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A WEB BASED LAND INFORMATION SYSTEM FRAMEWORK FOR LAND MANAGEMENT IN YOLA

Kakuru Ayuba Kake[1], Okpanachi Jockthan[2], Buhari Shehu Umar[3], Aliyu Umar[4], Bashir Damlami Muhammad[4], Joseph Ephraim Auza[5] & Abdulkadir Abubakar[6]
[1,2,3,4,5,6]Center for Geodesy and Geodynamics, National Space Research and Development Agency (Nasrda), Toro, Bauchi State
Corresponding Author: *abelkake21@gmail.com*

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ABSTRACT

Land is perhaps a sensitive resource. In Yola, we observed during field visits how the same plot was allocated to two different persons because records were kept in separate files and cabinets. The Ministry of Land and Survey, which is responsible for all statutory land matters in the state, still depends largely on paper-based methods. This manual approach has created room for double allocation, missing files, delay in processing, and difficulty in verifying ownership. We carried out this study to understand how land records are presently managed and to propose a practical digital alternative. We adopted participatory observation at the Ministry, conducted informal interviews with the staff, and reviewed sample documents such as allocation registers. Based on the findings, we designed a relational database and developed a prototype web-based Land Information System framework. The system was modeled with UML - use case, sequence, activity and class diagrams. For the implementation, the prototype runs on ASP.NET Core 8.0 (C# 12, .NET 8 LTS) for the backend, with HTML5, CSS3, Bootstrap 5.3 and TypeScript on the frontend, and Microsoft SQL Server 2022 as the data store. We used a three-tier architecture where the web server and database server are separated and all requests go through an API gateway behind a firewall. This improves security and prevents direct access to land titles. The framework, if adopted, will allow citizens to verify land, download forms, and track applications online without visiting the Ministry.

Keywords: Land Information System, Yola, Web Framework, Land, Database.

Introduction

Anyone who has tried to process land in Yola knows how stressful it can be. Despite occupying only a fraction of the earth surface, land remains the foundation for virtually all human activities (Adeoye, 2016). In Nigeria where population is growing fast, pressure on land has made it a constant source of dispute (Sadiq, 2011). The Ministry of Land and Survey Yola is not new. It is one of the ministries inherited from the old Gongola State, formerly under Works and Housing. Its job is clear: produce layouts (residential, commercial, industrial), handle survey and mapping, process statutory titles, and advice government on land policy (Babalola et al., 2015). But the reality on ground is different. During our visit to the ministry, we saw how land files were stacked in metal cabinets. Retrieval took time. There was no functional public portal. Sometimes it take days to search and confirm details of a Land. This is not surprising. Previous studies also reported that rural land ownership in Adamawa is often based on oral history, not documented titles (Didigwu & Olakanmi, 2016). When government wants to pay compensation or a bank asks for collateral, there is little paper to show.

Most earlier solutions focused on showing land coordinates on a map (Tumba et al., 2008; Aiello et al., 2018; Zevenbergen & Ploeger, 2019) but paid less attention to ownership, transfer and fraud prevention. That gap is what this work tries to fill. We asked: how can web technology, which people already use for banking, be applied to make land records open, searchable and secure? This idea of e-governance is not new (Lusthaus et al., 2002) but its application in Yola is still limited.

The ministry of Land and survey Yola, Adamawa State is one of the oldest ministries inherited from the defunct Gongola State, it was formerly known as ministry of works and housing. The ministry is saddled with the responsibilities of overseeing all Land related issues in the state. Specifically, the ministry performs the following major schedules which includes provisions of residential, commercial, industrial and other relevant layouts, preparation of physical developments plans, Surveying and Mapping, Processing of Statutory Land titles, which extend to subsequent transactions that may arise there from, advising Government on land policies and other activities that are geared towards the implementation of the National Land policies. The operations and activities of the ministry are manually carried out, whereby individuals and organizations find it difficult to access information in order to proceed with any business with the ministry..

A review of related empirical studies showed that Land ownership records are either not captured or documented properly or there was no available record to show. The only evidence available to Land owners is the generational history of the Land owners which is commonly owned by either clan or family, and the ownership moves from generation to generation. This is always a problem especially when government wants to compensate the owner of the Land or where the Land is to be used as a collateral. In addition, there is a serious problem in terms of boundary demarcation, most of the work focused on the locations of Lands on the map showing coordinates and give little attention to ownership, transfer, and titles.

This study reviewed extensive literature related to information system in general and Land information system in particular, and the study found out that web-based information system will serve well in accessing and verifying information across the globe, this can be used by organizations and government institutions. The wireless nature of the technology is another advantage of the technology; still the automation of data storage in a database is of a necessity for proper documentation and updating of information. In order to explore this area of information systems further, the choice of a web-based technology has necessitated this study.

Aim and Objectives of the Study

The main Aim of this study is to develop a reliable web-based Land information system framework so that management of Lands information and its associated attributes within the study area can be carried out with minimum effort.

This is achieved through the following objectives:

i. To study the existing system using an object-oriented approach
ii. To design a database to serve as the data storage for ministry of land and survey Adamawa State using Microsoft SQL Server Database.
iii. To design a conceptual model framework of a web-based Land information system; and
iv. To develop a prototype web-based Land information system for Land areas managed by Ministry of land and survey Adamawa state using Asp.net, html5, CSS and JavaScript for the front-end, C# as the Middle-end programming language and MSSQL as the back-end database.

Methodology

This describes the method and the tools that were used to develop the software design that can easily specify the functional requirement of the proposed web-based land information system.

Method of data collection

The information on Land ownerships record, allocation purpose record, Land ownership transfer record, and how these records are kept and used in ministry of Land and Survey was obtained through:

i. Participatory observation: In order to have a better understanding of the nature of how Land records are kept, the authors went to the ministry and examined how records are kept and updated.
ii. Interview: interviewed some administrative Staff of the ministry of Land and survey on the best way to improve their records keeping using the automated system was carried out.
iii. Secondary data: some materials like files, Land registration form, Land acquisition certificate, Land allocation record, transfer of ownership form, etc were received which information about the existing system.

