MZUMBE UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY (FST)

DEPARTMENT OF COMPUTING SCIENCE STUDIES (CSS)

PROJECT TITLE: DIGITAL GRAIN CROPS TRACKING SYSTEM.

CASE STUBY: AT NATIONAL FOOD RESERVE AGENCY

BY

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A project proposal submitted in partial fulfillment of the requirement of Bachelor degree of Science in Information and Communication Technology with Management of the Mzumbe University.

2025

CERTIFICATION

We, the undersigned, certify that we have read and here by recommended for acceptance by the Mzumbe University, a project report entitled" DIGITAL GRAIN CROPS TRACKING SYSTEM" is my own original work done by me under assistance and supervision. It has not previously submitted for award of any academic qualification.

Signature. Date.

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Major supervisor

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Internal Examiner

Accepted for the board of Faculty of Science and Technology

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Signature.

Dean, Faculty of Science and Technology

DECLARATION AND COPYRIGHT

I**, HAPPINESS G. NDUNGURU,** declare that this project entitled "**DIGITAL GRAIN CROPS TRACKING SYSTEM** "is my own original work and has not been presented and will not be presented to any other university for a similar or any other certificate award.

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ACKNOWLEDGMENT

Firstly, I give thanks to GOD for strengthening me during the whole project development time,

I express much gratitude to my Supervisors, **PROF MERCY KOMBA** for his help, support and cooperation throughout the work for this project.

Kindly, I give thanks to Mzumbe university examination office member and my parents for their help as my interviewee for me to collect and analyze the project requirements which is done by me.

Finally, I would like to thank my collages friends for their help to accomplish of this project.

DEDICATION

I dedicate this project to the Almighty GOD, my strong pillar the source of inspiration, wisdom, and knowledge and understand. I also dedicate this work to my supervisor, parents and collagenous friends for their encouragement to finish this which I have started.

May GOD Bless you All!

ABSTRACT.

Food security remains a critical concern in Tanzania, with the National Food Reserve Agency (NFRA) playing a pivotal role in procuring, storing, and distributing grain crops to stabilize national food supplies. However, NFRA currently relies on manual stock tracking methods, leading to inefficiencies, inaccuracies, and delays in decision-making. This project proposes the development of a Digital Grain Crops Stock Tracking System (DGCTS) a web-based platform designed to automate inventory management, enhance financial oversight, and improve operational efficiency. The study applies a qualitative research design to analyze existing stock management challenges and develop a digital solution that centralizes record-keeping, provides real-time tracking, and facilitates data-driven decision-making. The system incorporates features such as automated data entry, stock movement monitoring, financial tracking, and analytical reporting to improve transparency, accountability, and responsiveness in food stock management.

This report is divided into different chapters as follows, Chapter one which gives the elaborations on the background of the study that is, the origin of Digital Grain Crops Stock Tracking system at NFRA also it gives objectives of this study.

Chapter two is about literature review where it elaborates similar works performed by other researchers and authors or programmers on Digital Grain Crops Stock Tracking System, all over the world, in this chapter will explain different methods used in Digital grain crops stock tracking before implementation of its online system. Also, this chapter tends to explain how to deal with different challenges which may arise in Digital grain crops stock tracking system especially in security means and implementation. Chapter three is all about system methodology which explain about methods used in collecting data which made the use of this system which is observation and questionnaires whereas different questions formulated. Also, this chapter explained about system analysis that is functional requirements, non-functional requirements and requirements specifications that on what kind of device the system can be applied or used

Keywords: Grain crops, stock tracking, inventory management, web-based system, food security, Tanzania.

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ABBREVIATION AND ACRONYMS

DGSTS……Digital Grain Crops Stock Tracking System

NFRA…….National Food Reserve Agency

FAO…… Food and Agriculture Organization

TARI…… Tanzania Agricultural Research Institute

NCPB……. National Cereals and Produce Board

ATA…… Agricultural Transformation Agency

AMIS…… Agricultural Market Information System

WRS…… Warehouse Receipt Systems

UML……Unified Modelling Language

RDBMS……. Relational Database Management System

SQL……Structured Query Language

GUI…….Graphical User Interface

HTML……..Hypertext Markup Language

CSS…….Cascading Style Sheets

ERD……..Entity Relationship Diagram

UI……..User Interface

LIST OF FIGURES.

CHAPTER ONE

BACKGROUND AND PROBLEM STATEMENT

1.1 Introduction

The origin of the National Food Reserve Agency (NFRA) goes back to the drought of 1974-1975 when Tanzania was hit by an acute food shortage. The country was unable to meet its food requirements and to depend on imports food aid. The disaster made the Government realize the importance of establishing a food reserve organ and the need to have a sustainable solution to the problem. The Government sought a technical assistance from the Food and Agriculture Organization (FAO) Of the United Nations. NFRA has a mandate to guarantee the national food security through procuring, reserving and recycling grain stocks-primary maize-and doing so in cost effective manner. The National Food Reserve Agency (NFRA) in Tanzania operates in eight regions Dodoma, Dar es Salaam, Njombe at Makambako, Songwe, Rukwa at Sumbawanga, Arusha at Babati, Shinyanga and Songwe.

Currently, food security remains a pressing issue in Tanzania due to population growth, climate change, and logistical challenges in food distribution. Despite NFRA's crucial role, its operations are hindered by inefficiencies in stock tracking and financial management. Reports indicate that poor inventory monitoring leads to grain wastage, delayed responses to shortages, and financial mismanagement, which directly affect national food security.

This study aims to address these challenges by proposing the development of a Digital Grain Crops Stock Tracking System (DGCTS) to modernize inventory management, enhance transparency, and improve decision-making within NFRA.

1.2 Background of the study

Food security is a critical concern for many nations, especially those reliant on agriculture as a primary economic activity. The National Food Reserve Agency (NFRA) in Tanzania was established in response to the severe drought of 1974-1975, which caused acute food shortages and highlighted the need for a structured food reserve system. Since its inception,

NFRA has played a key role in procuring, storing, and distributing staple crops—primarily maize—to ensure national food security.

Despite its crucial function, NFRA currently faces significant challenges in managing its food stock and financial resources. The existing system for tracking grain inventory and budgeting relies heavily on manual processes, which are prone to inaccuracies, inefficiencies, and delays in decision-making. These inefficiencies can lead to food shortages or surplus stock, affecting food availability, market stability, and financial sustainability.

To address these challenges, the Digital Grain Crops Stock Tracking System is proposed as an automated solution to enhance NFRA's operational efficiency. This system aims to centralize record-keeping, provide real-time stock tracking, improve budget control, and enable data-driven decision-making. By leveraging modern technology, the system will help NFRA optimize food reserve management, reduce financial wastage, and ensure timely response to food security needs.

This study explores the development and implementation of the Digital Grain Crops Stock Tracking System, focusing on how digital solutions can improve inventory management, financial oversight, and overall food security in Tanzania.

1.3 Problem statement

The National Food Reserve Agency (NFRA) of Tanzania plays a crucial role in ensuring food security by purchasing, storing, and distributing grain crops such as maize. However, the agency faces challenges in efficiently managing stock levels and financial resources. A 2022 government audit report highlighted that 25% of NFRA's grain reserves were lost due to mismanagement and inefficiencies in manual tracking. Additionally, a study conducted by the Tanzania Agricultural Research Institute (TARI) in 2021 revealed that delays in updating stock records contributed to nationwide food shortages during drought seasons.

To address these challenges, this project proposes the development of a Digital Grain Crops Stock Tracking System (DGCTS) that will automate inventory management, ensure real-time data access, and enhance transparency. By implementing this system, NFRA can

optimize its stock tracking process, improve resource allocation, and make informed decisions to maintain food security in Tanzania. A case study from Kenya's National Cereals and Produce Board (NCPB) demonstrated that digitalizing grain stock tracking reduced wastage by 40% and improved decision-making efficiency.

1.4 Project objectives

This part shows the general objective of the project and the specific objects.

1.4.1 General objective

The general objective of this project is to develop a web-based system Digital Grain Crops Stock Tracking System that enables centralization of records keeping.

1.4.2 Specific Objectives

1. To analyze the limitations and inefficiencies of the existing manual grain stock tracking system.
2. To identify and document the specific requirements of users, including stock managers, procurement officers, and financial officers.
3. To design and implement an automated system that improves the accuracy and efficiency of grain stock records management.
4. To develop a real-time data update mechanism for improving access to market information for grain sellers and buyers.
5. To create a secure and user-friendly interface that facilitates efficient stock monitoring, procurement management, and financial tracking.

