",
    "deedsInformation": {
      "deedofficerName": "Notary A",
      "deedNumber": "DEED001"
    },
    "listofcolateral": [
      {
        "ranking": 1,
        "rightType": "right of ownership",
        "Region": "Province A",
        "partial ammount": 1300000000.00
      }
    ]
  }
]
```


Invitation (/invitations)


```
[
  {
    "invitationNumber": "INV0001",
    "invitationDate": "2023-06-15",
    "measurementDate": "2023-07-01",
    "involvedName": [
      {
        "name": "Neighbor A",
        "role": "Witness"
      }
    ]
  }
]
```

Deeds (/deeds)


```
[
  {
    "deedNumber": "DEED001",
    "deedType": "Sale and Purchase",
    "objectInformation": {
      "objectAddress": "Jl. Akhmad Yani no.166",
      "ownershipproofType": "Hak Milik",
      "ownershipdocumentNumber": "DOC12345",
      "linktoownershipDocument": "https://example.com/doc/ownership_proof.pdf"
    },
    "involvedName": [
      {
        "name": "Seller A",
        "role": "Seller"
      }
    ],
    "deedDetail": "Detailed information about the deed",
    "landdeedofficerInformation": {
      "landdeedofficerName": "Notary A",
      "landdeedofficerRegion": "Region A"
    }
  }
]
```