Software development methodology

Software development methodology is important to the development of the web-based Land information system. The study used "AGILE software development methodology" for the system. Agile software development is a type of incremental model where software is developed in incremental, rapid cycles. This resulted in small incremental releases with each release building on previous functionality and will be thoroughly tested to ensure that software quality is maintained. Extreme Programming (XP) is currently one of the most known agile development life cycle models. In this Land information system software development process, the design phase will involve decomposing the system into modules and defining the relationships among the constituent modules. Top-down design approach will be employed in doing this. This involves dividing the system into sub-systems or modules and each sub-system is further divided into even smaller units. This process of division is repeated until each module is sufficiently small enough to be conveniently coded (implemented) as an independent entity that will perform a clearly defined operation.

Requirement engineering of the system

According to Ridley (2006) Unified Model Language (UML) is a structure for documenting the functional and non-functional requirements for a system, usually involving software, whether it is new or being changed. For the purpose of this study, the UML diagrams is used for documenting the functional and non-functional requirements of the

system which will include; Context Diagram, Use Case Diagram and Activity Diagram. The user's requirement as described by Sampath was adopted. The hardware requirement for this system will include: a complete computer set and the software requirement will include: web browser with internet access.

Modeling Approach

Unified Modeling Language (UML) model was used to represent Land information record system processes which will ease understanding and provide an exact picture of the procedures involved in web-based Land record system. The use of UML in this research is an essential requirement. The UML notation used to model the web-based statutory Land record system is described in the following sub-sections.

Context diagram

Context Diagram is a data flow diagram that gives just a high-level overview of the system. It showed how data flows between the subsystems of web-based Land information system that will derive the system functional requirements; furthermore, it will show the input and output of data of each process into subsystem.

Used case Diagram

A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. In this context, the term "system" refers to something being developed or operated, such as a mail-order product sales and service Web site. Use case diagrams are employed in UML (Unified Modeling Language), a standard notation for the modeling of real-world objects and systems. System objectives can include planning overall requirements, validating a hardware design, testing and debugging a software product under development, creating an online help reference, or performing a consumer-service-oriented task.

Activity Diagram

Activity diagram is another important diagram in UML to describe dynamic aspects of the system. Activity diagram is basically a flow chart to represent the flow form one activity to another activity. The activity can be described as an operation of the system. So, the control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent. Activity diagrams deals with all type of flow control by using different elements like fork. The basic purposes of activity diagrams are similar to other four diagrams. It captures the dynamic behaviour of the system. Other four diagrams are used to show the message flow from one object to another but activity diagram is used to show message flow from one activity to another. Activity is a particular operation of the system. Activity diagrams are not only used for visualizing dynamic nature of a system but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in activity diagram is the message part.

Database Model

Database model is an organized collection of data. Its contents can easily be managed, updated, retrieved, stored and have access to the data. Database is prevalent in the world of business because they permit centralized access to information in a way that is consistent, efficient and relatively easy to setup and maintain. The two types of database modeling include: Logical database modeling and Physical database modeling. Logical modeling deals with gathering business requirements into model. Logical model revolves around the needs of the business not the needs of the database, although the needs of the business are used to establish the needs of the database. Physical database modeling involves the actual design of a database according to the requirements that were established during logical modeling. There are three models for designing a database, which are; Relational database model, Network database model and Hierarchical database model. Therefore, the model that was used in this research is relational database model.

A relational database model stores data in tables which comprise of rows and columns. It enables data retrieval or query subsets of data from tables faster and easier. Relational database model is the easiest and the most flexible database model. Each record within a well-designed relation (table) has a key field, which is unique to that record, and relationships between tables are shown using link fields. That is, relationship can be established among the tables that have common field which is presented using entity relation diagram.

Development and Programming Tools

The development phase of this work was carried out by using Microsoft Visio which was used for models and database structure to show the entity relationship that exists among entities for the persistency. Microsoft SQL Server will be used for database design. Java script, ASP.net and Microsoft Visual Studio being the platform while C# for programming aspect and CSS was used for positioning the content on the portal.

Functional and Non-functional Requirements

This phase involves outlining the functions that the property information system prototype can achieve, and an ideal working environment in which the prototype is delivered. The analysis stage involved a detailed learning of the existing system, leading to requirements of a new system. It also involved a detailed study of various operations performed by the system and their relationships.

The requirements are gathered through a chain of interviews with the different stakeholders. Answers from these users generate the requirements needed for further design of the property information system prototype.

Functional requirements

Requirements are divided into functional requirements and non-functional requirements. Functional requirements are related with detailed functions, tasks or actions the system must support. The functional requirements are as follows:

i. The users should be able to access data from different location.
ii. The users should be able to access property information and details from different location without any setbacks.
iii. The system should be able to allow property registration by authorized users.
iv. The system should be able to allow users to search for property from different location.
v. The users should be able to download property application and leasing forms.
vi. The users should be able to print downloaded figures and charts.
vii. vii. The system should be able to allow users to buy or submit their property information for sales or leasing.
viii. The users should be able to access the system from anywhere at any point in time (24/7).

Nonfunctional requirements

i. The system should be based on user authentication so that un-authorized user's do not access the application sensitive section.
ii. The front end application should be web enabled and no installation is required on users system.
iii. The front-end application should be hosted on a reliable web hosting company.
iv. User level permission is required in order to protect the integrity of the data and restrict user's accessibility to data.
v. The system should perform very well at all times and should be easy to recover after system down time.
vi. The system should be able to keep up to-date information at all times.

User requirements

i. Ability to use data from the property information system Prototype database for data and reports.
ii. Ability to perform complex queries to produce required data views and reports with little effort.
iii. Ability to download view and print information from the property information system prototype and use it for other purposes.
iv. System reliability at all times.

