ETTAKA_LYO LAW APPLICATION

A PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY OF UGANDA CHRISTIAN UNIVERSITY

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UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

Declaration

We, the undersigned, declare that this report titled "Ettaka_Lyo: Bridging the gap between Land Owners and Lawyers" is original and has not been published or submitted for any other degree award to any other university before.

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Abstract

Ettaka-Lyo is a groundbreaking land law application designed to bridge the gap between landowners and legal experts. By incorporating video call and chat features along with Google Map integration, Ettaka Lyo revolutionizes access to legal assistance in land-related issues.

This report provides a comprehensive overview of the development process and functionalities of Ettaka Lyo, highlighting its crucial role in facilitating legal services pertaining to land matters.

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List of Abbreviations

NAPE

National Association of Professional Environmentalists

DB

Data Base

JS

JavaScript

CSS

Cascading Style Sheet

HTML

Hyper Text Mark Up Language

HTTPS

Hypertext Transfer Protocol Secure

ACLs

Access Control Lists

RBAC

Role Based Access Control

WCAG

Web Content Accessibility Guidelines

VPN

Virtual Private Network

Chapter One

1. Introduction

In the heart of Uganda, amidst its lush landscapes and vibrant communities, lies a longstanding struggle that has plagued generations: the battle for control over land. Land ownership and the legal issues surrounding land tenure have emerged as pressing concerns in the Ugandan society ((Carmody, 2016). Globalization, land grabbing, and the present-day colonial state in Uganda) From disputes over boundaries and ownership to the insidious practice of land grabbing, the quest to control natural resources has often led to intimidation, displacement, and deprivation for countless communities.

According to the sobering statistics revealed in the 2020-2021 Justice, Law and Order Sector Annual report, the magnitude of the issue becomes starkly evident. With a staggering total of 40,944 land cases flooding the magistrates and high courts, and only 22.7% of them resolved, Uganda finds itself grappling with a crisis that extends far beyond legal proceedings. The remaining 77.3% of cases linger in limbo, a testament to the systemic challenges that obstruct justice and perpetuate uncertainty among landowners.

At the heart of this multifaceted issue lies the insidious phenomenon of land grabbing—a practice characterized by the large-scale acquisition of land by individuals, corporations, or governments((Carmody, 2016). Globalization, land grabbing, and the present-day colonial state in Uganda). Motivated by the desire to exploit natural resources or maximize profits, land grabbing has emerged as a formidable threat to the rights and livelihoods of Uganda's rural communities. The repercussions are profound, leading to homelessness, clan conflicts, displacement, and even starvation for those robbed of their ancestral lands.

Recognizing the urgent need for intervention, organizations such as the National Association of Professional Environmentalists (NAPE) shed light on the underlying factors driving land grabbing ((Monitor., 2012). A study on land grabbing cases in Uganda). High food prices, escalating demand for land and resources, and the global financial crisis have converged to

create a fertile ground for speculative investments, further exacerbating the vulnerability of rural communities. As fertile agricultural land increasingly falls prey to privatization, marginalized populations are stripped of their access to vital resources, perpetuating cycles of poverty and injustice.

In response to these challenges, a beacon of hope emerges in the form of the Ettaka-Lyo Web Application—a revolutionary tool designed to combat land grabbing and empower landowners with access to legal guidance. Ettaka-Lyo seeks to bridge the gap between legal expertise and those in dire need of it, offering a lifeline to communities grappling with the complexities of land tenure. As written by((Muigua, 2023). technology for enhanced efficiency and access to justice in the legal profession .).

The primary aim of Ettaka-Lyo is nothing short of revolutionary: to democratize access to legal services pertaining to land ownership. Through a comprehensive suite of features and functionalities, Ettaka-Lyo endeavors to empower landowners, foster transparency, and facilitate informed decision-making. From providing a platform for virtual consultations with legal experts to integrating resources such as legal documents and guidelines, Ettaka-Lyo aspires to be a catalyst for change in Uganda's land tenure landscape.

As we delve deeper into the intricacies of Ettaka-Lyo, this paper will explore its aims, objectives, and scope, shedding light on its potential to transform the trajectory of land ownership in Uganda. By harnessing the power of technology, Ettaka-Lyo stands poised to usher in a new era of justice, equity, and empowerment for Uganda's landowners. As suggested by ((Muigua, 2023). technology for enhanced efficiency and access to justice in the legal profession .).

1.1 Background

Land ownership and legal issues surrounding land tenure are prevalent concerns in many societies. For centuries, communities have been intimidated to abandon – or have been forcibly removed from – their land in a seemingly endless battle to control natural resources. The common land problems in Uganda are disputes over land boundaries, ownership, land use and land grabbing.

According to the 2020-2021 Justice, Law and Order Sector Annual report, the **total number of land cases was 40,944** in the magistrates and high courts, of these a total of **9,303 (22.7%)** land cases were completed and a total of **31,641 (77.3%)** pending. (Justice, 2015)

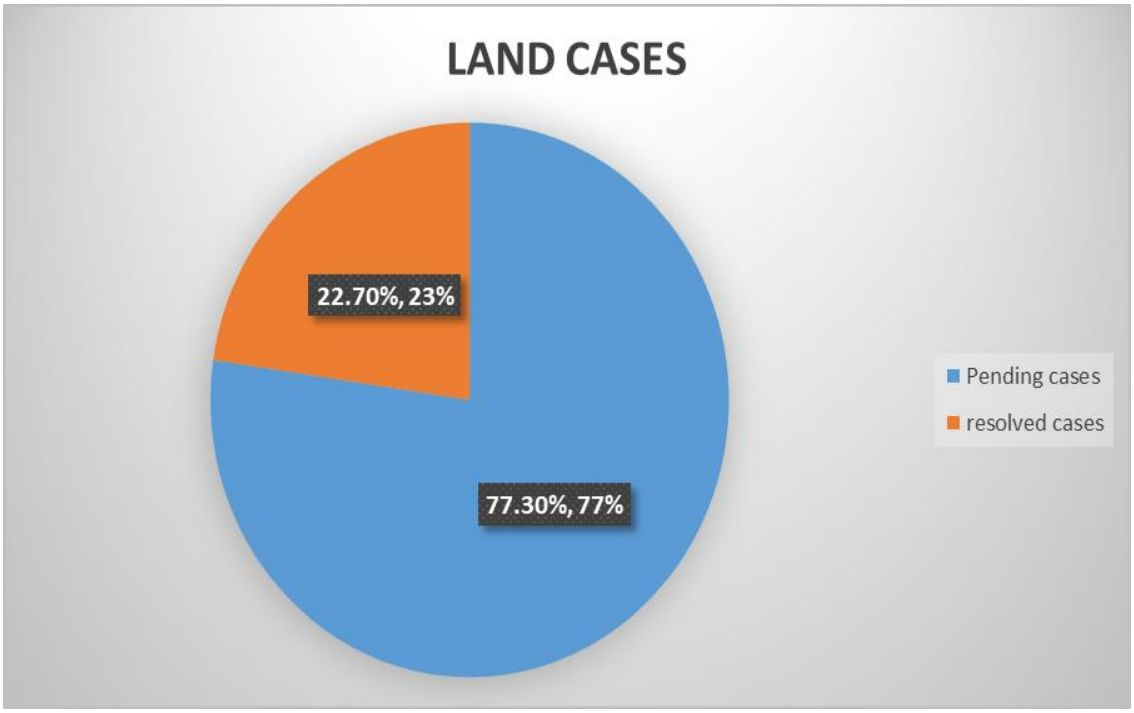

Figure 1: Pie chart of unresolved land cases.

Land grabbing is the practice of large-scale acquisition of land by individuals, corporations, or governments, often with the intent to control or exploit the natural resources and/or labor of that land.

The NAPE, Uganda says land grabbing is not a new phenomenon. High food prices, combined with growing demand for land and for other natural resources and a financial crisis that forced investors to look for new speculative investments, have triggered a new global land grab ((Monitor., 2012). A study on land grabbing cases in Uganda). These companies often secure long leases to exploit the land for profits, extracting natural mineral resources, or growing crops for food, fuel or carbon credits. As a consequence, land, especially fertile agricultural land, is increasingly being privatized, depriving rural communities of access to vital resources.

1.2 Problem Statement

Land grabbing is a significant problem in Uganda, with detrimental effects on the population mentioned by((Ronald, 2014). Land-grabbing in Uganda.). It can lead to homelessness, clan fights, displacement, and even starvation. The lack of accessible legal assistance exacerbates this problem, leaving landowners vulnerable to exploitation and displacement.

According to the 2020-2021 Justice, Law and Order Sector Annual report, the **total number of land cases was 40,944** in the magistrates and high courts, of these a total of **9,303 (22.7%)** land cases were completed and a total of **31,641 (77.3%)** pending.

Solution Ettaka-Lyo Web Application

To address the challenges posed by land grabbing and facilitate access to legal guidance, a web application called **Ettaka-Lyo** has been developed. ((McGill, 2017). Opportunities, Risks and Information Gaps.) Ettaka-Lyo serves as a platform that connects landowners with land lawyers over the internet, bridging the gap between legal expertise and those in need of it.

1.3 Objectives

Main Objective

To democratize access to legal services related to land ownership through the Ettaka Lyo platform.