1.5 Significance and the scope of the project

1.5.1 Scope of the project:

The Digital Grain Crops Tracking System for the National Food Reserve Agency (NFRA) is designed to enhance efficiency in grain stock management, budget control, and decision-making. The scope of this project is outlined based on geographical coverage, data management, functionalities, technology and user interface, and security and privacy.

1.Geographical Coverage

The system will initially be implemented in NFRA's eight regional warehouses located in: Dodoma, Dar es Salaam, Njombe (Makambako), Songwe,Rukwa(Sumbawanga),

Arusha(Babati), Shinyanga, Another site in Songwe

2. Data Management

- Real-Time Stock Monitoring: The system will track the quantity and movement of maize and other grains across NFRA warehouses.
- Automated Data Entry: Minimized manual intervention to reduce errors in stock and financial records.
- Cloud-Based Storage: Data will be stored on a secure cloud platform to enable accessibility across multiple locations.
- Data Analytics and Reporting: The system will generate real-time reports on inventory levels, financial expenditures, and stock movement.

3.Functionalities

The system will have the following core functions:

- Stock Tracking: Real-time monitoring of grain stocks, including incoming and outgoing shipments.
- Budget Control: Automated financial management to track procurement, storage, and distribution costs.
- Alerts and Notifications: Automatic notifications for low stock levels, budget overruns, and upcoming stock expiration.
- Reporting and Decision Support: Generation of analytical reports for better decision-making.
- User Role Management: Role-based access for warehouse managers, financial officers, and administrators.

Technology and User Interface

- Web-based system: Ensuring accessibility through mobile and other electronic devices for wider user reach and access the system.

- User-Friendly Interface: Designing a simple and intuitive interface catering to users with varying technological literacy levels.
- Language Localization: Offering the system in Swahili and English languages for broader user adoption in Tanzania.

5. Security and Privacy

- Data Security: Implementing robust security measures to protect sensitive information from unauthorized access and manipulation.
- Privacy Protection: Adhering to data privacy regulations and ensuring user control over their information.

- Scalability: Designing the system with the ability to accommodate future growth and adopt to change requirements.
- Maintenance and Updates: Establishing clear plans for ongoing maintenance, system updates, and user training.
- Capacity Building: Training land administration officials and users on system operation and maintenance

1.5.2. Significance of the project

2 Improved Food Security: By ensuring accurate tracking and timely replenishment of food reserves, the system will help NFRA maintain a stable supply of staple crops, reducing the risk of food shortages.

3 Financial Efficiency: The integration of budget control will help NFRA monitor and control its financial resources, minimizing wastage and maximizing the efficiency of allocated funds.

4 Operational Efficiency: The automation of stock tracking and financial processes will reduce the time spent on manual record-keeping, improving overall operational efficiency and responsiveness.

5 Transparency and Accountability: A digital system will ensure greater transparency in stock management and financial transactions, enhancing trust among stakeholders and enabling better audits.

6 Better Decision-Making: The system will provide valuable insights through data analytics, allowing NFRA management to make well-informed decisions regarding stock procurement, storage, and distribution.

7 Sustainability: The project promotes sustainability by optimizing resources, reducing the risk of spoilage, and ensuring that budget allocations are used effectively to meet food security goals.

CHAPTER: TWO

LITERATURE REVIEW

2.0 Introduction

This chapter documents the available relevant literature concerning the problem domain. The implication was that the researcher devoted sufficient time to reviewing research already undertaken on related problem from different countries. This was done to find out what data and other materials are already available from earlier research, and identify gaps and weaknesses that the present research may fill.

A literature review is as a reference of what has been published on a topic by accredited scholars and researchers about the topic of DIGITAL GRAIN CROPS TRACKING SYSTEM This chapter consists of four parts. The first part will discuss about topic review, the second one will discuss about the Methodology, the third part will discuss about the Domain review, forth part is about the problem conclusion and conceptual frame work, and the lastly conclusion which will describe a briefly summary of the entire chapter.

2.1 Topic review

The digitalization of inventory management has transformed supply chain operations globally, particularly in the agricultural sector. Studies have shown that digital tracking systems enhance transparency, minimize losses, and improve efficiency in managing food reserves (World Bank, 2019). In the context of food security, an effective stock tracking system is essential for ensuring the availability and sustainability of staple grains. Despite these advantages, many food reserve agencies, especially in developing countries, continue to rely on outdated manual systems that are prone to inefficiencies and inaccuracies (FAO, 2020).

Recent research highlights how automated tracking solutions, such as cloud-based platforms and IoT-integrated monitoring systems, have improved stock control and financial accountability in various agricultural institutions. Ethiopia's Agricultural Transformation Agency (ATA) has implemented digital inventory management tools that enhance food stock tracking accuracy (Bekele, 2022). Similarly, Kenya and Uganda have

adopted warehouse receipt systems (WRS) to streamline grain reserve management and market access (Ochieng & Mutua, 2021). However, these approaches, while promising, have not fully addressed real-time tracking challenges in large-scale food reserve agencies.

Although previous studies have provided valuable insights into digital stock tracking applications in agriculture, gaps remain in addressing real-time inventory monitoring, financial integration, and scalability in government-controlled food reserves. Most existing research focuses on private sector-driven solutions rather than large-scale public food reserve agencies like NFRA. This study seeks to fill this gap by developing a specialized DGSTS tailored to the unique operational requirements of NFRA, ensuring real-time stock visibility, automated financial reporting, and enhanced decision-making capabilities.

2.1.1 Existing system and challenges

1. Inefficient Stock Tracking; Manual stock records lead to inaccuracies in inventory levels and difficulties in tracking the movement of grains in and out of warehouses.
2. Budget and Financial Management Issues; Challenges in tracking procurement costs, storage expenses, and distribution costs.
3. Transparency and Accountability Risks; Manual documentation increases the chances of fraud and corruption, harder to audit inventory and financial records effectively.
4. Limited Data Analytics and Reporting**;** No real-time insights into stock trends, food security risks, or budget adjustments and reports are manually generated, which is time-consuming and prone to errors.

2.2.2 Related research and Systems:

- Ethiopia's Agricultural Transformation Agency (ATA) Digital System; The ATA takes a leadership role in implementing specific projects within the Agricultural Transformation Agenda or Agricultural Commercialization Clusters Initiative, focused on exploration of new ideas or national scale up of a particular concept to rapidly improve the production and productivity of crop and livestock commodities or o develop the agribusiness and agricultural marketing sub-sectors. (ATA, 2019).

- Warehouse Receipt Systems (WRS) in Kenya and Uganda; Warehouse receipt systems (WRS) allow farmers and traders to access markets and financial systems. While this system is not new in Uganda, as seen by both public and private effort since 2004 during its pilot, very little is known why it failed to ensure market access and credit. With the Uganda Warehouse Receipt System Authority in place, the government of Uganda seeks to reinstate the public warehouse receipt system with a focus on the electronic WRS (E-WRS). This study therefore seeks to document perceived benefits and challenges of private sector stakeholders of the WRS in Uganda. (FAO, 2020).
- FAO's Agricultural Market Information System (AMIS); The Agricultural Market Information System (AMIS) is an inter-agency platform that aims to enhance food market outlook information and policy response for food security. Bringing together the principal trading countries of agricultural commodities, AMIS assesses global food supplies (focusing on wheat, maize, rice and soybeans) and provides a platform to coordinate policy action in times of market uncertainty. AMIS is composed of G20 members plus Spain and seven additional major exporting and importing countries of agricultural commodities. (FAO, 2021).

2.1.3 Potential benefits of Digital Grain Crops Tracking System to NFRA

1. Improved Food Security; Ensures accurate tracking of grain reserves, prevents food shortages and overstocking, also enables timely procurement and distribution of food supplies.
2. Financial Efficiency**;** Enhances budget control by tracking procurement, storage, and distribution costs, it reduces financial wastage by minimizing losses due to spoilage or mismanagement. Ensures funds are allocated efficiently for food security operations.
3. Operational Efficiency**;** Automates stock tracking, reducing reliance on manual record-keeping, speeds up decision-making by providing real-time inventory data. Enhances coordination between NFRA's regional warehouses.
4. Transparency and Accountability**;** Reduces corruption and fraud by digitizing records. Provides a clear audit trail for financial and stock management activities. Improves stakeholder trust by ensuring openness in operations.

5. Scalability and Sustainability**;** Designed to expand to accommodate future needs. Uses cloud storage for easy access and security. Reduces food spoilage through better inventory monitoring.