The Software system requirements are:

i. System type: 64-bit Operating System (Windows 11 Pro / Server 2022).
ii. Database engine: SQL Server 2022.
iii. Visual Studio 2022 (v17.12) + VS Code
iv. Backend : ASP.NET Core 8.0, .NET 8 LTS, C# 12, EF Core 8
v. Frontend: HTML5, CSS3, Bootstrap 5.3, TypeScript 5.5
vi. Identity + JWT, TLS 1.3, AES-256, WAF

Design And Implementation

This described the actual implementation process for developing a reliable database and a web based land information system for the Adamawa state ministry of Land and Survey, Yola.

Data Presentation

The researcher was able to bring out the required database requirements, data types and all the required entities for the proposed database, based on the information gotten from the interview.

Process Design

The second objective is to design a relational database that will serve as a secure means of data storage for the ministry of land and survey, Yola, where land information can be securely save, retrieved and updated in a relational database. There are several activities and process being carried out between the ministry and the general public. These processes include; land and property registration, download of application documents and process of viewing land/properties that are available for leasing or sale to the general public.

Land and property registration

This process involves all the necessary steps taken in registering land or property with the ministry of land and survey, Yola, this process include:

i. Personal land registration
ii. Land for sale registration
iii. Land for leasing registration

Document download

This process involves all the necessary steps taken by the general public in getting the required documents for registering and listing of land either for selling or leasing, this process involves:

i. Download of Certificate of Occupancy Application form
ii. Download of Conversion of Customary Title form
iii. Download of Property Leasing and Selling Application form

Viewing and acquiring of land

The viewing and acquiring of land process involves the steps taken by the general public to acquire, sale or lease a land. This process gives the users the privilege to retrieve all available registered land with the ministry and those land listed for sales, leasing or those under litigation.

Logical Designs

The logical design shows all the logical process that was design for developing a land information system for Adamawa State Ministry of Land and Survey, Yola Adamawa State. Some of the logical designs include a Use Case Diagram, a Sequence Diagram, an Activity Diagram and a Class Diagram.

Conceptual Framework Design

Conceptual Model

Another key objective of the study is to design a conceptual model for the web based Land information system. The model also showcases the security methodology to be adopted by separating the web pages of the application with the application database in two different servers and only connecting via an application program Interface (API). All web requests are made to pass through a firewall for security checks before accessing the application pages. See Figure 1

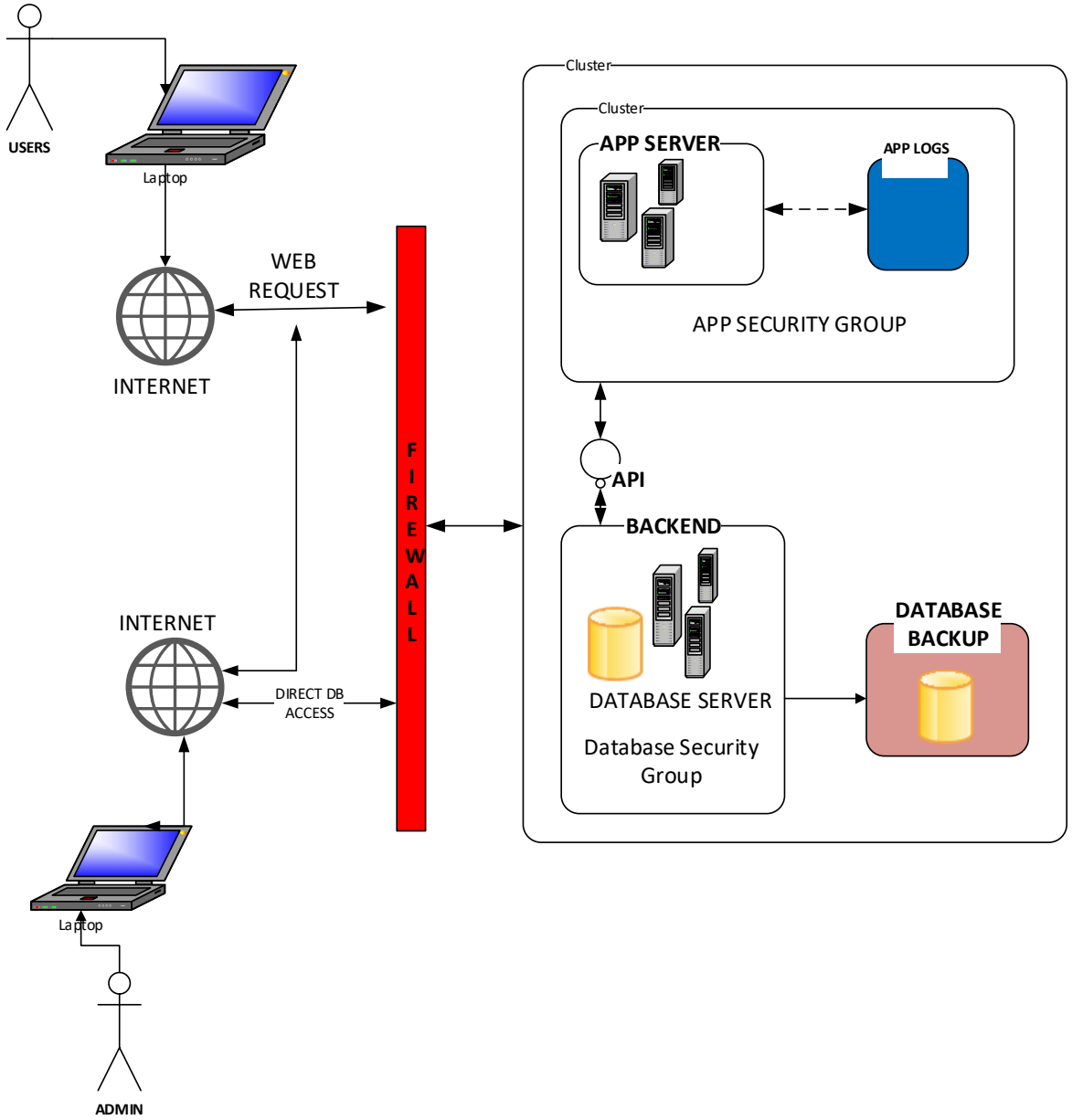


Figure 1: Land Information System Framework

Use Case Diagram

Figure 2 and Figure 3 show the Land Information System Use Case Diagram that describes the sequence of actions that will be carried out by the user and the administrator of the system. Activities are graphically represented as an ellipse with solid line including only its name.