Specific Objectives

1. Provide a platform for landowners to connect with lawyers through video call and chat features. As written by ((Bhatt, 2017) The potential of ICTs to Combat land corruption in Uganda.).
2. Integrate resources such as legal documents and guidelines for land-related matters.
3. Utilize Google Map integration to facilitate location-based services and land documentation.
4. Ensure efficient management of Admin access and lawyer registration on the platform through the Admin Panel.

1.4 Project Scope

Ettaka Lyo is a land law application designed to provide legal assistance and resources tailored to the needs of landowners and stakeholders. The project scope encompasses several key components aimed at enhancing accessibility, usability, and effectiveness in addressing land-related legal matters. The following details the specific areas within the project scope:

User-Friendly Interface:

Development of a user-friendly interface that is intuitive and easy to navigate for both landowners and legal professionals.

Emphasis on simplicity and clarity in design to ensure that users can easily access the required features and functionalities.

Video Call and Chat Functionalities:

Incorporation of video call and chat functionalities within the application to facilitate communication between landowners and lawyers. Integration of real-time communication features to enable users to engage in virtual consultations, discussions, and interactions with legal experts.

Legal Assistance for Land Ownership and Tenure:

Provision of legal assistance and guidance specifically related to land ownership, tenure, and associated legal issues.

Access to legal experts who can provide advice, clarification, and assistance in navigating legal procedures, rights, and responsibilities related to land ownership.

Resource Integration:

Integration of resources such as legal documents, guidelines, and templates relevant to land ownership and tenure.

Curating a comprehensive repository of resources to empower landowners with knowledge and information necessary for making informed decisions and taking appropriate actions.

Google Maps Integration:

Integration of Google Maps functionality to provide location-based services and visualization of land-related information. Utilization of Google Maps API to display land boundaries, property details, and other spatial data to enhance the understanding and management of land assets ((Muigua, 2023). technology for enhanced efficiency and access to justice in the legal profession .).

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Accessibility and Compatibility:

Ensuring accessibility and compatibility across various devices and platforms, including web browsers, mobile devices, and tablets. Optimization of the application for different screen sizes, resolutions, and operating systems to accommodate diverse user preferences and technological environments.

Security and Privacy:

Implementation of robust security measures to protect user data, privacy, and confidentiality. Adherence to industry standards and best practices in data encryption, authentication, and authorization to mitigate security risks and vulnerabilities.

1.6 Significance of the System

Ettaka Lyo holds significance in empowering landowners with knowledge and access to legal assistance, thereby promoting transparency and fairness in land-related transactions. By leveraging technology, the system aims to overcome barriers to legal services and foster informed decision-making among landowners.

Increased access to legal aid especially for land owners residing in remote areas, often face challenges connecting with qualified land lawyers. Ettaka-Lyo bridges this gap by providing a digital platform for convenient access to legal professionals, regardless of location.

The application equips landowners with knowledge through its land document resources. This empowers them to understand their rights, strengthens their position during legal consultations, and fosters informed decision-making.

The video call and chat functionalities facilitate clear communication between landowners and lawyers. This transparency fosters trust and ensures accurate information exchange, crucial for effective legal representation.

Enhanced Efficiency through google maps integration streamlines the legal process. Landowners can easily share property locations, allowing lawyers to visualize the land in question and expedite casework.

Ettaka-Lyo provides potential for conflict resolution by facilitating communication and legal guidance, Ettaka-Lyo has the potential to mitigate land-related conflicts. Early legal intervention can prevent escalation and promote peaceful resolution.

Chapter Two

2. Literature Review

In recent years, technology has played a pivotal role in transforming various aspects of legal practice, including land management. Among these technological innovations, Ettaka Lyo emerges as a groundbreaking application designed to streamline the connection between lawyers and landowners. By integrating video calls, chat features, and Google Maps, Ettaka Lyo aims to revolutionize communication, consultation, and documentation processes related to land matters ((Muigua, 2023). technology for enhanced efficiency and access to justice in the legal profession .).

This chapter delves into the implications, effectiveness, and potential challenges associated with Ettaka Lyo in the realm of land law.

2.1 Evolution of Technology in Legal Practice

The evolution of technology has reshaped the landscape of legal practice, introducing innovative solutions to traditional challenges. Document management systems, virtual collaboration tools, and case management software have revolutionized how legal professionals operate as seen by (((Parker, 1999) Understanding the evolution of land administration systems in some common law countries.). These advancements have not only enhanced efficiency but also improved accessibility and connectivity within the legal profession as written by by ((Home, 2021) History and prospects for African land governance. *institutions, technology and 'land rights for all*.).

Technology has enabled legal practitioners to streamline processes such as case research, document drafting, and communication with clients. With the advent of cloud computing and mobile applications, lawyers can now access case files and collaborate with colleagues from anywhere, at any time.

In the context of land law, technological advancements have facilitated the digitization of land records, simplifying property transactions and dispute resolution as written by. Geographic Information Systems (GIS) have become indispensable tools for land owners and surveyors, enabling them to visualize and analyze spatial data with precision. ((Akeh, 2016) The role of geographic information system in urban land administration in Nigeria.)

2.2 Land Law and Technological Integration

Land law encompasses a complex array of regulations, transactions, and disputes concerning property rights and land management. Technological integration in land law has introduced various tools aimed at streamlining processes and enhancing access to legal services.

2.3 Features of Ettaka Lyo

Ettaka Lyo offers a comprehensive suite of features tailored to the needs of lawyers and landowners:

Video Call Functionality: Real-time video calls enable remote consultations and discussions, overcoming geographical barriers and facilitating efficient communication.
Chat Features: Instant messaging and document sharing features foster collaboration and information exchange, enhancing communication between lawyers and landowners.
Google Maps Integration: Integration with Google Maps provides users with visualizations of land parcels, boundaries, and geographic features, enabling better understanding and analysis of land-related issues ((Akeh, 2016) The role of geographic information system in urban land administration in Nigeria.).

The combination of these features enhances the accessibility, efficiency, and effectiveness of legal services in the domain of land law. By leveraging technology, Ettaka Lyo empowers lawyers and landowners to communicate effectively, collaborate seamlessly, and make informed decisions regarding land matters.

2.4 Implications for Legal Practice

The adoption of Ettaka Lyo presents several implications for legal practice in the domain of land law:

Enhanced Accessibility: By overcoming geographical barriers, Ettaka Lyo improves access to legal services, particularly in rural areas where physical consultations may be challenging.

Efficiency and Convenience: The application streamlines communication and collaboration processes, saving time and resources for both lawyers and landowners involved in land-related transactions.

Geospatial Analysis: Google Maps integration facilitates geospatial analysis of land parcels, supporting due diligence, boundary disputes resolution, and decision-making processesm ((Kamilaris, 2018) Geospatial analysis and the internet of things.).

Challenges and Considerations

Despite its potential benefits, Ettaka Lyo faces several challenges and considerations:
Privacy and Security Concerns: The use of video calls and chat features raises concerns regarding data privacy, confidentiality, and security. Robust safeguards and encryption protocols are necessary to mitigate these risks.

Digital Divide: Unequal access to technology and internet connectivity may hinder the adoption and effectiveness of Ettaka Lyo, particularly in underserved communities lacking access to reliable internet infrastructure.

Legal and Regulatory Framework: Compliance with legal and regulatory requirements, including data protection laws and professional ethics guidelines, is essential to ensure the application's legality and ethical use.

2.5 Future Directions and Recommendations

To enhance the functionality and effectiveness of Ettaka Lyo, the following recommendations are proposed:

Continued Innovation: Further development and refinement of Ettaka Lyo should incorporate additional features such as electronic signatures, augmented reality, and block chain technology to enhance its functionality and utility.

User Training and Support: Providing comprehensive training and support resources for lawyers and landowners using Ettaka Lyo can enhance user adoption and satisfaction.

Collaboration with Stakeholders: Engaging with stakeholders such as bar associations, land registries, and government agencies can foster collaboration and support for the widespread adoption of Ettaka Lyo.

Chapter Three

3. Methodology

The development of Ettaka Lyo was guided by the principles of agile methodology ((Al-Saqqa, 2020) Agile software development: Methodologies and trends.), focused on emphasizing continuous development, customer collaboration, and responsiveness to change. The agile approach allowed the project team to adapt to evolving requirements and prioritize features based on user feedback.

3.1Phase 1: Planning and Requirements Gathering

During the requirements gathering phase, the primary objective was to understand the needs, preferences, and legal constraints of stakeholders. This phase involved various activities, including:

Stakeholder Interviews: Conducting interviews with lawyers, landowners, and other relevant stakeholders to gather insights into their requirements and expectations regarding the application through questionnaires.

How frequently do you deal with land-related legal matters?

What specific challenges do you encounter when dealing with land issues?

What features would you consider essential in a land lawyer app?

How important is it for you to have access to legal resources and information regarding land laws?

Would you prefer a mobile app or a web-based platform for accessing legal assistance regarding land matters?

What type of legal documents related to land transactions do you frequently require assistance with?

How comfortable are you with using technology for legal purposes?

Would you be interested in a feature that provides real-time updates on changes in land laws and regulations?