2.1.4 Challenges and Considerations:

- Technological infrastructure: Implementing a DIGITAL GRAIN CROPS TRACKING SYSTEM AT NFRA requires reliable internet connectivity, access to digital devices, and user training.
- Data migration and integration: Transitioning from manual records to a digital system needs careful planning and data migration strategies.
- Sustainability and maintenance: Long-term system maintenance and resource allocation are crucial for the DGCTS success.
- Community engagement and awareness: Public education and sensitization programs are essential for user adoption and trust in the new system.

2.2 Domain Review

Existing digital systems for agricultural inventory management in Tanzania and neighboring countries have attempted to address stock tracking challenges. However, many lack real-time monitoring features, fail to integrate financial oversight, and do not offer tailored solutions for food reserve agencies. This study builds upon previous research by addressing these gaps and proposing an innovative, user-friendly DGSTS for NFRA (Harris et al., 2023).

Example; Warehouse Receipt Systems (WRS) in Kenya and Uganda.

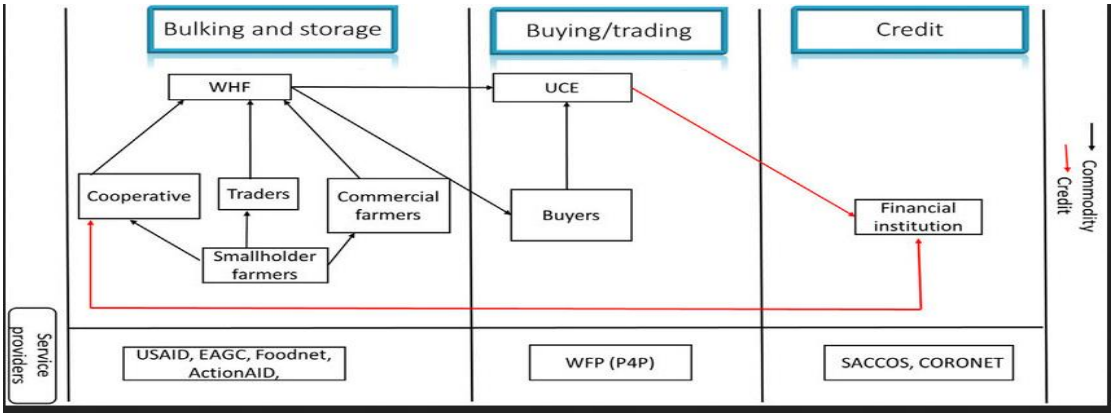

Figure 01: show the Warehouse Receipt System in Uganda: stages and linkages among actors

2.3 Problem conclusion

Despite the global advancements in digital inventory management, research on real-time stock tracking for food reserve agencies in Tanzania remains limited. Existing studies focus primarily on warehouse receipt systems and market integration but do not provide a comprehensive solution for government-controlled food reserves. This study seeks to bridge this gap by developing a robust, web-based DGSTS that integrates real-time tracking, automated financial monitoring, and predictive analytics to optimize food security management in Tanzania. The proposed system will improve efficiency, transparency, and decision-making in grain stock management**.**

CHAPTER: THREE

REQUREMENT ELICITATION AND SYSTEM ANALYSIS

3.0: Introduction

Requirement elicitation (requirement gathering) is the process of identifying system requirements from key stakeholders to ensure the successful implementation of the Digital Grain Crops Stock Tracking System (DGCTS). This chapter discusses the stakeholders involved in the requirement gathering process and how their needs were considered. It also covers the system functionalities and analysis.

In the requirement elicitation system requirements, there are two parts to consider these are;

i. Functional requirements
ii. Non-functional requirements.

These two requirements describe to use the capabilities of the system based on the objectives and what physical software requirements are necessary for the system to work. This chapter will mostly cover on the analysis of the system as well as general requirements of the system for the both functional requirements, non-functional requirements and domain. The chapter will also show how the system together with diagram showing how they flows from the user to the system and back again to the user.

3.1 Methods Used for Collecting Requirements

To ensure the system met stakeholders' needs, the following requirement-gathering techniques were used:

- Interviews: Conducted with warehouse managers, procurement officers, and government officials to understand their operational challenges.
- Surveys and Questionnaires: Distributed to farmers and financial officers to gather input on transaction transparency and financial monitoring.
- Observation: Stakeholder workflows were observed in NFRA warehouses to identify inefficiencies in stock tracking and manual data entry.

Document Review: Existing stock management reports and procurement records were analyzed to identify gaps in the current system

3.2 System Functionalities

These are the requirements that the system is expected to perform to meet user expectations. User requirements are based on how the user will interact with the system and what the user expects. These requirements can be categorized into two (2) groups namely:

3.2.1 Functional requirements of the project

1. Inventory Management; System must be able to manage real-time tracking of grain stocks in all NFRA warehouses. Automatic notifications for low stock levels and expiration dates, also manage stock movement logs for tracking incoming and outgoing shipments.

2. Financial Management; System must be able to oversee budget tracking for procurement, storage, and distribution.

3. Reporting and Analytics; System must be able to generates real-time reports on stock levels, warehouse performance, and financial metrics.

4. User Management; System must manage role-based access control to define user permissions (e.g., warehouse manager, financial officer, administrator), user activity logs for monitoring system interactions.

5. Alerts and Notifications; System must notify for critical events such as low stock, budget overruns, or pending tasks. Email and SMS integration for delivering alerts to stakeholders.

3.2.2Non-functional requirements

1.Performance; Support simultaneous access by at least 100 concurrent users. Ensure response times of less than 2 seconds for key operations like stock searches or report generation.

2.Scalability; Accommodate the addition of new warehouses and users without system performance degradation.

3.Security; Implement data encryption for all sensitive information during storage and transmission.

4.User Experience: System should be user-friendly and easy to navigate, providing a seamless and intuitive experience for farmers and buyers.

5.Compatibility: System should be compatible with a range of devices and operating systems, including smartphones, tablets, and desktop computers.

6.Localization: System should be able to support multiple languages and currencies, ensuring a seamless experience for warehouse manager, procurement officers and transaction officer

7.Data Management: System should provide efficient and reliable data storage and management, including data backup and recovery capabilities

- **Key Stakeholders and Their Needs**

The key stakeholders identified in the requirement gathering process included:

- Warehouse Managers: Responsible for overseeing stock levels, tracking grain movement, and ensuring accurate inventory records. Their needs focused on real-time stock updates and automated inventory tracking.
- Procurement Officers: Handle grain purchasing and supplier transactions. They required a streamlined procurement process with automated alerts for stock shortages and financial tracking.
- Farmers: Supply grains to NFRA and needed transparency in stock management and payment processing.
- Government Officials: Oversee food security policies and NFRA operations. They required accurate data reports for decision-making and policy formulation.
- Financial Officers: Manage the budget and financial transactions related to stock procurement and distribution. They required integration with financial monitoring tools to ensure accurate spending and budget compliance.

3.3 System Analysis

System analysis refers to the detailed examination of the existing grain stock tracking system used by NFRA to identify its inefficiencies and areas for improvement. Currently, NFRA relies on manual stock tracking methods that are prone to human errors, delays, and lack of real-time data access. Reports indicate that stock mismanagement has led to

wastage, delayed restocking, and inaccurate record-keeping, which ultimately affects food security in Tanzania.

3.3.1 Analysis of the current system

1.Manual Record-Keeping: Data entry is done manually, increasing the risk of errors and discrepancies in stock levels.

2.Delayed Decision-Making: Lack of real-time stock monitoring causes delays in procurement and distribution, leading to shortages or surplus stock.

3.Inadequate Security Measures: Paper-based records are vulnerable to loss, tampering, and unauthorized access.

4.Limited Accessibility: Data is only available at specific locations, making it difficult for regional warehouses to share information effectively.

5.Lack of Analytics and Forecasting: The current system does not provide analytical tools to predict stock demand, leading to inefficient stock replenishment.

3.3.2 Analysis of the Proposed System DGCTS

The Digital Grain Crops Stock Tracking System (DGCTS) aims to automate inventory management, enhance transparency, and improve decision-making. Key features include:

1.Automated Inventory Tracking; Real-time monitoring of stock levels across all NFRA warehouses and digital logs for incoming and outgoing shipments to improve traceability.

2.Financial and Budget Management; Integration with financial systems for procurement tracking and cost monitoring and budget controls to prevent overspending and track financial efficiency.

3.Enhanced Security and Transparency; Role-based access control to ensure only authorized personnel can modify records and audit logs to track changes in stock data and prevent fraud.

4.Cloud-Based Storage and Accessibility; Web-based system accessible from any location, improving collaboration between NFRA warehouses. Secure data backup to prevent loss of critical stock information.