An actor represents a real-world object. The use case also shows how the users and the system interact with each other to complete a particular process. With regard to this design the system uses two use case diagrams based on public privileges and the administrator privilege.

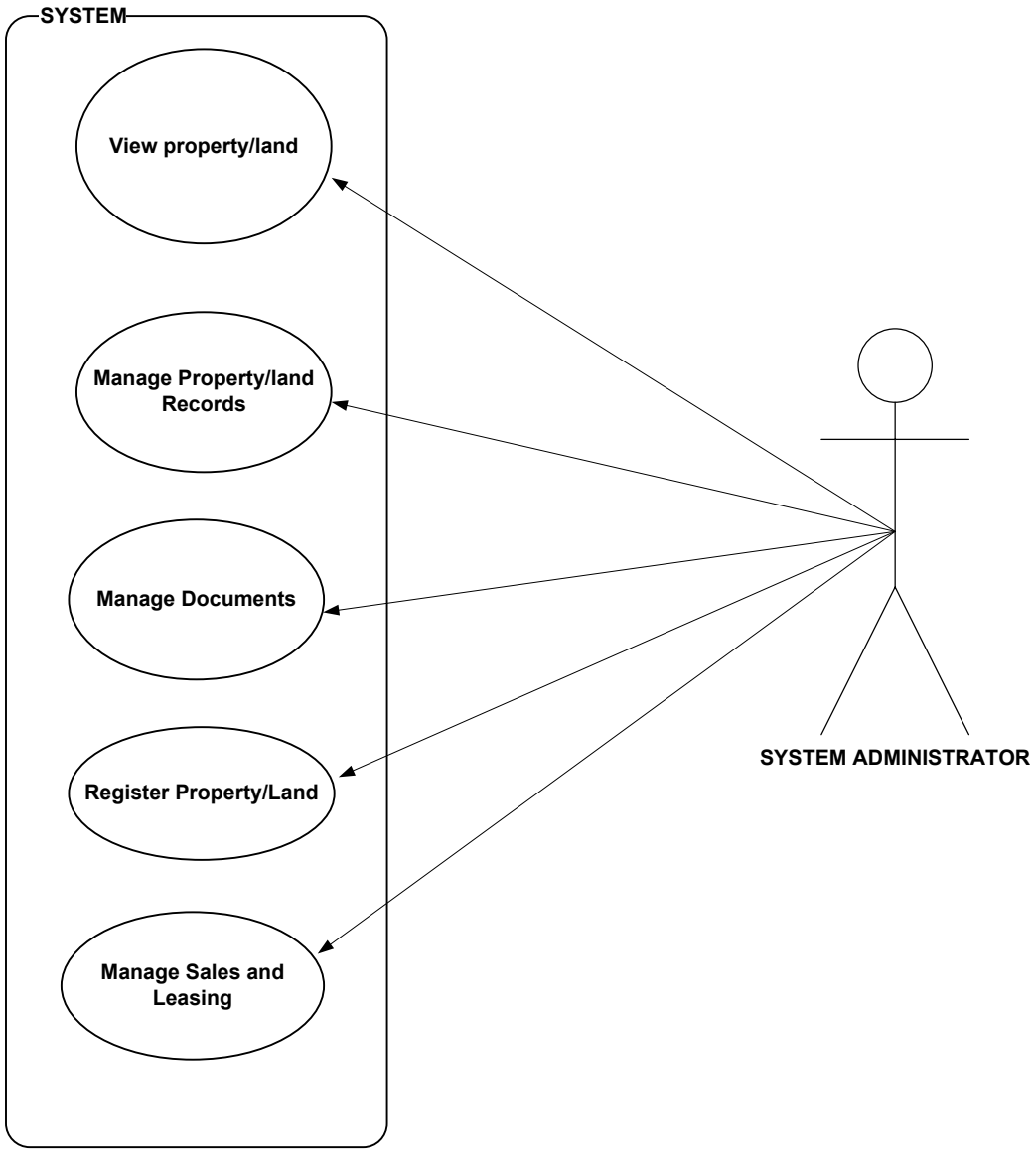


Figure 2: Administrators Use Case Diagram

Figure 2, shows the Administrator's use case diagram, it shows how the administrator interact with the various section and activities of the system. The administrator has high access privilege to the system. The various activities accessible by the administrator include; Viewing of available properties and land, Management of land and property records, management of property and land documents, Property registration, property leasing and property sales record management.