How important is it for you to have a secure and confidential platform for discussing your land-related legal issues?

Are there any specific areas of land law where you feel you need more guidance or support?

This Is the Flow of the Questionnaire.

Surveys: Administering surveys to a wider audience to gather quantitative data on user preferences and pain points.

Users of Ettaka-Lyo: Ettaka-lyo has three types of users, the land owner, land lawyer and administrator. The land owner is the targeted client and customer to our application and the aim is to connect them to lawyers. Lawyer interacts with client or land owner to provide computing services and the administrator is the one who adds other administrators, lawyers and adds resources. Multiple lawyers can interact with multiple clients and multiple clients can interact with multiple lawyers. Multiple Lawyers can interact with and Administrator.

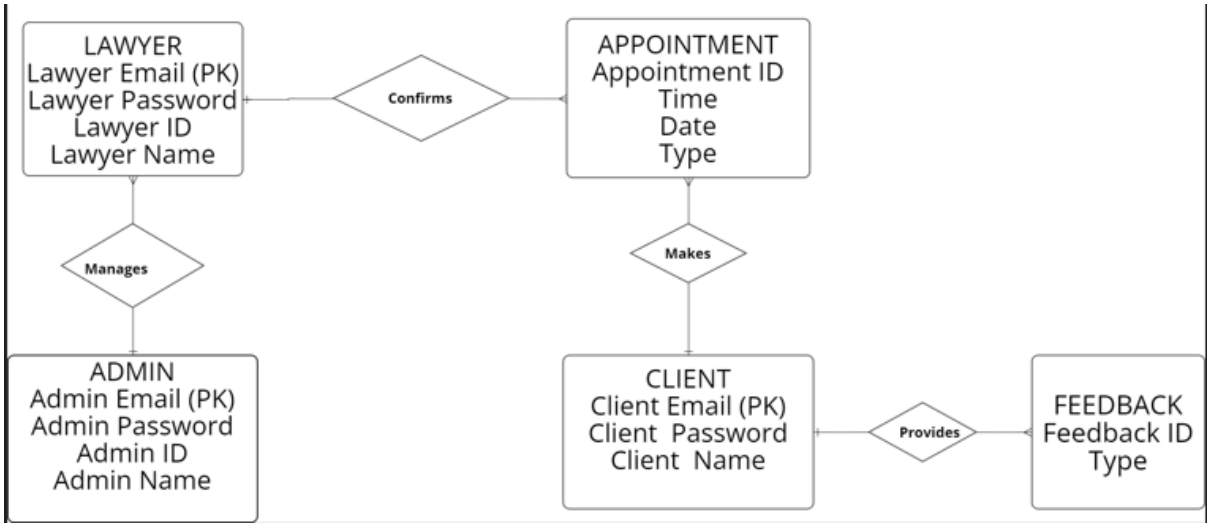

Figure 2: Entity Relationship Diagram showing user relationships

Legal Requirements Analysis: Conducting a thorough analysis of legal regulations and requirements related to land law to ensure compliance and alignment with legal standards.

Stakeholder Verification: Utilizing tools such as Google Forms to record stakeholder requirements and preferences for verification purposes, ensuring transparency and accountability in the development process.

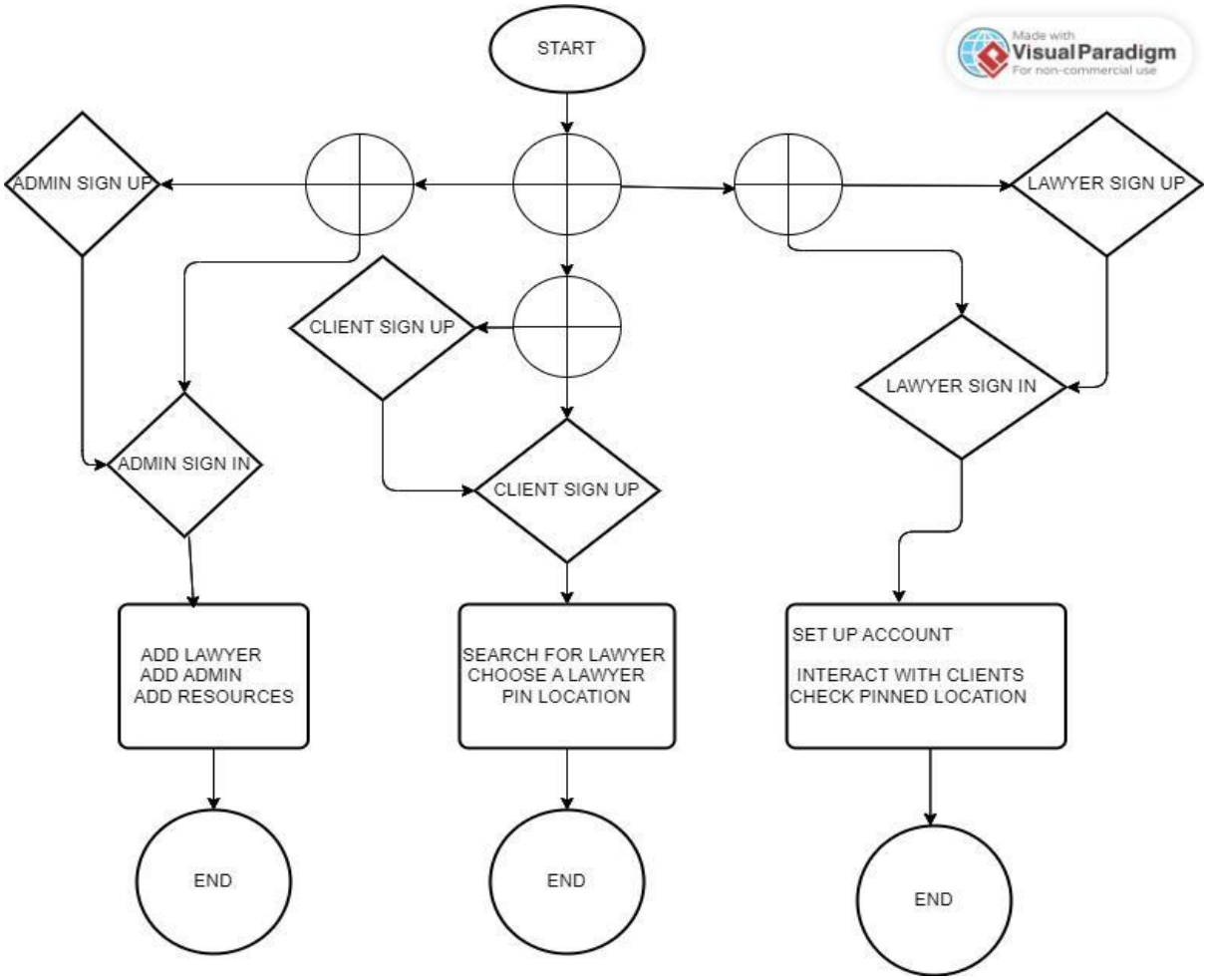

Figure 3: Flow Chart showing the processes of Ettaka Lyo .

Competitive Analysis: we made research on other existing law applications in the market with different deliverables and how Ettaka Lyo stands out.

	ACCESSIBILITY	EASY TO USE	INTERACTIVITY
FINDER UGANDA	❌	❌	✅
LEGAL AID UGANDA	❌	❌	❌
LAND RIGHTS NETWORK UGANDA	✅	✅	❌
ETTAKA LYO	✅	✅	✅
LAW FIRMS	❌	❌	✅

Table 1: Competitive Analysis

3.2 Phase 2: Design

In the design phase, the focus was on translating the gathered requirements into a visual representation of the application. Key activities in this phase included:

UI Prototyping: Utilizing design tools such as Figma to create wireframes and mock-ups of the application's user interface, allowing stakeholders to visualize the layout and flow of the application.

Feedback Gathering: Soliciting feedback from stakeholders on the design prototypes to ensure alignment with user expectations and preferences.

3.3 Phase 3: Implementation

Implementation encompassed the development of the application based on the finalized design specifications. This phase involved several key steps:

Development of Two Versions: Developing both an initial version using HTML, CSS, JavaScript, and Node.js, and a subsequent version leveraging React.js for its advantages in performance and user experience.

Version Control: Utilizing Git as the version control system to manage collaboration and versioning effectively, enabling multiple developers to work on the codebase concurrently.
Integration of APIs: Integrating various APIs to enable key functionalities such as video chat, chat messaging, authentication of clients and lawyers, and document transfer. Third-party services like the Google Maps API were also integrated to facilitate land mapping functionalities.

3.4 Phase 4: Testing and Quality Assurance

Testing and quality assurance activities were conducted to ensure that the application met functional, usability, and performance requirements. Key activities in this phase included:

Functional Testing: Testing the application's features and functionalities to ensure they function as intended.
Usability Testing: Soliciting feedback from users to evaluate the application's ease of use and user experience.
Performance Testing: Assessing the application's performance under various conditions to identify and address any performance bottlenecks.

3.5 Phase 5: Deployment

The deployment phase focused on making the application available to users. Key activities in this phase included:

Building the Application: Compiling the application code into executable files ready for deployment.
Deploying the Application: Deploying the application to cloud platforms using continuous integration/continuous deployment pipelines for automation. The front end of the application is deployed on vercel and the backend is deployed on render.