5.User Alerts and Notifications; Automatic alerts for low stock levels, upcoming expiration dates, and budget overruns. Email and SMS notifications for faster decision-making.

The proposed DGCTS will address the limitations of the manual system by automating stock tracking, enhancing financial transparency, and enabling real-time decision-making. This will reduce wastage, improve food security, and enhance NFRA's operational efficiency.

3.3.2 Use case diagram

A use case diagram is a type of Unified Modelling Language (UML) diagram that depicts the interactions between a system and its actors to achieve a specific goal. The main elements of a use case diagram include actors, systems, and use cases.

Actors are the external entities that interact with the system. They can be represented as stick figures or any other appropriate symbols.

The system, on the other hand, is the entity being modelled. It is depicted as a rectangle with the system name written inside.

This use case shows the utilization scenario of digital grain crops tracking system that highlights the functional requirements

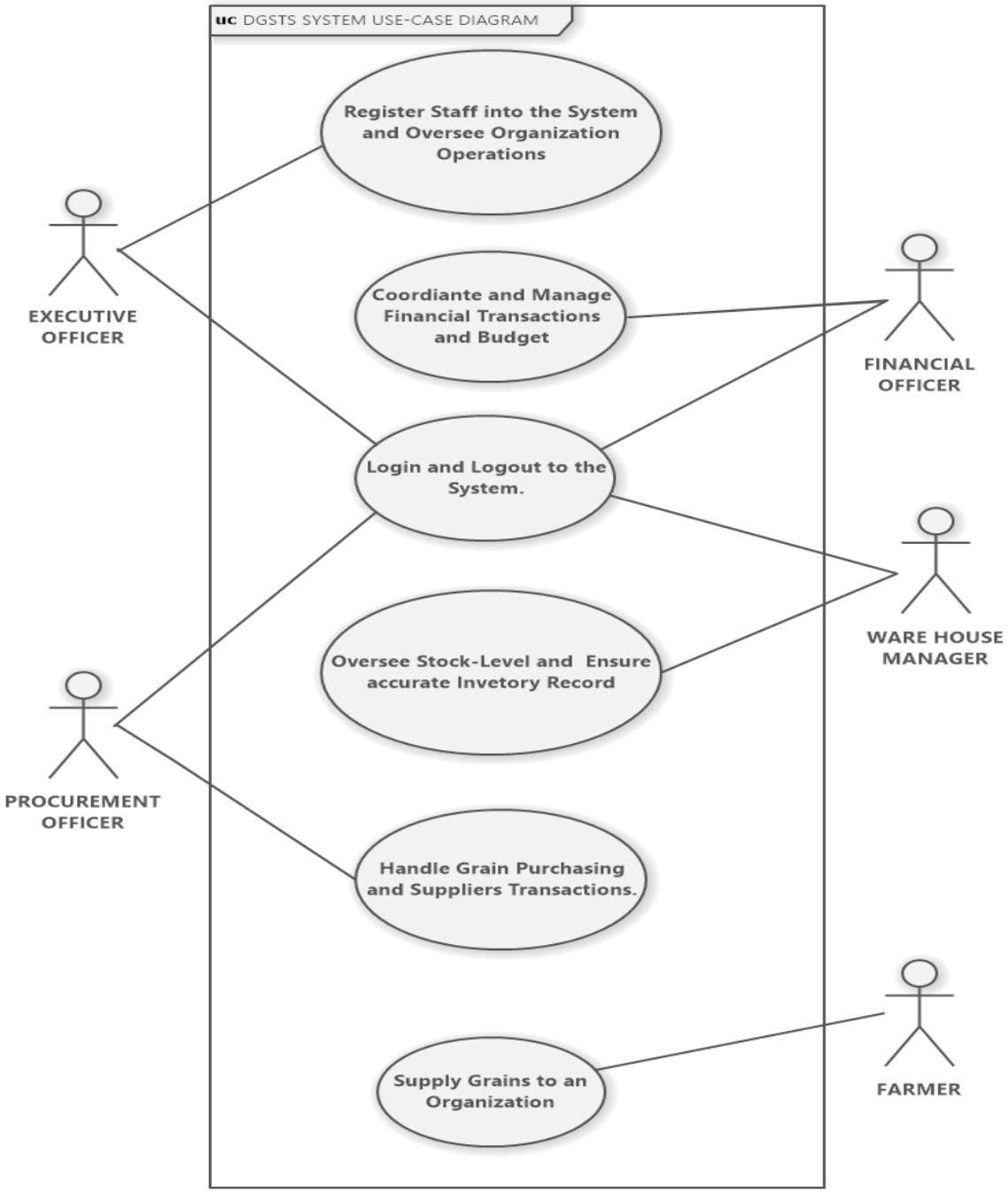

Figure 02: Shows use case diagram

CHAPTER: FOUR

SYSTEM DESIGN

4.1 Introduction to System Design

System design is defined as a process of creating architecture for different components, interfaces, and modules of the system and providing corresponding data helpful in implementing such elements in a way that meets the end-user requirements. It is a multi-disciplinary field that involves trade-off analysis, balancing conflicting requirements, and making decisions about design choices that will impact the overall system.

This phase acts as an intermediate bridge between system analysis and system implementation in the system development life cycle (SDLC). The purpose of the System Design process is to provide detailed data and information about the system and its elements to enable consistent implementation with architectural entities as defined in models and views of the system architecture.

For the **DGCTS**, system design plays a critical role in ensuring that each component — including inventory tracking, procurement requests, financial reporting, and user management — works seamlessly to support the operational needs of stakeholders such as warehouse managers, procurement officers, financial officers, and administrators.

There are three kinds of design based on requirement elicitation, which are:

- **Architectural design**: This refers to defining the overall structure, components, relationships, and behavior of the system. In this project, it includes designing the interactions between modules like inventory, procurement, warehouse operations, and financial management dashboards. The architectural design serves as the blueprint that ensures modules are integrated properly and workflows are efficient.
- **Logical design**: This provides a conceptual presentation of system functionalities and behavior, independent of any specific implementation or technology. For this system, it captures business rules such as procurement approval flow, inventory stock updates, and

budget tracking without focusing on code or databases yet. This helps validate the correctness of the system from a user and stakeholder perspective.

- **Physical design**: This involves transforming the logical design into an actual implementation using Django (Python), relational databases (e.g., SQLite or MySQL), and web technologies such as HTML, CSS, and Bootstrap. It defines the technical setup, including deployment considerations and server configuration, to ensure the system runs reliably and securely.

4.2 System Design Methodology and Technologies

A system design methodology is a systematic approach to the design of systems, products, and services. It is a set of principles and practices used to improve the quality and efficiency of the design process. The design methodology constructs a structure in terms of data entities, their dependencies, relative ordering, and associated attributes, which are subject to verification and later transformation into executable form.

4.2.1 Agile Model

For the DIGITAL GRAIN CROPS TRACKING SYSTEM, the Agile development methodology was chosen to facilitate rapid delivery and adaptability to evolving user needs. Agile divides the project into small, manageable iterations (sprints), allowing continuous feedback from stakeholders and gradual improvements.

The system's key modules — such as warehouse inventory, procurement management, financial reporting, and user role-based dashboards — were developed in incremental phases. After each sprint, feedback was collected from potential end-users (e.g., warehouse managers and procurement officers), allowing the development team to refine and enhance functionalities before the next iteration.

This methodology greatly improved collaboration and ensured that the system met practical needs, minimized risks, and allowed quick adaptation to any requirement changes from the administrative team or stakeholders.

4.2.3 Technology and Tools of the Project

In this section, the technologies and tools used to accomplish the DIGITAL GRAINS CROPS TRACKING SYSTEM are discussed in detail:

- **MySQL / SQLite**: A freely available open-source Relational Database Management System (RDBMS) that uses structured query language (SQL). It is used to store and manage data related to users, warehouses, inventory, procurement requests, budgets, and financial transactions. SQLite is commonly used during development for simplicity, while MySQL can be used in production for scalability.
- **Microsoft Windows**: This operating system provides a graphical user interface (GUI) that supports the development and deployment of the system, allowing developers to easily manage files, run local servers, and access development tools.
- **Hypertext Markup Language (HTML)**: This markup language is used to structure the content of the web pages in the system. It defines the layout and structure of dashboards, forms, tables, and reports presented to the various user roles (e.g., warehouse managers, procurement officers, financial officers).
- **Cascading Style Sheets (CSS)**: CSS is used to style and design the presentation of HTML documents. It enhances the visual appearance of dashboards, forms, and reports by defining colors, fonts, spacing, and overall layout. Bootstrap (a CSS framework) is also used to achieve responsive and modern UI design.
- **Python**: Python is a widely used high-level programming language known for its simplicity, readability, and versatility. The system uses Python as the main backend language through the Django framework. Django handles URL routing, request processing, database interaction, and template rendering.
- **JavaScript**: JavaScript is used to add dynamic behaviors to the web pages, such as form validations, password strength checks, live charts, and interactive sidebars. Libraries like Chart.js are used for rendering graphical financial reports.
- **Django Admin & Jazzmin**: The Django admin panel, customized using the Jazzmin package, provides an intuitive and user-friendly interface for administrators to manage system data, register users, and oversee operations.