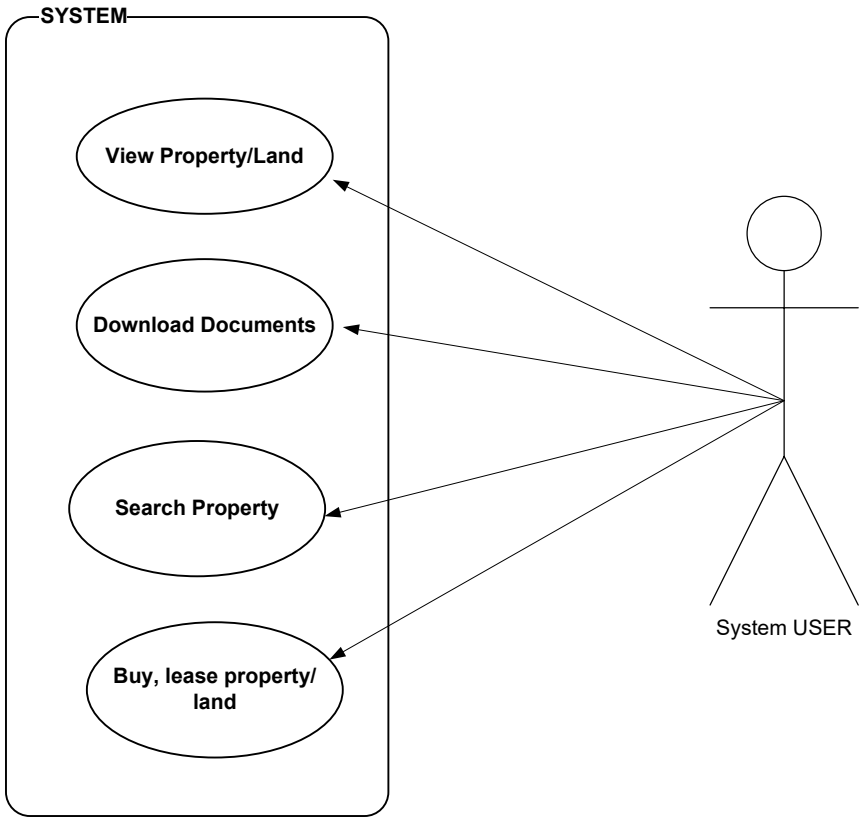


Figure 3: Users Use Case Diagram

Figure 3, shows the User's use case diagram, it shows the various interaction of the system users with the system, the various activities include: viewing of property/lands, download of documents, searching for property/land and buying, leasing and selling of property/land.

Sequence Diagram

This study has design two sequence diagrams, one for the sequence of operations that would be available for the System Administrator while the other is for the system users. Figure 4 and Figure 5 show the Sequence diagram of the system.