3.6 Phase 6: Maintenance

Maintenance of the application was acknowledged as an ongoing phase, emphasizing continuous monitoring, updates, and improvements based on user feedback and evolving requirements. Key activities in this phase included:

Monitoring: Continuously monitoring the application for performance issues, security vulnerabilities, and other issues.

Updates and Improvements: Rolling out updates and improvements to the application based on user feedback and changing requirements.

Bug Fixes: Addressing any bugs or issues identified by users or through monitoring activities to ensure the application's stability and reliability.

3.7 Implementation and Testing

The implementation and testing phase of Ettaka-Lyo involved a systematic approach to develop, deploy, and validate the application's features and functionalities.

3.8 Implementation Process

Requirement Analysis: The implementation process began with a comprehensive analysis of user requirements, business objectives, and technical specifications. Stakeholder feedback, user stories, and use cases were gathered and prioritized to define the scope and features of Ettaka-Lyo. We used questionnaires to collect information from people in our community in mukono to know their insight on land matters and how a web application would help landowners tackle that matter.

Design and Architecture: Based on the requirements analysis, the design and architecture of Ettaka-Lyo were conceptualized, outlining the system components, data structures, user interfaces, and integration points. Design mockups, wireframes, and architecture diagrams were created to visualize the application's layout and structure. Figma platform was used to make mockups of the design of the different pages.

Development: The development phase involved coding, programming, and software engineering activities to build the application according to the defined specifications. Using technologies such as React.js for the frontend, Node.js for the backend, and MongoDB for the database, developers implemented the core functionalities of Ettaka-Lyo, including user authentication, chat messaging, video calling, and integration with third-party services.

Testing and Quality Assurance: Concurrent with development, rigorous testing and quality assurance procedures were conducted to validate the functionality, performance, and

reliability of Ettaka-Lyo. Various testing techniques, including unit testing, integration testing, system testing, and acceptance testing, were employed to identify and rectify defects, bugs, and inconsistencies in the application.

Deployment: Once development and testing were completed, Ettaka-Lyo was deployed to production servers or cloud platforms for public access. Deployment processes the front end is deployed on vercel and backend is on render platform. They were executed to ensure smooth and seamless deployment of the application without disrupting ongoing operations.

Software Testing Methodologies

Unit Testing: we conducted unit tests to verify the correctness of individual components, modules, and functions within Ettaka-Lyo.

Integration Testing: Integration tests were performed to validate the interaction and interoperability between different modules, services, and external dependencies of Ettaka-Lyo. Integration testing focused on ensuring seamless data flow, communication protocols, and error handling mechanisms across interconnected components.

How Ettaka-lyo works:

Interface with a variety of our services on the landing page.

Get started, A user get started after they still have interest in the application and are taken to the sign up page.

Sign up, a client is now tasked to signup if they have never used the application using an email and their names and pre3ferred password. An email acts as an identifier If a client has ever used Ettaka-lyo then they have to sign in.

Lawyer sign up, If a client is a first time lawyer or administrator, they are to sign up as a lawyer because their accounts require them to use tokens for verification. The emails are used to add them as the other users of the application. Then they can now sign in.

Lawyer lists page, the next page is the lawyer lists page where the client can choose their most preferred lawyer by searching for the lawyer based on location or language spoken on their profile.

Search lawyer, this enables the client to search for a lawyer based on the language they speak or the name of your most preferred lawyer for second times users. The lawyer profiles, have the languages they speak and all our lawyers speak Luganda and English.

Start conversation, the client can interface with our lawyers through the chat feature which uses HTTPS for secure communication.

Start video call, the client can make a video call to interact with the lawyer face to face. The tokens for the video call are on each users chat. This enables automation of the call of the particular client.

Google maps, the google maps feature is in the chat page it can be accessed through a button on the right hand side of the page, that helps users to pin their exact locations in the chat for lawyers to have a look at their land and show it to surveyor for court proceedings.

Resources, the resources page has a number of resources like the **land title format,** land act of Uganda. The resources help to educate the client on how the legal documents are to be and also helps help him know how his rights are being breached.

Outcomes of Testing Phases

Defect Identification and Resolution: Through rigorous testing, various defects, bugs, and issues were identified and logged for resolution. Developers collaborated to address identified issues promptly, applying patches, fixes, and updates to improve the stability and reliability of Ettaka-Lyo.

Performance Optimization: Testing revealed performance bottlenecks, scalability constraints, and optimization opportunities within Ettaka-Lyo. Performance tuning efforts, including code refactoring, database optimization, and resource allocation adjustments, were undertaken to enhance application performance and responsiveness.

Validation of Functionalities: Testing validated the correctness, completeness, and effectiveness of Ettaka-Lyo's core functionalities, including user authentication, communication features, data management, and integration with external services. Functional testing ensured that users could successfully perform desired actions and tasks within the application without encountering errors or inconsistencies.

User Feedback Incorporation: User feedback collected during acceptance testing and beta testing phases was incorporated into the development process to address usability issues, feature requests, and user experience enhancements. Iterative improvements were made based on user input to refine Ettaka-Lyo's usability, accessibility, and overall user satisfaction.

3.9 Presentation and discussion of the Results

The architecture of the Ettaka-Lyo web application is designed to provide a seamless and secure platform for connecting landowners with land lawyers. The system architecture comprises several components that work together to deliver the intended functionalities efficiently.

Ettaka Lyo is a web application that helps land owners address land grabbing and seek legal advice by providing access to land lawyers.

Technologies we used;

Firebase: Firebase is leveraged for user account management, registration, login, and real-time chat messaging. It offers a convenient package for handling user accounts, basic user data storage and enables real-time features like chat messaging application.

HTTPS: HTTPS protocol is employed for robust real-time communication, ensuring secure and encrypted communication between users, which is crucial for chat messages and video calls.

MongoDB: MongoDB serves as the NoSQL database management system that stores data in a flexible document format, storing user emails, passwords, legal documents, and other user data with flexibility.

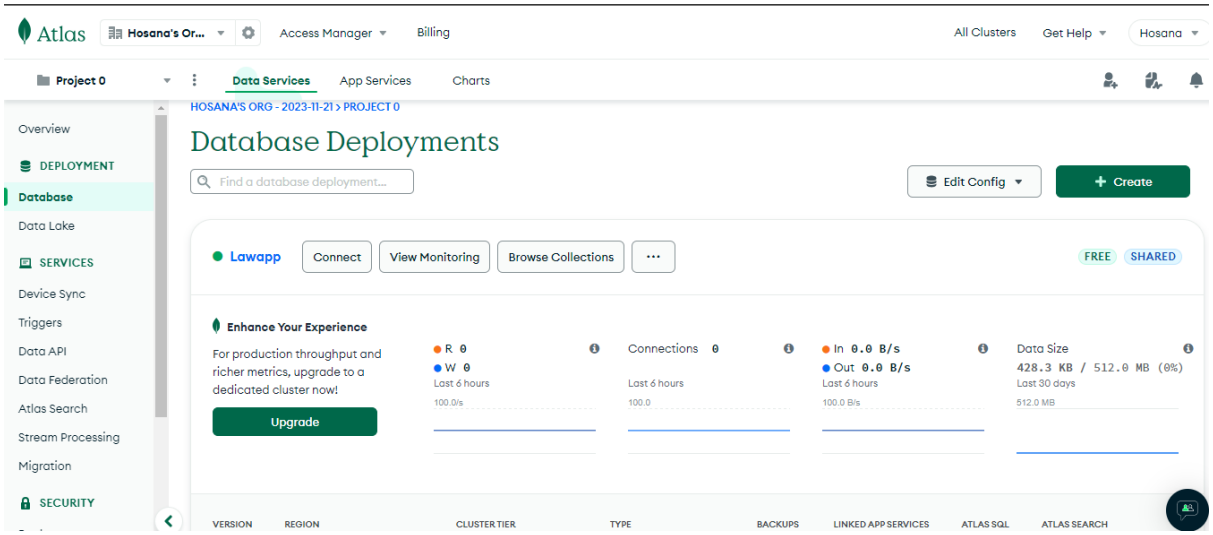

Figure 4: the database on Mongo dB

3.9.1 Frontend Design

The frontend design of Ettaka-Lyo plays a pivotal role in ensuring a seamless and user-friendly experience for landowners and lawyers accessing the application. Leveraging the capabilities of modern web technologies, the frontend is meticulously crafted to provide intuitive navigation, visually appealing interfaces, and efficient interaction.

React.js and CSS Framework:

React.js serves as the foundational framework for the frontend development of Ettaka-Lyo. Known for its component-based architecture and declarative syntax, React.js enables the creation of reusable UI components, facilitating modular development and code maintainability. CSS frameworks are integrated to expedite the styling process and ensure consistency across the application. Through the use of these frameworks, responsive design principles are implemented, ensuring that the application adapts seamlessly to various screen sizes and devices.

Vercel.com Hosting and Deployment:

The frontend of Ettaka-Lyo is hosted and deployed on vercel.com, a cloud platform optimized for deploying modern web applications. Vercel offers seamless integration with Git repositories, enabling continuous deployment workflows for automated deployments. Through Vercel's global content delivery network (CDN).