4.2.4 Flow Chart Diagram

A flow chart is a graphical or symbolic representation of a process. Each step in the process is represented by a specific symbol and contains a short description of the step. The symbols are connected by arrows indicating the process flow direction.

Grain Management System Flows

Admin Flow

• Log in to the system securely via Django Admin.

• Register and manage user accounts, assigning roles (warehouse manager, procurement officer, financial officer).

• Oversee inventory data, procurement requests, and budget records.

• Approve or reject financial and procurement activities.

• Monitor system performance and generate reports.

Warehouse Manager Flow

• Log in to the system with assigned credentials.

• Access the warehouse dashboard to view inventory levels and warehouse status.

• Add, edit, or remove inventory items.

• Record stock movements (incoming and outgoing).

• Track recent movements and update stock information.

Procurement Officer Flow

• Log in to the procurement dashboard.

• Create procurement requests for required grain supplies.

• Register and manage supplier details.

• View the list of procurement requests and supplier records.

• Track the status of each procurement request.

Financial Officer Flow

• Log in to the financial dashboard.

• Review and approve procurement requests submitted by procurement officers.

• Manage budget allocations and expense records.

• Track expenses by category and generate financial reports.

• Download reports in various formats (PDF, Excel, CSV) for further analysis.

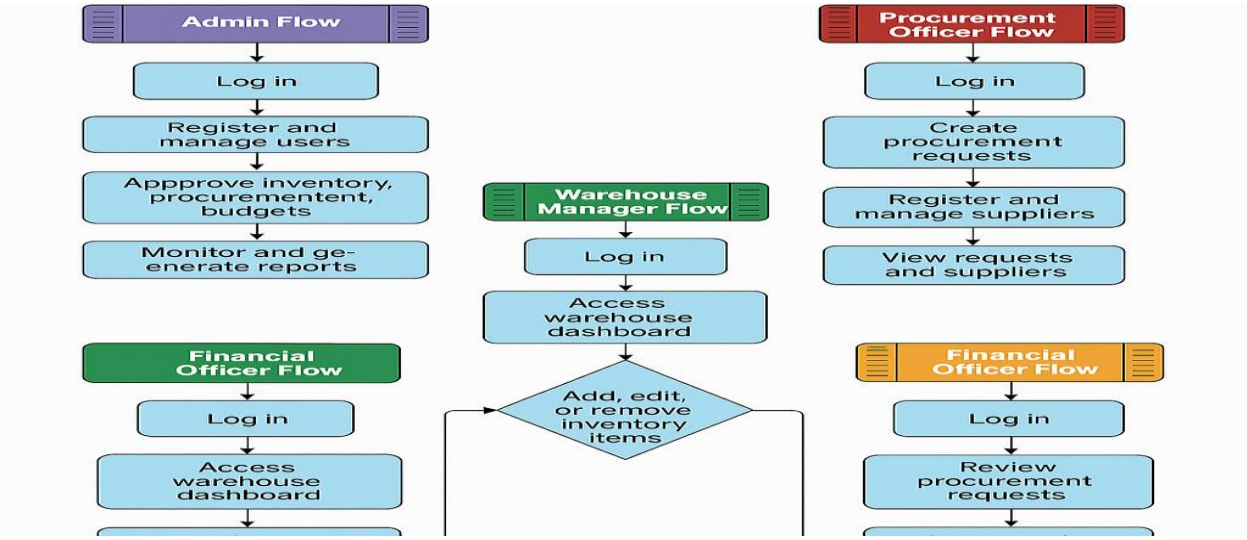

Figure 03: Flow chart

4.2.5 Class Diagram

Class diagrams represent the blueprints of the system. They are used to model the objects that make up the system, display the relationships between those objects, and describe their functions and services.

Grain Management System Class Diagram

The class diagram for this system illustrates the main entities and their relationships:

• CustomUser: Represents the user of the system, including roles and authentication details.

• Warehouse: Stores information about each warehouse, such as location, capacity, and assigned manager.

• Inventory: Represents the stock details of different grain types within warehouses.

• StockMovement: Records transactions related to stock movements, including type, quantity, and associated warehouse.

• ProcurementRequest: Holds information about procurement requests, including item details, supplier, and approval status.

• Supplier: Contains supplier details for procurement operations.

• Budget: Stores data about financial budgets for different departments or fiscal years

• Expense: Records expenses related to operational and procurement activities.

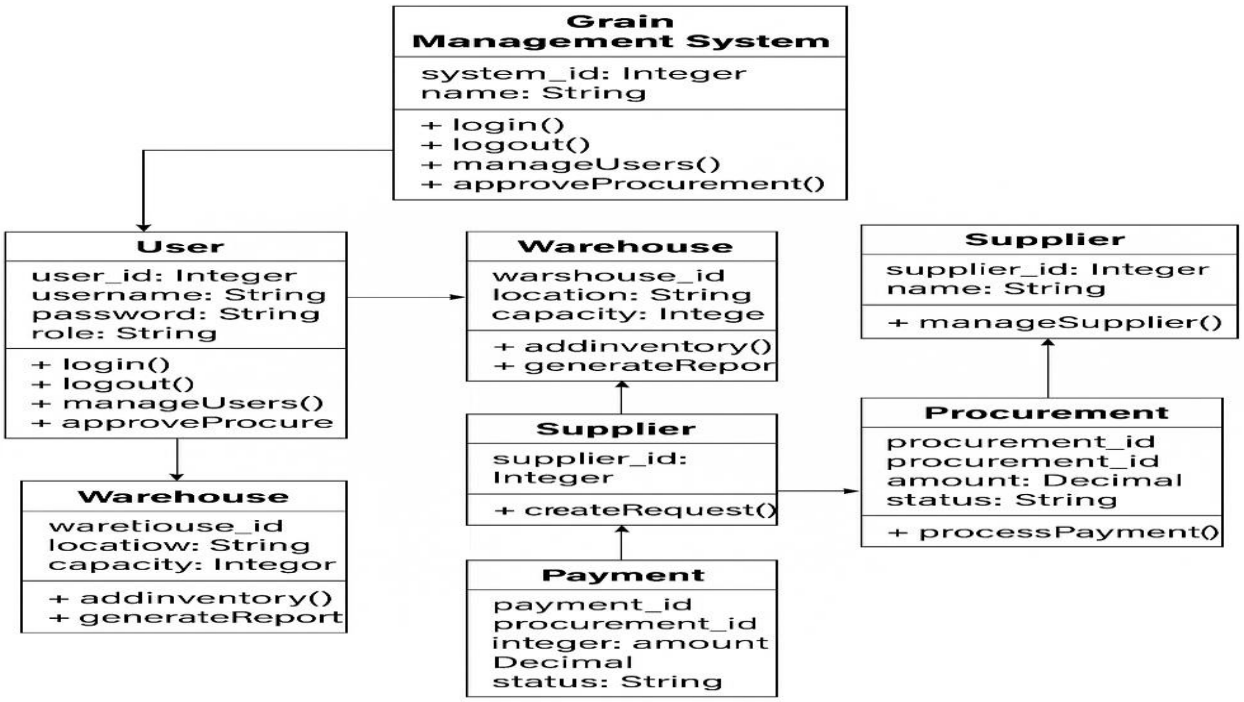

Figure 04:Class diagram

4.3 **Database Design**

The Database Design for the Digital Grain Crops Tracking System (DGCTS) is critical to ensure efficient, secure, and scalable data management across various modules and user roles. Manual approaches to managing grain stock, warehouse transactions, procurements, budgets, and financial records often result in high workloads, data redundancy, and errors. With this system, these tasks can be automated, enabling easy monitoring, accurate reporting, and faster decision-making.

The database design focuses on storing information related to grain inventories, stock movements, procurement requests, suppliers, budgets, expenses, warehouses, and users. It ensures data integrity and consistency, and allows role-based data access and operations by Admins, Warehouse Managers, Procurement Officers, and Financial Officers.