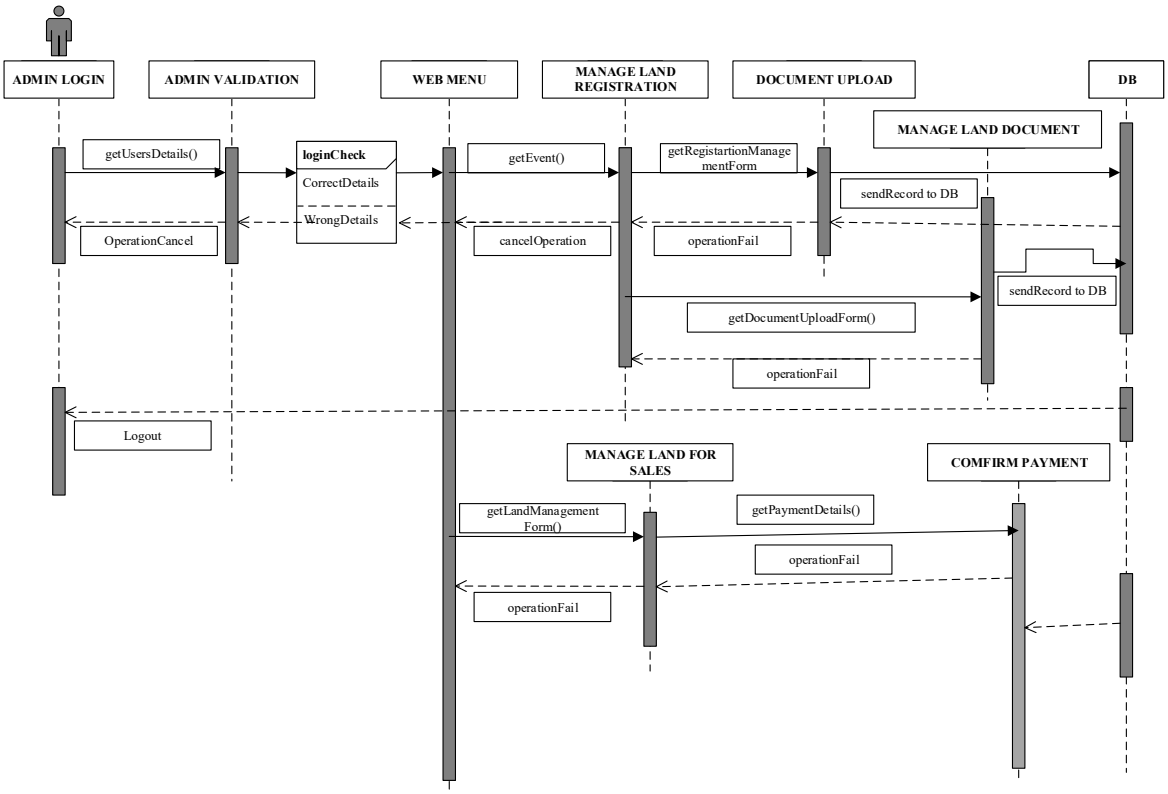


Figure 4: Admin Sequence Diagram

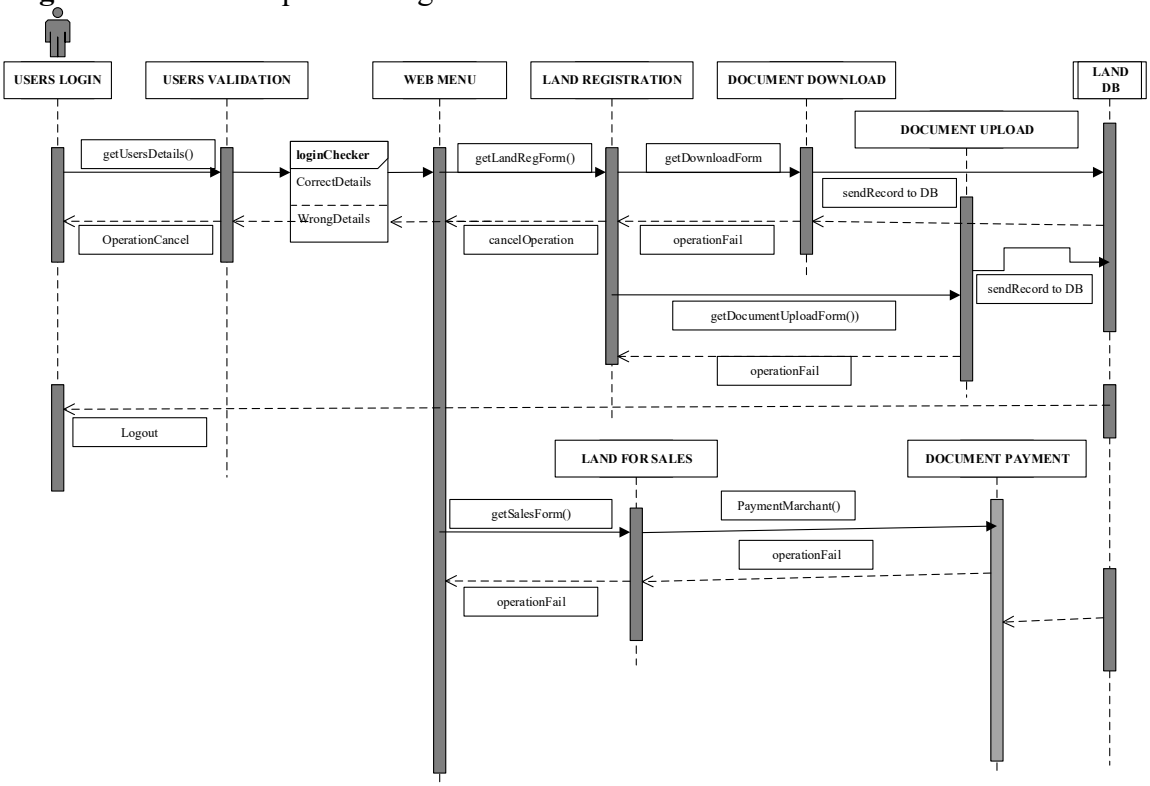


Figure 5: Users Sequence Diagram

Activity Diagram

Like the Sequence diagram the study has also designed an Activity diagrams showing the various activities that the system administrator and the system users can perform on the

system. The various activities available for the system administrator are much more than those available for the system users, thereby giving the system administrator more activity than the system user as can be seen in figure 6 and figure 7