The application benefits from low latency and high availability, ensuring optimal performance for users accessing the application from different geographical locations.

Firebase Integration for User Account Management:

Firebase is utilized for storing user accounts and profiles, providing a scalable and secure solution for user authentication and data storage. Leveraging Firebase Authentication, users can register, log in, and manage Lawyer and user profiles seamlessly within the application.

Additionally, Firebase Real-time Database or Cloud Fire store is employed to store user data, preferences, and other relevant information, enabling real-time synchronization and efficient data retrieval.

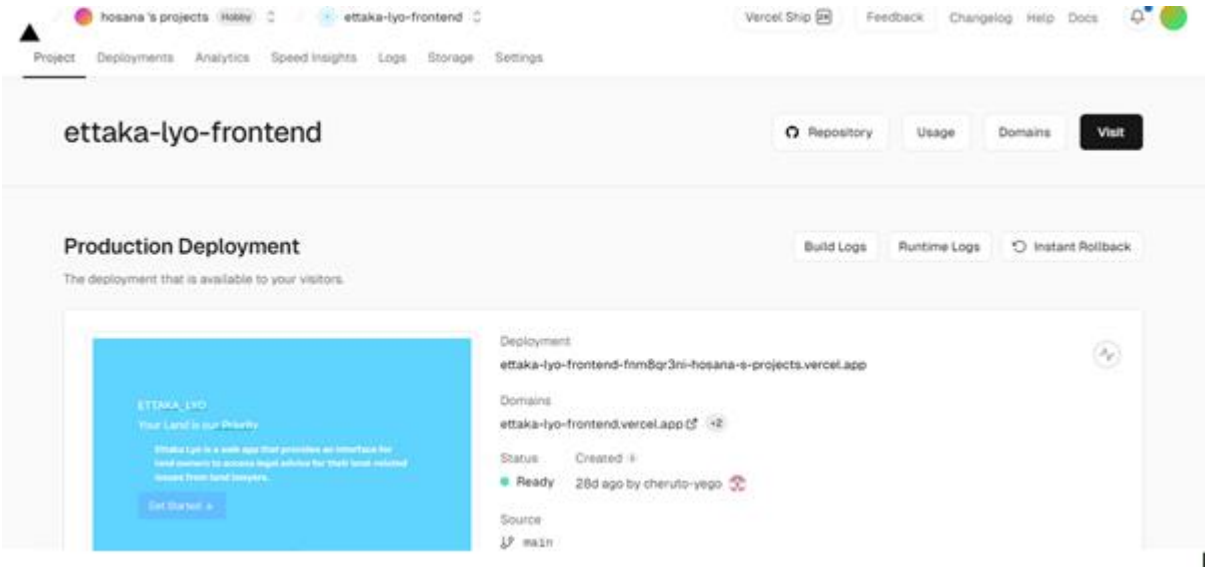

Figure 5: Application deployed on vercel

User Interface Design:

The user interface design of Ettaka-Lyo prioritizes clarity, simplicity, and intuitive interaction. Through thoughtful layout design, clear navigation menus, and strategically placed call-to-action buttons, users can effortlessly navigate through the application and

access the desired features. Visual cues, such as color schemes, typography, and iconography, are carefully chosen to enhance usability and guide users through the application flow.

Responsive and Accessible Design:

Accessibility and responsiveness are fundamental principles embedded within the frontend design of Ettaka-Lyo. The application is designed to be accessible to users with disabilities, adhering to WCAG (Web Content Accessibility Guidelines) standards for accessibility.

Responsive design techniques ensure that the application functions seamlessly across a wide range of devices, including desktops, laptops, tablets, and mobile phones, providing a consistent user experience regardless of the device used.

Continuous Improvement and Iterative Design:

The frontend design of Ettaka-Lyo is continuously evolving based on user feedback, usability testing, and design iterations. Regular user testing sessions are conducted to gather insights into user behavior and preferences, informing design decisions and enhancements. Ettaka-Lyo strives to meet the evolving needs and expectations of its users, ensuring a delightful and engaging user experience.

User Interface

The user interface (UI) of Ettaka-Lyo is meticulously designed to prioritize user-friendliness, accessibility, and seamless interaction. Through thoughtful layout design, intuitive navigation elements, and visually appealing aesthetics, the UI aims to provide a delightful and engaging experience for all users. Here's a detailed overview of the user interface design components and considerations:

Accessibility and Compatibility:

Ettaka-Lyo's UI is designed to be accessible from any modern web browser on various devices, including tablets and computers. The application adheres to web standards and best

practices to ensure compatibility across different browsers and platforms, allowing users to access the application seamlessly regardless of their preferred device or operating system.

Responsive Design:

The UI of Ettaka-Lyo adopts a responsive design approach, dynamically adjusting its layout and content based on the screen size and resolution of the device used. The application provides an optimal viewing and interaction experience across a wide range of devices, including desktops, laptops, tablets, and smartphones.

Clear Menus and Navigation:

Clear and intuitive menus and navigation elements are essential features of Ettaka-Lyo's UI, enabling users to navigate through the application effortlessly. The navigation menu is strategically positioned and prominently displayed, allowing users to access different sections of the application with ease.

Interactive Elements and Feedback:

Interactive elements such as buttons, form fields, and clickable icons are designed with user interaction in mind, providing immediate feedback and response to user actions. Hover effects, button animations, and transition effects enhance the interactivity of the UI, creating a more engaging and dynamic user experience.

Error indicators provide clear guidance and assistance to users, helping them understand the outcome of their actions and navigate the application effectively.

Video Call and Chat Interfaces

Need to talk face-to-face? Video calling and chat functionalities are seamlessly integrated, allowing real-time communication with lawyers. These features work well on different devices, so you can connect from wherever you are.

These interfaces are designed to be responsive and accessible on the web browsers of computers.

3.9.2 Backend Architecture

The backend architecture of Ettaka-Lyo forms the foundation of the application's functionality, data management, and communication processes. Utilizing Node.js as the server-side runtime environment and MongoDB as the NoSQL database management system, the backend is engineered to deliver robust performance, scalability, and flexibility. Here's a detailed breakdown of the backend architecture components and functionalities:

Node.js Server Environment:

Node.js serves as the core runtime environment for the backend of Ettaka-Lyo, providing a non-blocking, event-driven architecture that enables asynchronous I/O operations and scalable network applications.

Leveraging the JavaScript programming language, Node.js facilitates the development of lightweight, efficient backend services, handling HTTP requests, data processing, and business logic execution.

Express.js Framework:

Express.js, a minimalist web application framework for Node.js, is employed to streamline the development of RESTful APIs and HTTP server routes. With its modular architecture and middleware support, Express.js simplifies request handling, routing, and response generation, enabling rapid development of backend endpoints for handling user requests and data retrieval.

MongoDB NoSQL Database:

MongoDB serves as the backbend’s data storage solution, offering a flexible document-oriented database format that accommodates the dynamic nature of user data and legal documents within Ettaka-Lyo. As a NoSQL database, MongoDB stores data in JSON-like documents, allowing for hierarchical data structures and schema-less data modeling. User

emails, passwords, legal documents, and various user data elements are stored in MongoDB collections, providing efficient data retrieval and storage capabilities.

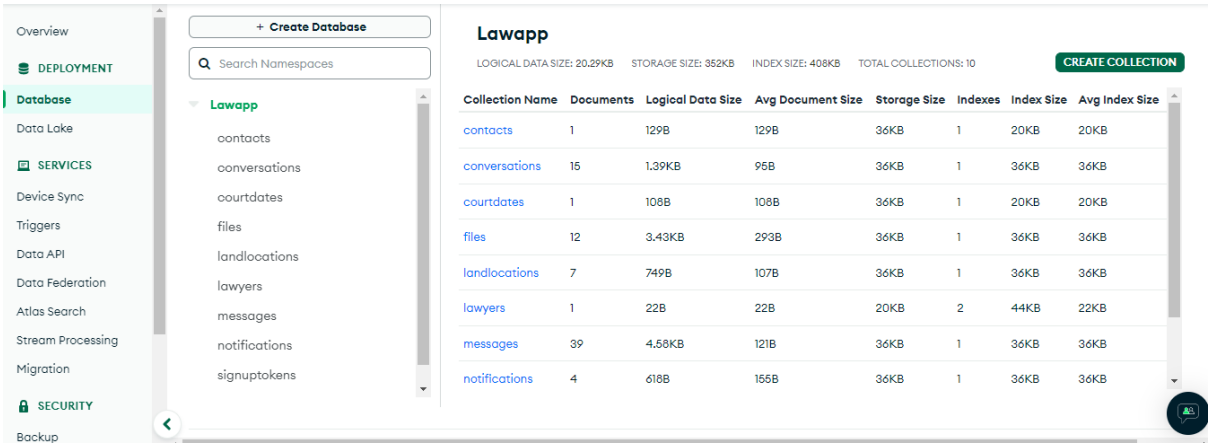

Figure 6: Mongo dB Database

Mongoose ORM:

Mongoose, an Object-Document Mapping (ODM) library for MongoDB and Node.js, is utilized to facilitate interaction with the MongoDB database from the Node.js backend. Mongoose simplifies data modeling, validation, and query execution, providing a structured approach to defining schemas, models, and relationships between data entities. By abstracting away, the complexities of MongoDB's native driver, Mongoose enhances developer productivity and code maintainability, enabling seamless integration with the backend application logic.