Digital Grain Crops Tracking System Database Design Features

- Provision for multiple grain types and their details (e.g., maize, rice, sorghum).
- Stock movement tracking (incoming and outgoing transactions).
- Inventory and warehouse management (monitoring quantities and capacity).
- Supplier registration and procurement request management.
- Budget and expense tracking with financial reporting.
- Role-based access control for different users (Warehouse Manager, Procurement Officer, Financial Officer, Admin).
- Secure login and password change functionalities.

Entity Relationship Diagram (ERD)

The Entity Relationship Diagram (ERD) for the proposed DGCTS illustrates the relationships between different entities and their roles in the system. The main entities include:

- CustomUser: Stores user login information and roles.
- Warehouse: Contains details about each warehouse, including location and capacity.
- Inventory: Tracks grain types and quantities per warehouse.
- GrainType: Defines available grain types.
- StockMovement: Records stock transactions (incoming/outgoing).
- ProcurementRequest: Stores data on procurement activities.
- Supplier: Keeps supplier details.
- Budget: Stores financial planning data.
- Expense: Tracks financial expenditures.
- Transaction: Logs overall movement of grains and related activities.

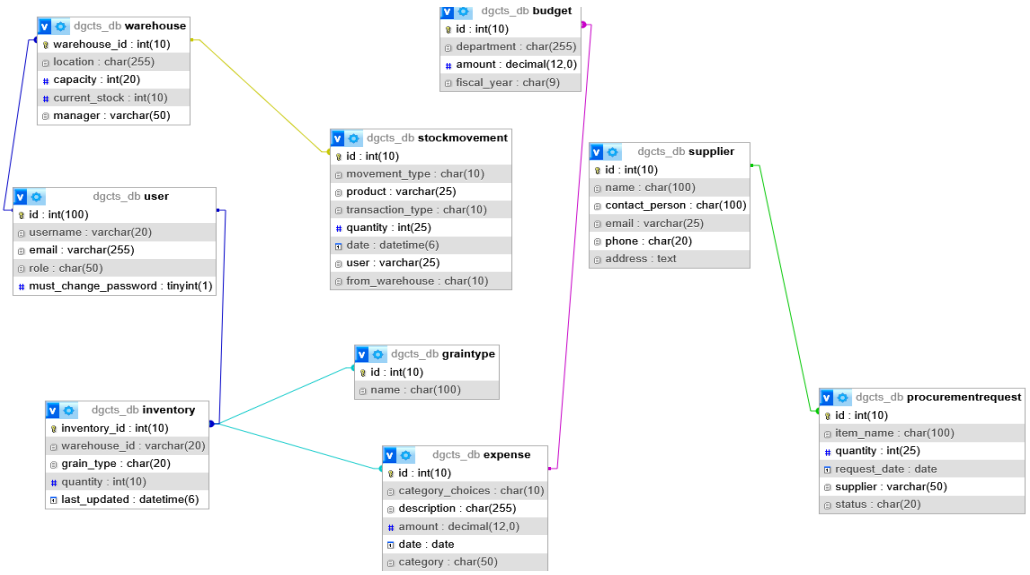

Figure 05: Database design

4.4 User interface

The User Interface (UI) in a private hostel management system is the visual and interactive component that allows users to interact with the system. It is responsible for presenting information to users, capturing user input, and displaying the system's functionalities in an intuitive and user-friendly manner.

The following are the things that the system captured for user to use the system

Layout and Navigation:A clear and organized layout that allows users to easily navigate through different sections and functionalities of the system we designed.

The use a consistent navigation structure, such as a menu bars or sidebar, to provide easy access to different modules or pages within the system was also captured.

Responsive Design: System user interface is responsive and adapts well to different screen sizes and devices. This will provide a seamless experience for users accessing the system from various devices like desktops, laptops, tablets, or smartphones.

Forms and Input Validation: Forms for capturing user input, such as warehouse details, add inventory, or payment information.Client-side validation to provide immediate feedback to users when they enter invalid data or miss required fields

CHAPTER: FIVE

SYSTEM IMPLEMENTATION AND TESTING

5.1 Introduction to System Implementation

This chapter presents the actual implementation of the Grain Management System, translating system design into a working software application. The implementation was guided by the system requirements and design models discussed in the previous chapters. The process involved backend development, database structuring, frontend user interface creation, and integration of system modules for each user role. Furthermore, the system underwent a series of tests to ensure its functional correctness, reliability, and usability.

5.2 Functionalities Implementation

The system was implemented with role-based access control, allowing different user types to interact with specific modules based on their responsibilities.

5.2.1 User or Admin authentication and authorization

In terms of the system, authentication is where the system checks log in credentials to see if it can recognize user as log in and authorizes when the system looks up access control whether to allow user to view, edit, delete or create content, in-order to log in a user required to provide a username and password. when the username and password are provided, the system checks to see whether the username and password provided are exist in the database, log in failure is returned to as replay from database, otherwise the system goes on checking whether the username is wrong.

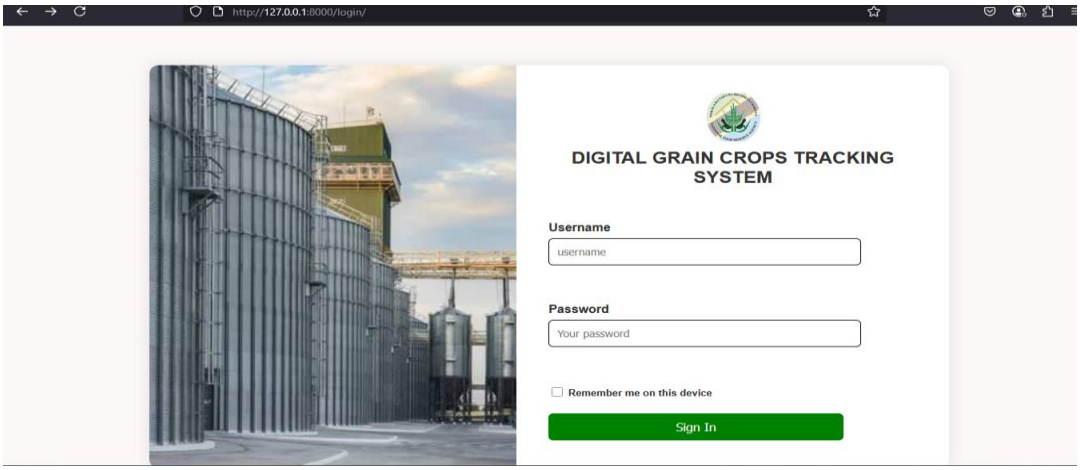

Figure 06: Login page

5.2.2 Change password

The user after given a username and password by the admin when they login for the first time are required to change password immediatery for security purpose.

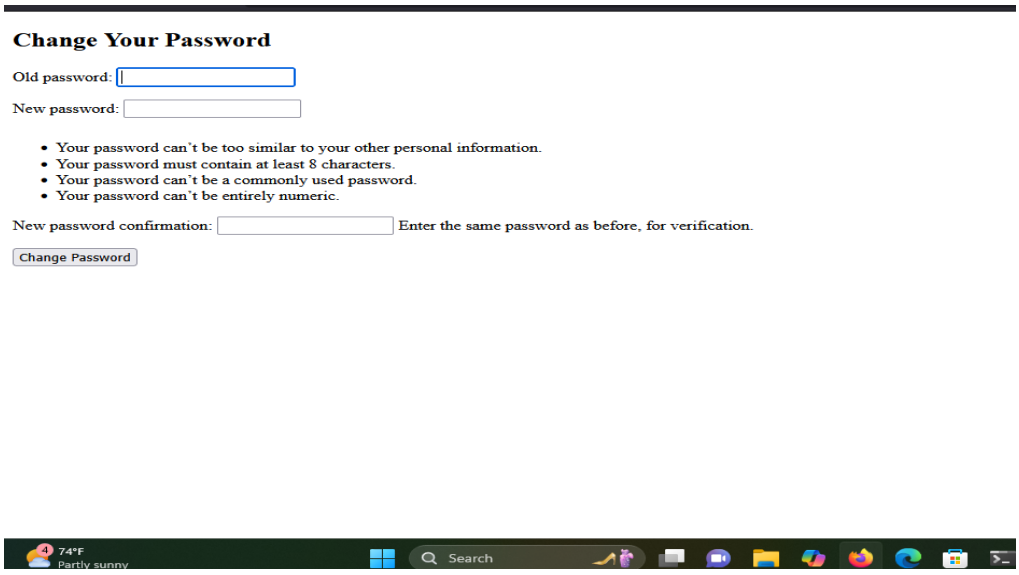

Figure 07: Change password

5.2.2 Admin

- Registers new users (Warehouse Manager, Procurement Officer, Financial Officer)