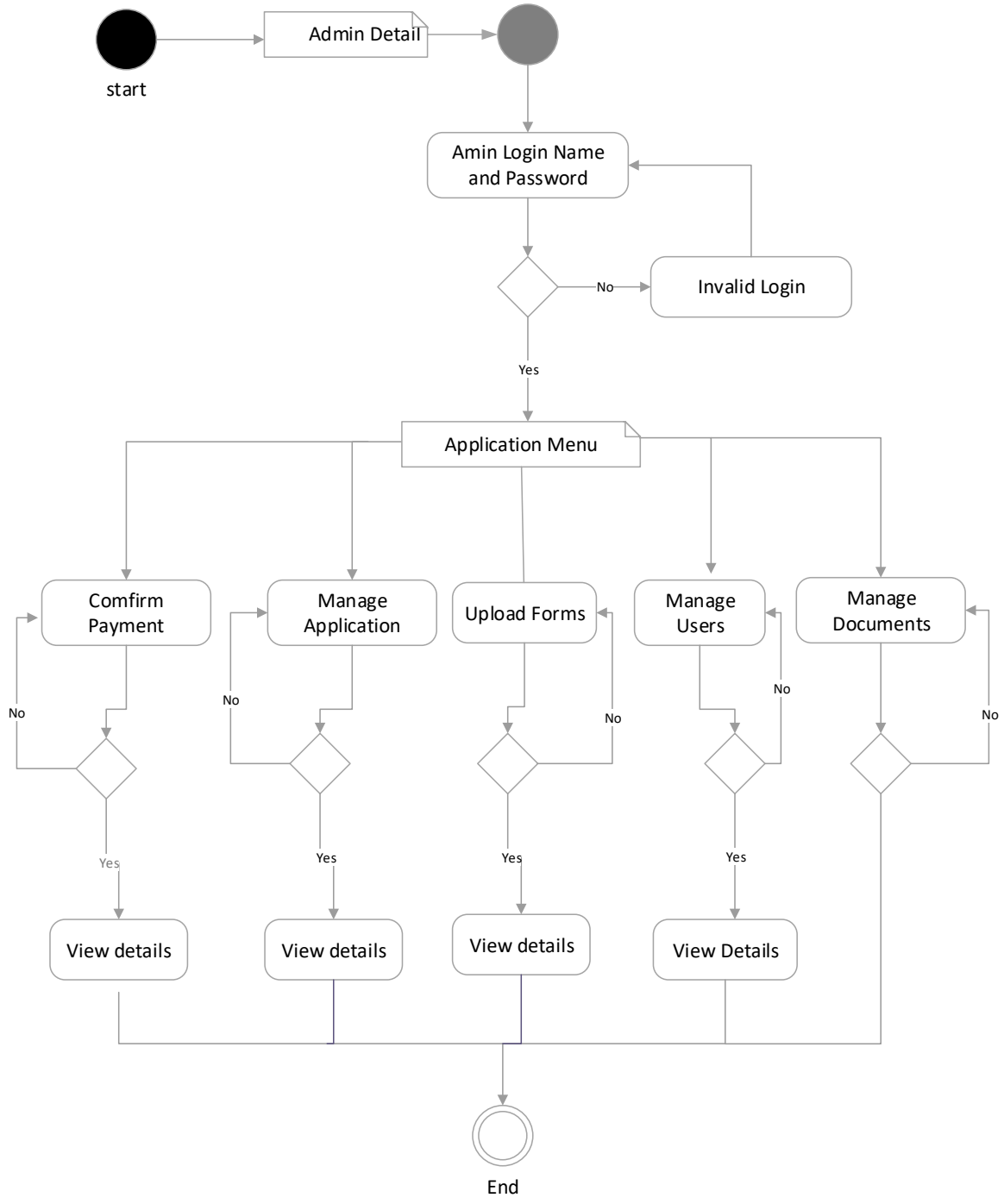


Figure 5: Admin Activity Diagram

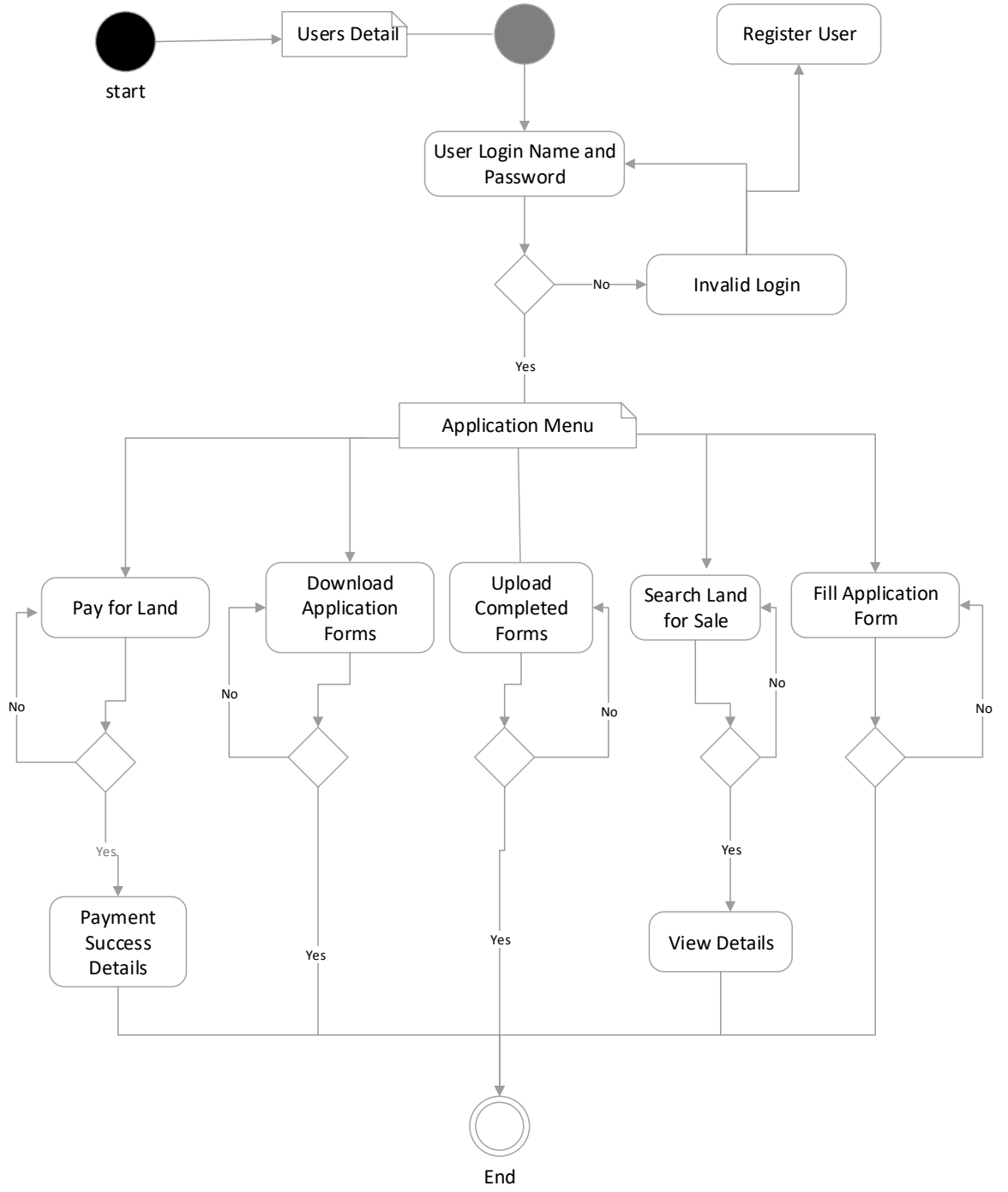


Figure 6: User Activity Diagram

Class Diagram

Figure 6 shows the class diagram of the system, where all the various classes making up the system database are shown. The class consist of all the various objects and variable type for each class. The system consists of eight classes.