Authentication and Authorization:

The backend architecture incorporates authentication and authorization mechanisms to secure user accounts, protect sensitive data, and enforce access control policies. User authentication is implemented using industry-standard techniques such as JSON Web Tokens (JWT) or session-based authentication, ensuring that only authenticated users can access protected resources and endpoints.

Error Handling and Logging:

Comprehensive error handling and logging mechanisms are integrated into the backend architecture to facilitate troubleshooting, debugging, and monitoring of application errors and exceptions. Error middleware functions capture and handle runtime errors gracefully, providing descriptive error messages and appropriate HTTP status codes to clients.

Logging functionality records relevant information about application events, requests, and responses, enabling administrators to track system activities, diagnose issues, and analyze performance metrics effectively.

Scalability and Performance Optimization:

The backend architecture of Ettaka-Lyo is designed for scalability and performance optimization, leveraging techniques such as load balancing, caching, and database sharding to handle increased traffic and workload demands

The resilient design that leverages Node.js, MongoDB, and associated technologies to deliver efficient data management, secure authentication, and seamless communication capabilities.

Server Infrastructure

The server infrastructure of Ettaka-Lyo is meticulously designed to provide a resilient and scalable environment for hosting the backend services of the application. Leveraging cloud computing technologies and industry-standard practices, the server infrastructure ensures reliable performance, high availability, and seamless scalability to meet the demands of users accessing the platform. Here's a detailed breakdown of the components and functionalities of the server infrastructure:

Cloud Hosting Provider:

Ettaka-Lyo is hosted on a leading cloud hosting provider, such as vercel for the front end and render for the backend.

These cloud platforms offer a comprehensive suite of infrastructure services, including virtual machines, storage, networking, and management tools, enabling the deployment and management of scalable and resilient applications. By leveraging cloud hosting, Ettaka-Lyo benefits from flexible resource allocation, on-demand scalability, and built-in redundancy features that enhance reliability and availability.

Load Balancing and Auto-Scaling:

To distribute incoming traffic evenly and optimize resource utilization, Ettaka-Lyo employs load balancing techniques within the server infrastructure. Load balancers dynamically route incoming requests across multiple backend servers or instances, ensuring that no single server becomes overwhelmed with traffic.

Additionally, auto-scaling this enables the server infrastructure to scale up or down dynamically in response to changes in workload, ensuring optimal performance and availability during peak usage periods.

High-Performance Networking:

The server infrastructure of Ettaka-Lyo is equipped with high-performance networking capabilities to facilitate fast and reliable communication between backend servers, databases, and external services. Virtual private networks (VPNs), dedicated interconnects, or high-speed internet connections are utilized to establish secure and low-latency network connections, minimizing data transfer times and ensuring smooth operation of the application.

Fault Tolerance and Disaster Recovery:

Redundancy and fault tolerance measures are implemented within the server infrastructure to mitigate the risk of downtime and data loss. Additionally, data replication and backup mechanisms are employed to create redundant copies of critical data and ensure timely recovery in the event of data corruption or loss.

Database Management

The database management system employed by Ettaka-Lyo plays a crucial role in storing, managing, and retrieving various types of data essential for the application's functionality. Here's a detailed breakdown of the components and functionalities of the database management system:

Data Schema Design:

The database schema of Ettaka-Lyo uses MongoDB which is a schema-less or schema-flexible, meaning that it does not enforce a rigid schema like RDBMS.

MongoDB's data model is based on collections of JSON-like documents, and relationships between data are typically handled through embedded documents or references rather than foreign keys.

Data Storage and Indexing:

MongoDB uses a different approach to indexing and data storage compared to RDBMS. MongoDB employs a B-tree data structure for indexing, similar to some relational databases, but the overall indexing strategy and mechanisms are tailored to MongoDB's document-oriented nature.

MongoDB also supports various indexing options, including single-field, compound, and multi-key indexes. Additionally, MongoDB's storage engine and architecture are optimized for handling document-based data rather than tabular data.

Data Security and Access Control:

Ettaka-Lyo implements robust data security measures and access control mechanisms to protect sensitive information and prevent unauthorized access to the database. Role-based access control (RBAC) is enforced to restrict access to specific database tables, views, or operations based on users' roles and privileges.
User authentication and authorization mechanisms, such as username/password authentication and database user accounts, are implemented to authenticate users and regulate their access to the database.

Backup and Recovery:

Regular database backups are scheduled to capture incremental changes and full backups of the database, stored on separate storage devices or cloud storage platforms.
MongoDB and Firebase offer backup and recovery mechanisms to ensure data resilience and availability. MongoDB provides more granular backup options and point-in-time recovery capabilities, while Firebase focuses on automated replication and data export features for backup purposes.

Integration of Third-Party Services

Google Maps Integration

The integration of Google Maps within Ettaka-Lyo serves as a powerful tool for enhancing user experience, facilitating efficient communication, and providing valuable geographic insights for addressing land-related issues. Leveraging the robust features and functionalities of the Google Maps platform, Ettaka-Lyo empowers users to pinpoint their location accurately. Here's a detailed breakdown of the components and functionalities of the Google Maps integration:

Geolocation Services:

Ettaka-Lyo utilizes Google Maps' geolocation services to determine the geographical coordinates of users' devices, enabling precise location tracking and identification. Through integration with the device's GPS capabilities or IP-based geolocation techniques, the application retrieves users' current location information, allowing them to accurately pinpoint their position on the map interface.

This geolocation functionality enhances communication between users and land lawyers, facilitating real-time collaboration and consultation based on users' geographic proximity.

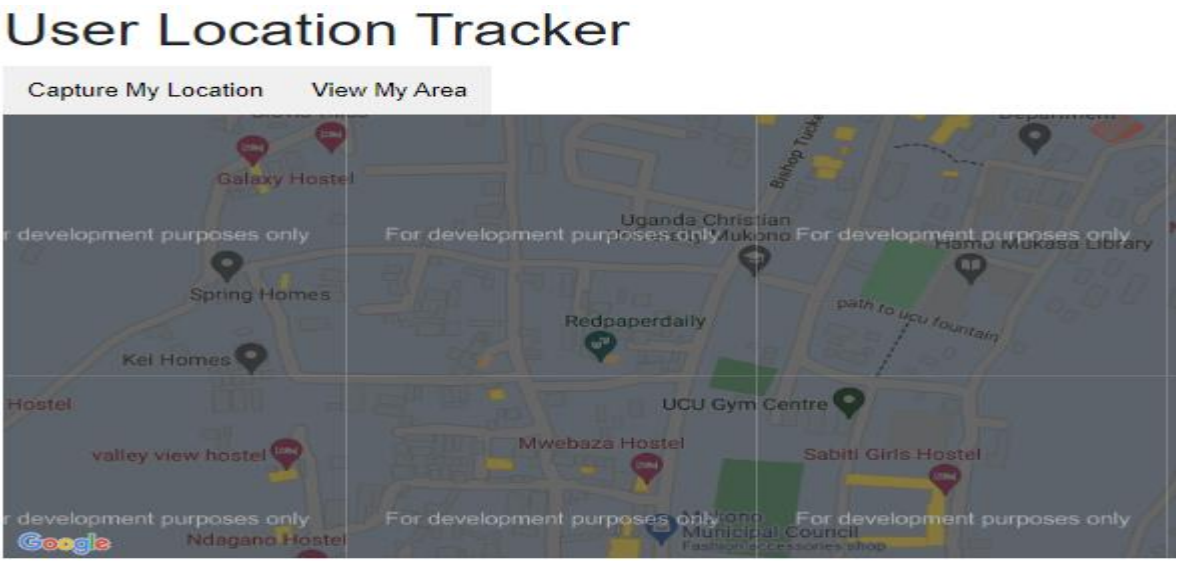

Figure 7: The google earth feature.

Video Call Service Provider

The integration of a third-party video call service provider within Ettaka-Lyo serves as a cornerstone for enabling seamless and high-quality video conferencing capabilities between users and lawyers. Ettaka-Lyo enhances communication, collaboration, and consultation experiences for users engaged in land-related matters.

Selection Criteria and Vendor Evaluation

Ettaka-Lyo conducted a thorough evaluation process to select a suitable video call service provider based on specific criteria such as video quality, reliability, scalability, security features, and compatibility with the application's technical requirements.

API Integration

Upon selecting a video call service provider, Ettaka-Lyo integrated the provider's application programming interface (API) into the application's backend and frontend infrastructure. The API facilitates seamless communication and data exchange between Ettaka-Lyo's application logic and the video call service provider's platform, enabling features such as initiating, joining, and managing video calls within the application's user interface.

Security and Privacy Measures

Ettaka-Lyo prioritizes the security and privacy of video communications by implementing robust encryption protocols and security measures in collaboration with the video call service provider. End-to-end encryption techniques are employed to encrypt video and audio streams, protecting sensitive information from unauthorized interception or tampering through the use of HTTPS.

Scalability and Reliability

The integration with the video call service provider ensures scalability and reliability of video conferencing capabilities within Ettaka-Lyo, enabling the application to accommodate growing user demand and handle concurrent video calls with minimal disruption.