- Sends system-generated login credentials to the user's email

- Accesses Django's default admin panel for managing all models

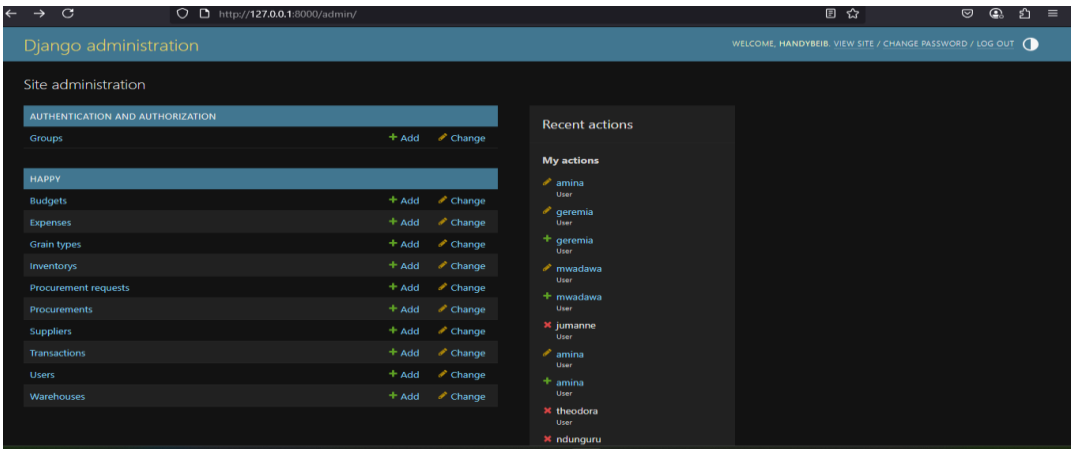

Figure 07: Admin Dashboard

5.2.3 Warehouse Manager

- Adds and edits inventory items

- Records stock movement (incoming/outgoing)

- Views inventory data in table and chart formats

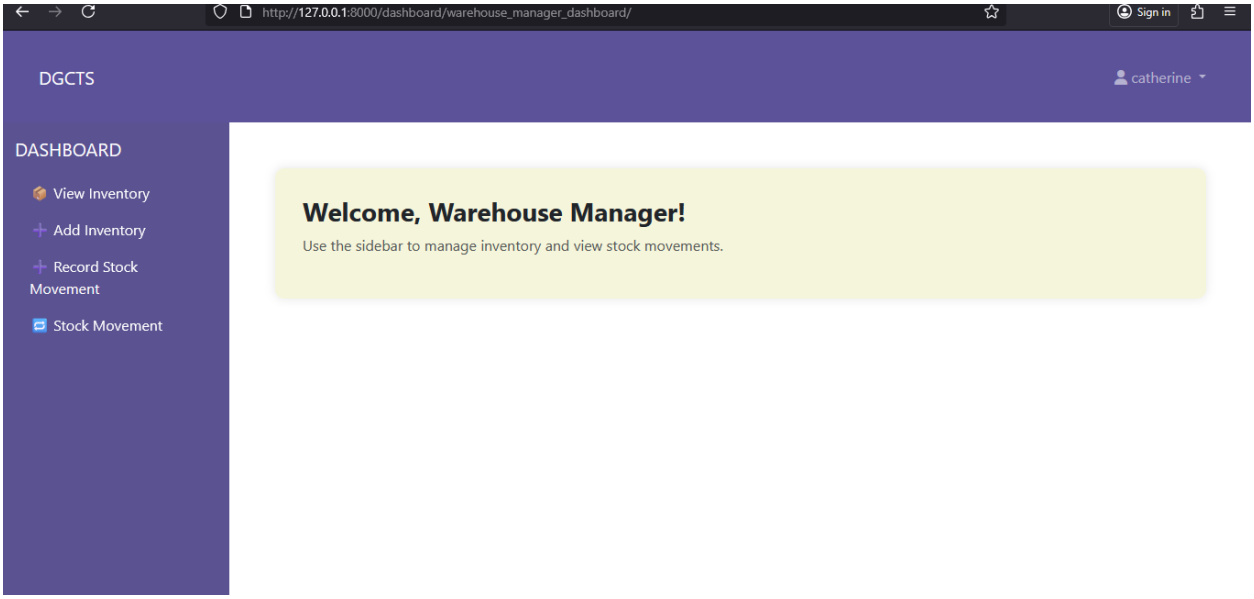

Figure 09: Warehouse Manager Dashboard

5.2.4 Procurement Officer

- Creates procurement requests

- Registers and manages supplier records.Views list of existing procurement requests and suppliers

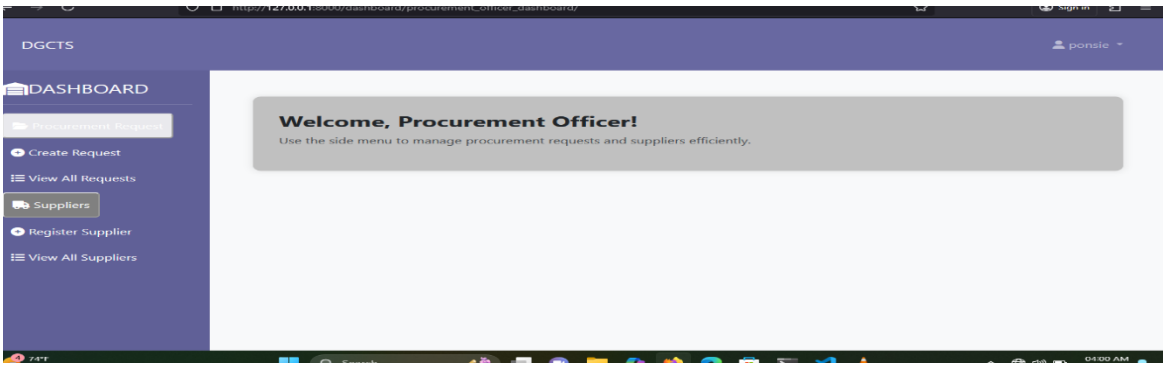

Figure 10: Procurement Officer Dashboard

5.2.5 Financial Officer

- Reviews, approves, or rejects procurement requests

- Manages budget entries and expense tracking

- Generates and downloads financial reports in Excel or PDF format

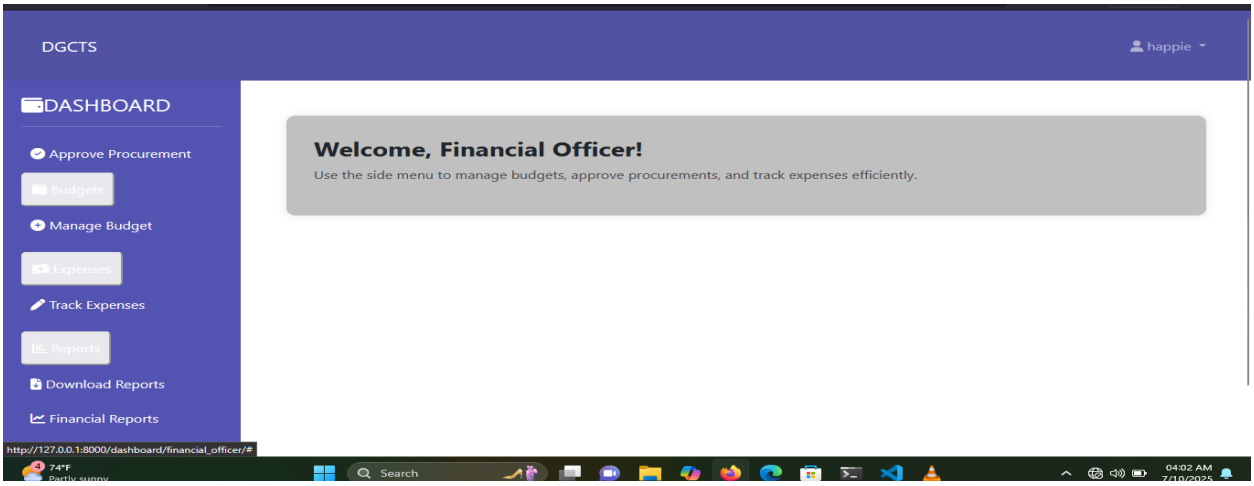

Figure 11: Financial Officer Dashboard

5.2.6 Database Implementation

In this project, I have chosen to implement an SQLite database as the backend storage for the application. SQLite is a lightweight, file-based relational database engine that is included by default with Django, making it convenient and easy to set up, especially during development and small to medium-scale deployments.The database configuration is specified in the DATABASES setting of the Django project's settings file. Below is the configuration used:

```
# https://docs.djangoproject.com/en/5.1/ref/settings/#databases

DATABASES = {
    'default': {
        'ENGINE': 'django.db.backends.sqlite3',
        'NAME': BASE_DIR / 'db.sqlite3',
    }
}
```

Figure 12: Database Implementation

Explanation of each parameter:

ENGINE: This parameter defines the database engine or backend that Django should use to interact with the database. In this configuration, 'django.db.backends.sqlite3' is specified, indicating the use of the SQLite engine.