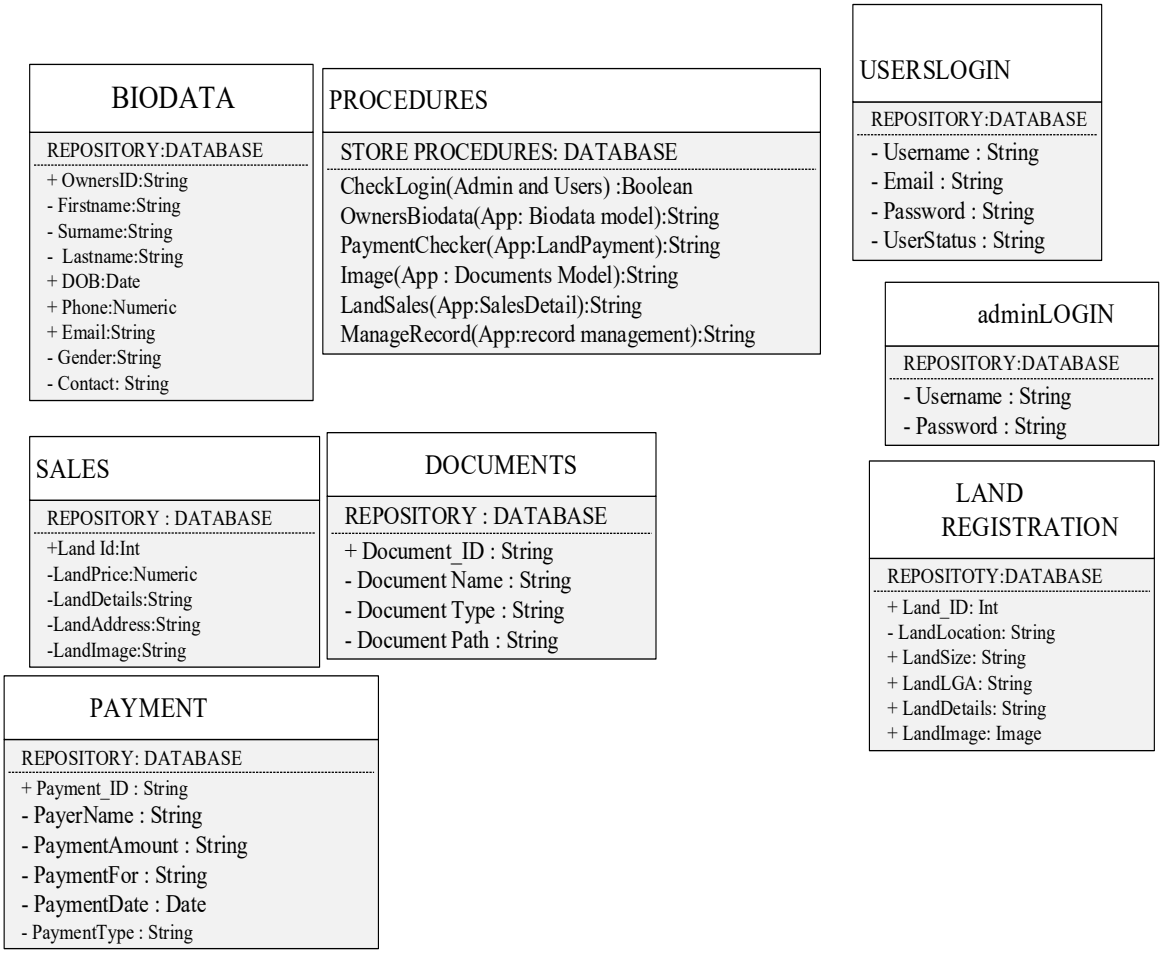


Figure 7: Class Diagram of the System

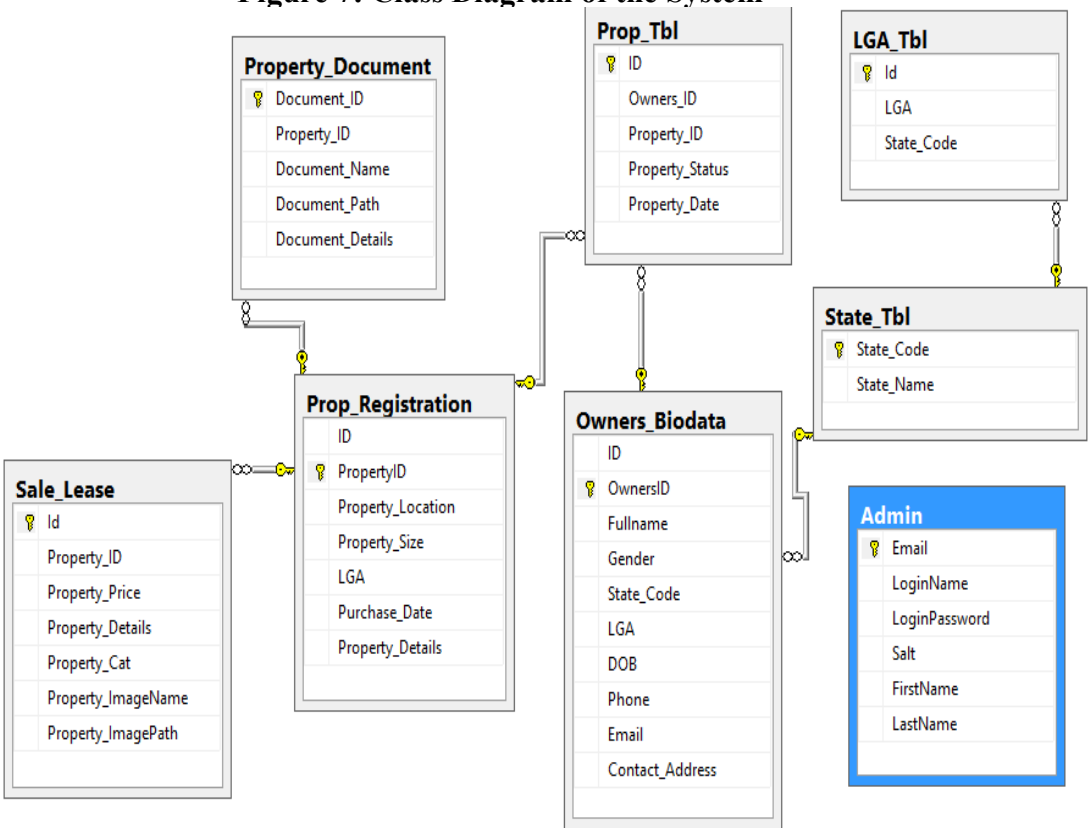


Figure 8: Entity relationship diagram of the system

Results and Discussion

i. What we found from the field:
The filing system is functional but risky. A file could be in one cabinet but the allocation registers in another office. No backup. If fire occurs, records are gone. Staff were actually willing to use computers but complained about lack of training and unstable power.

ii. Database result. We designed a database to avoid duplication. By using the primary and foreign keys one parcel cannot have two active titles at same time - this simple constraint alone solves double allocation.

iii. Discussion - How this is different, Unlike Babalola et al. (2015) who used single server, we separated database and web server. This is the model Kalogianni et al. (2020) recommended for security. Also, earlier work (Babalola et al., 2018) used PHP/MySQL; we used .NET 8 and SQL Server 2022. The big difference is practicality - we involved real staff from Yola, not just theory.

Limitations

We have not added GIS and NIN to the design. Those will need partnership with NASRDA and NIMC. Also, the work is framework that needs to be fully implemented.

Conclusion

If this framework is implemented fully, Yola will move from cabinet-based to cloud-based land management. It will be faster, more transparent and less prone to fraud. Citizens will not need to travel from their location to verify a record, they can check online. The state will also have a backup of all titles.

Recommendations

We recommend that the state government to

i. Approve pilot implementation.
ii. Provide training for its staff.
iii. Conduct cost analysis.
iv. Later integrate NIN and payment gateway.

Scientific Significance of the Study

This work contributes a tested schema and framework that other states facing similar manual problems can adapt. The code and schema are available for academic use on request.

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