The integration of a third-party video call service provider within Ettaka-Lyo enables the application to deliver seamless, high-quality video conferencing experiences for users and lawyers engaged in land-related consultations.

Security Measures

Ensuring the security and confidentiality of user accounts and sensitive information is a top priority for Ettaka-Lyo. Ettaka-Lyo safeguards user privacy and mitigates potential security

risks. Here's a detailed overview of the security measures implemented within the application:

Password Security:

Ettaka-Lyo employs advanced password security measures to protect user accounts from unauthorized access and brute-force attacks. Passwords are securely hashed and salted using cryptographic algorithms before being stored in the database. This ensures that even in the event of a data breach, attackers cannot easily decipher or reverse-engineer user passwords.

Session Management:

To prevent unauthorized access to user accounts, Ettaka-Lyo implements robust session management mechanisms to manage user authentication and authorization. Upon successful login, Lawyers are assigned a unique session identifier or token, which is securely stored and validated on subsequent requests to authenticate the user's identity.

Data Encryption:

Ettaka-Lyo encrypts all sensitive data transmitted between users and lawyers through HTTPS (Hypertext Transfer Protocol Secure) to ensure confidentiality and integrity of communication. HTTPS encrypts data preventing eavesdropping, tampering, and interception of sensitive information by unauthorized parties. By encrypting communication channels, Ettaka-Lyo guarantees that only authorized individuals with the appropriate encryption keys can access and decrypt the exchanged information, safeguarding user privacy and confidentiality.

Access Controls and Authorization:

Granular access controls and authorization mechanisms are implemented within Ettaka-Lyo to regulate user permissions and restrict access to sensitive functionality and data. Role-based access control (RBAC) principles are to be employed to assign specific roles or privileges to users based on their responsibilities and level of authority within the application.

Access control lists (ACLs) and permission matrices are utilized to define fine-grained access policies, specifying which users or user groups are allowed to perform certain actions or access particular resources within the application. This ensures that only authorized users can

access and manipulate sensitive data, reducing the risk of unauthorized data breaches or misuse.

Security Auditing and Logging:

Ettaka-Lyo maintains comprehensive audit logs and security event logs to track user activities, system events, and security-related incidents within the application.

Security event logs capture anomalies, intrusion attempts, and suspicious activities, enabling real-time detection and response to potential security threats.

Regular Security Assessments and Penetration Testing:

Ettaka-Lyo undergoes regular security assessments and penetration testing conducted by independent security experts or internal security teams to identify vulnerabilities, weaknesses, and potential attack vectors within the application.

Penetration testing involves simulated attacks and exploitation attempts to evaluate the resilience of Ettaka-Lyo's security controls and defenses against real-world threats.

Ettaka-Lyo prioritizes user privacy, confidentiality, and data integrity, Ettaka-Lyo ensures that sensitive information remains protected from unauthorized access and exploitation, fostering trust and confidence among users and stakeholders.

Scalability and Performance

Ettaka-Lyo places a strong emphasis on scalability and performance to ensure that the application can effectively handle increasing user traffic and maintain optimal responsiveness under varying workload conditions.

By prioritizing scalability, reliability, and performance, Ettaka-Lyo remains well-equipped to meet the evolving needs and expectations of its users while delivering high-quality legal services in land-related matters.

System Maintenance and Monitoring

Ettaka-Lyo places a strong emphasis on system maintenance and proactive monitoring to ensure the continuous reliability, and performance of the application. By employing a combination of specialized monitoring tools, regular updates, and meticulous maintenance procedures. Here's a detailed breakdown of the system maintenance and monitoring practices implemented within Ettaka-Lyo:

Continuous Monitoring:

Ettaka-Lyo's infrastructure is equipped with specialized monitoring tools and services that continuously track system activities, performance metrics, and key indicators to detect any anomalies or potential issues in real-time.

Monitoring tools collect and analyze data on various parameters, including server health, network latency, application response times, error rates, and resource utilization.

Regular Updates and Maintenance:

Regular updates and maintenance are integral components of Ettaka-Lyo's operational practices, aimed at ensuring the application remains secure, up-to-date, and aligned with evolving user requirements. The application undergoes periodic software updates, patches, and version upgrades to address security vulnerabilities, software bugs, and compatibility issues with underlying dependencies.

Comprehensive Backup and Disaster Recovery:

Ettaka-Lyo implements comprehensive backup and disaster recovery strategies to protect against data loss, system failures, and unforeseen disruptions. Regular data backups are performed to capture and store copies of critical application data, configuration settings, and user information in secure, redundant storage repositories.

Chapter Four

4. Evaluations

The Ettaka Lyo land law application has been evaluated positively for its ability to connect lawyers with landowners through innovative features such as video call, chat, and Google map integration.

Users have reported satisfaction with the ease of communication and access to legal advice provided by the application. The ability to resolve land law issues efficiently and effectively has been a key strength of Ettaka Lyo, making it a valuable tool for both lawyers and landowners.

4.1 Limitations on the Technology

Connectivity Issues

Ettaka Lyo heavily relies on internet connectivity for its video call and chat features. However, in areas with poor internet infrastructure or limited access, users may experience connectivity issues, hindering effective communication and usage.

Device Compatibility

The application's compatibility with different devices and operating systems may pose limitations. Users with older or incompatible devices may face difficulties in accessing or using Ettaka Lyo, limiting its reach and effectiveness.

Data Privacy Concerns

Given the sensitive nature of legal consultations and land-related information, ensuring robust data privacy and security measures is paramount. Ettaka Lyo must address concerns regarding data encryption, storage, and unauthorized access to protect user confidentiality.

4.2 Challenges faced During Development

Technical Glitches

During the development and deployment phases, Ettaka Lyo may encounter technical glitches, software bugs, or compatibility issues. These issues can disrupt user experience and functionality, necessitating timely troubleshooting and updates.

User Adoption Challenges

Introducing a new technology-enabled solution like Ettaka Lyo may face resistance or skepticism from both lawyers and landowners. Overcoming inertia and promoting adoption requires effective marketing, training, and user support initiatives.

Regulatory Compliance

Ensuring compliance with legal and regulatory requirements poses a significant challenge. Ettaka Lyo must adhere to data protection laws, professional ethics guidelines, and regulatory frameworks governing legal practice and technology use.

4.3 Recommendations

Enhancing User Experience

Continuously improving the user interface, navigation, and functionality of Ettaka Lyo can enhance user experience and adoption. Incorporating user feedback and conducting usability testing are essential for iterative refinement.

Strengthening Security Measures

Investing in robust data encryption, access controls, and authentication mechanisms can bolster data privacy and security on Ettaka Lyo. Regular security audits and compliance checks are necessary to mitigate risks and ensure regulatory compliance.

Integration with Emerging Technologies

Exploring integration with emerging technologies such as block chain for secure transactions, artificial intelligence for document analysis, and augmented reality for immersive visualization can enhance the functionality and value proposition of Ettaka Lyo.

Training and Capacity Building

Providing comprehensive training programs and capacity-building initiatives for lawyers, landowners, and relevant stakeholders can promote effective utilization of Ettaka Lyo. Empowering users with the necessary skills and knowledge fosters adoption and maximizes benefits.

Research on User Needs and Behaviors

Conducting research on user needs, behaviors, and preferences can inform the ongoing development and enhancement of Ettaka Lyo. Understanding user expectations and pain points enables targeted improvements and feature prioritization.

Conclusion

In conclusion, Ettaka Lyo has demonstrated significant potential in addressing challenges related to land ownership and legal services by connecting lawyers with landowners through digital innovation.

Despite limitations and problems encountered during its development, the application has shown promise in improving access to legal advice and facilitating the resolution of land law issues. By implementing recommendations for improvement and conducting further research, Ettaka Lyo can continue to make a valuable impact in the legal industry.