NAME: This parameter specifies the name (or path) of the database file. Here, BASE_DIR / 'db.sqlite3' means that the SQLite database file named db.sqlite3 is stored in the project's base directory.

5.5 System testing and evaluation

5.5.1 System testing

The system testing was done throughout the development process in all phases to guarantee error free and fulfil system functionalities all as planned. System testing can be of two types unit testing and system testing.

- **Unit testing**: Unit testing was performed on each module or block of code during development of the system to ensure that functionalities are meet. Here we can test a small unit like users try to login into the system by providing wrong information

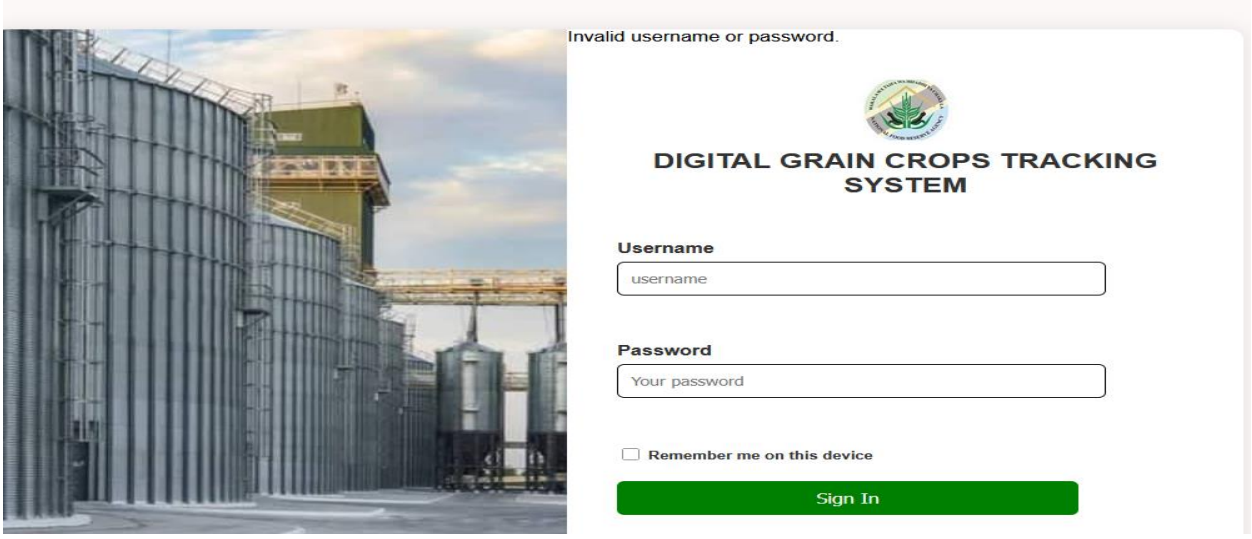

Figure 13: Unit Testing

- **System testing**: System testing is openly related to the system design phase. System tests inspection the entire system ability and the transmission of the system under improvement with externally systems.

- **Functional Testing**; Functional testing was conducted to validate the various functionalities of the Digital Grain Warehouse Management System. Key features tested included user registration, login, dashboard interactions, inventory management, procurement requests, supplier registration, stock movement recording, and financial reporting. The testing process ensured that each feature works as expected and produces the desired outcomes.

Specific attention was paid to verifying that warehouse managers could effectively manage stock entries and movements, procurement officers could create and track procurement requests and suppliers, and financial officers could approve procurements and manage budgets and expenses. Through this thorough functional testing, the system demonstrated its capability to support the operational needs of all user roles and deliver accurate, reliable results.

5.5.2 System Evaluation

System evaluation focuses on assessing the overall performance, usability, and effectiveness of the Digital Grain Warehouse Management System. It involves gathering feedback from relevant stakeholders, including administrators, warehouse managers, procurement officers, and financial officers, to evaluate their satisfaction with the system and its features. This evaluation was conducted under the guidance of my project supervisors and with feedback from representative system users at Mzumbe University.

The evaluation process included the following aspects:

- Usability Evaluation:The system's dashboards (Warehouse Manager, Procurement Officer, and Financial Officer) and login interfaces were assessed to ensure they are intuitive, easy to navigate, and user-friendly. The evaluation focused on clarity of menu structures, responsiveness of forms (such as inventory addition and procurement requests), and general user satisfaction.

- Performance Evaluation:System performance was measured in terms of response time, reliability, and scalability. Tests were conducted to evaluate how quickly pages load, how the system handles concurrent user activities (like stock updates and procurement approvals), and how well it performs under increased load. The evaluation confirmed that the system can reliably support multiple user roles performing various tasks simultaneously.
- Functionality Evaluation:The evaluation team tested all intended functionalities to ensure they were implemented correctly and met user requirements. These included inventory management (adding, editing, and tracking stocks), procurement requests and supplier management, budget and expense tracking, and transaction logging. Special attention was given to role-based access and dashboard-specific functions to confirm that each user could perform their respective tasks without errors.

CHAPTER SIX:

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the results of implementing the Grain Management System and evaluates how well the developed system met the intended objectives. It also discusses the challenges addressed, the effectiveness of the implemented functionalities, and concludes with recommendations for further improvement.

6.1 Summary of Achieved Objectives

Improve efficiency in tracking grain stocks and movements: By automating inventory and stock movement records, the system has eliminated the need for manual paperwork and physical registers. This has greatly enhanced efficiency and reduced the likelihood of errors in tracking stock levels across warehouses.

Enable warehouse managers to easily monitor stock and warehouse data: The system provides a user-friendly dashboard where warehouse managers can view real-time data about current stock levels, incoming and outgoing transactions, and low-stock alerts. This supports better decision-making and effective warehouse operations.

Simplify procurement tracking and supplier management: Procurement officers can now create and manage procurement requests, register new suppliers, and view all procurement activities in one centralized platform. This reduces the time and cost previously spent on manual follow-ups and paperwork.

Enhance financial control and reporting: The financial officer can easily manage budgets, track expenses, and generate reports in various formats (PDF, Excel, CSV). This strengthens financial transparency and enables better planning and budget control.

Reduce operational costs and paperwork: By digitizing record-keeping and processes, the system reduces the need for physical forms, manual filing, and additional administrative staff, leading to cost savings and improved organizational efficiency

6.2 Conclusion

The Digital Grain Crops Tracking System has successfully met its main objectives, improving efficiency in inventory management, procurement processes, and financial tracking. It has enabled warehouse managers to monitor stock accurately, streamlined procurement workflows, and provided financial officers with reliable budget and expense tools.

Although some advanced features, such as full external integrations, were not fully implemented, the system overall has modernized grain management, reduced paperwork, and supported better decision-making across all roles

6.3 Recommendations

Simplify System Logic: To improve overall efficiency and enhance user experience, it is recommended to simplify the logic in various workflows — particularly in procurement approvals and stock movements. Review existing processes and eliminate unnecessary complexities to make the system easier for all user roles to navigate.

Engage Management and Stakeholders: Actively involve management and key stakeholders to secure ongoing support and ensure successful system adoption. Their feedback and involvement are critical for system improvements and continuous updates.

Explore Alternative Integration Options: If external system integrations (for example, advanced financial or supplier APIs) prove difficult to implement, consider exploring alternative solutions that are accessible and widely supported. Evaluate local integration options or standardized third-party services to ensure smoother connections for future enhancements.

Prioritize Automated Notifications and Tracking: Strengthen the system by further developing automated notifications and tracking features for procurement approvals, stock alerts, and financial transactions. Implementing real-time notifications and detailed tracking will improve transparency, foster better communication among warehouse managers, procurement officers, financial officers, and administrators, and ensure all parties stay updated on important activities.

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