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Appendices

```
function App() {
  return (
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      <AuthProvider>
        <Routes>
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          <Route index path="/home" element={<Home />} />
          {/* <Route path="/login" element={<Login />} /> */}
          <Route path="/login" element={<SignIn />} />
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```

Figure 8: App Code snippet showing routing to the other pages.

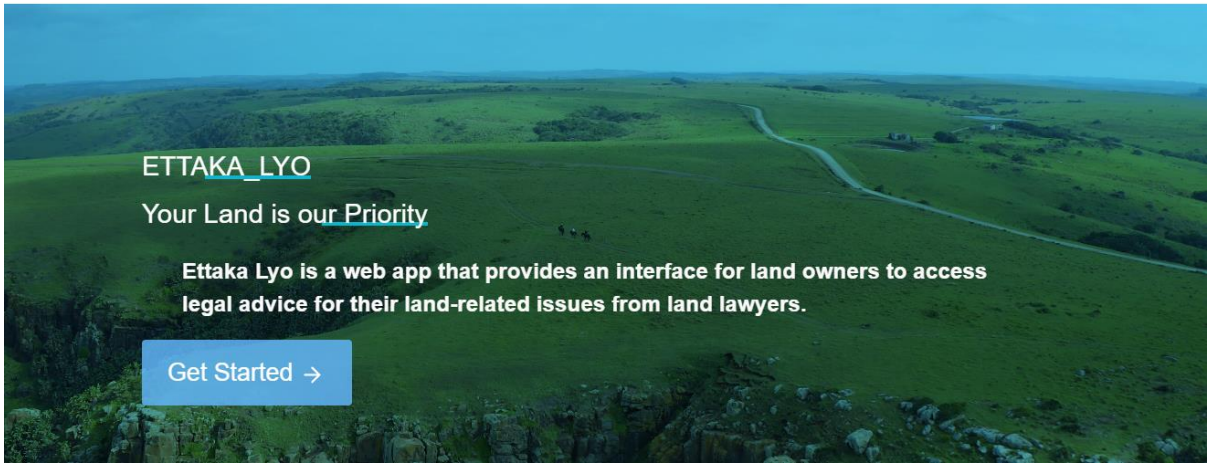

Figure 9: Landing page of EttakaLyo application.

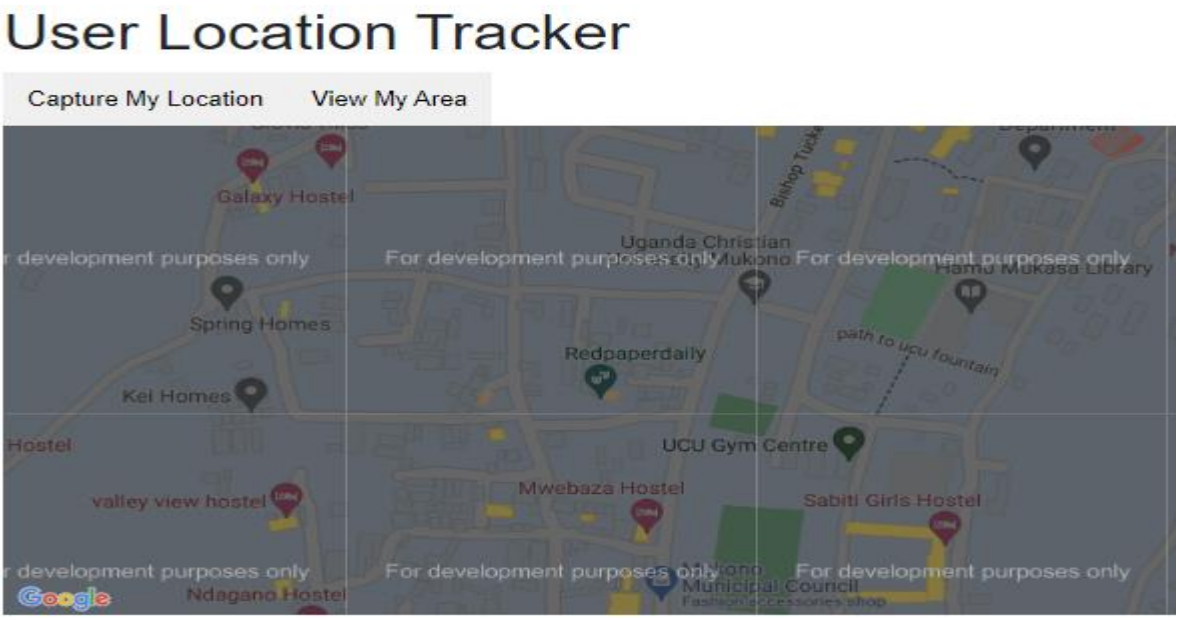

Figure 10: The google earth feature in Ettaka-Lyo application.

Tools and Environments

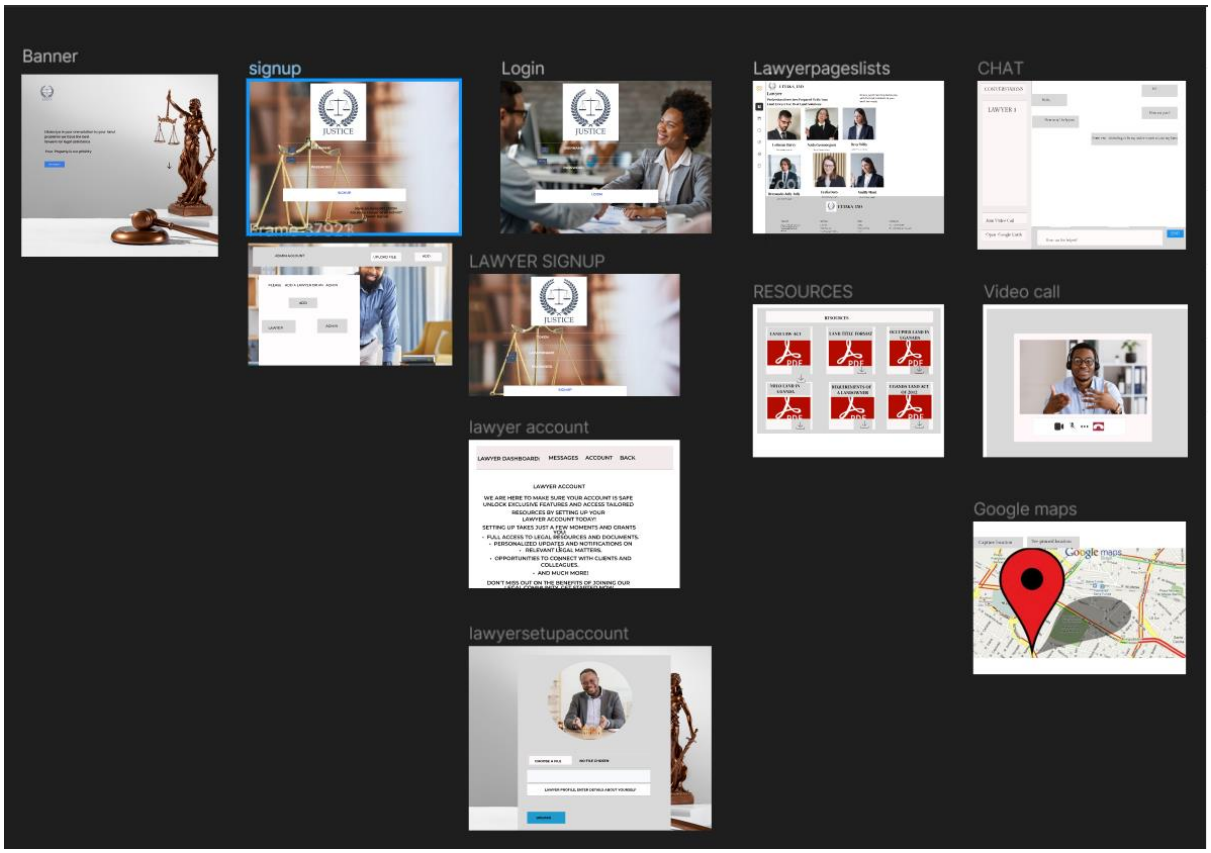

Figure 11: Figma design of the prototype of Ettaka-lyo.

Figure 12: Ettaka-Lyo poster

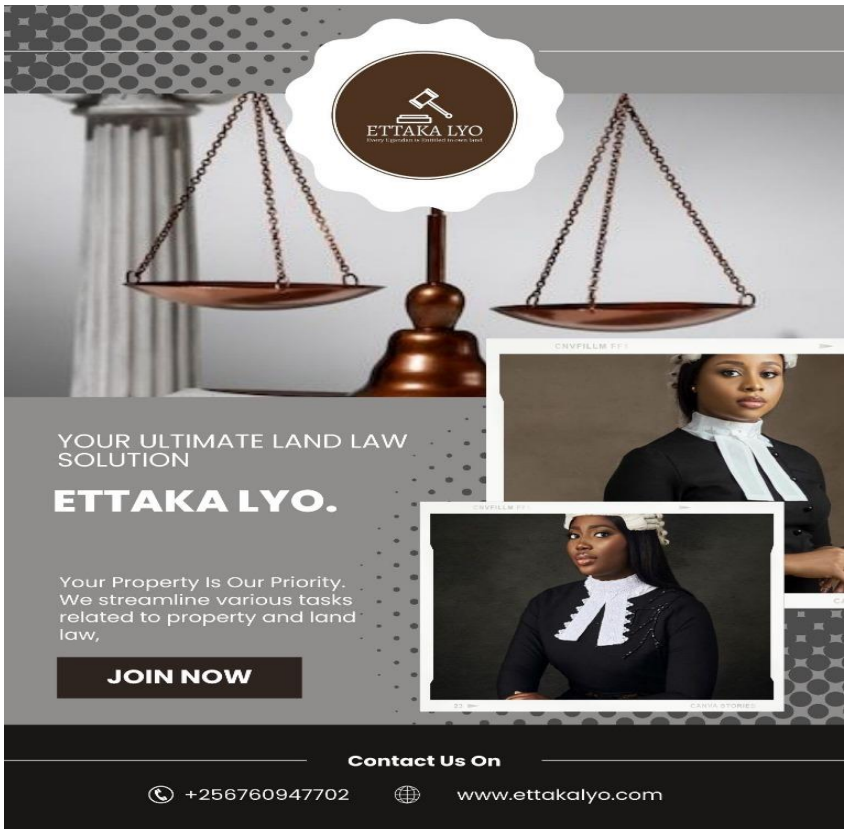

Figure 13: Poster 2 of Ettaka-lyo