A WEB-BASED UCU FLEET MANAGEMENT SYSTEM: A CASE STUDY OF UGANDA CHRISTIAN UNIVERSITY

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UGANDA CHRISTIAN UNIVERSITY

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DECLARATION

We declared that this project report titled A Web-Based UCU Fleet Management System had been developed by us and had not been submitted to any other university or institution for academic credit. All sources of information used in this report had been acknowledged.

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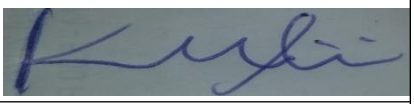
Kiyaga Kassim	S23B13 / 024	
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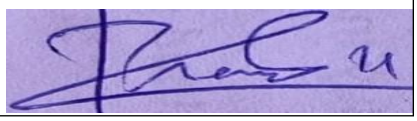
Domado Peter	S23B13 / 124	

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05/05/2026

DEDICATION

This project is dedicated to our families for their continuous support, encouragement, and motivation throughout our academic journey at Uganda Christian University.

ACKNOWLEDGEMENT

We express our sincere gratitude to God for the strength and wisdom that enabled us to complete this project successfully. We also extend our appreciation to our supervisor, Madam Justine Mukalere, for her guidance, patience, and valuable feedback throughout the development of this project. Special thanks were given to the staff and administration of Uganda Christian University who provided the information required during data collection. We also appreciate our classmates and friends for their support and encouragement.

Contents

ABBREVIATIONS

Abbreviation	Meaning
UCU	Uganda Christian University
DFMS	Digital Fleet Management System
JWT	JSON Web Token
API	Application Programming Interface
DBMS	Database Management System
GPS	Global Positioning System
HOD	Head of Department
UI	User Interface

ABSTRACT

Transportation services are a critical component of institutional operations in universities, supporting academic fieldwork, administrative functions, and logistical coordination across departments. Uganda Christian University currently relies on a partially manual fleet management process where vehicle requests are submitted through paper forms, approvals are handled manually, and vehicle dispatch coordination is conducted through the Facilities and Capital Projects Office. This process often leads to delays in approvals, lack of transparency in vehicle availability, and increased administrative workload.

This project presents the design and implementation of a Digital Fleet Management System aimed at improving efficiency in vehicle booking, approval workflows, driver assignment, and fleet monitoring at Uganda Christian University. The system is implemented as a web-based application using a modern technology stack consisting of React for the frontend interface, Node.js with Express for the backend services, and MySQL as the relational database management system. Security mechanisms including JSON Web Token (JWT) authentication and bcrypt password hashing were implemented to ensure secure system access and role-based authorization.

The system introduces multiple user roles including administrators, drivers, and requesters, each interacting with the system through role-specific dashboards. Core functionalities include vehicle browsing, transport request submission, automated vehicle availability checks, prevention of double bookings, trip assignment, and system activity logging. The system integrates frontend, backend, and database components to create a unified digital workflow that replaces manual paper-based transport request procedures.

Implementation results demonstrate that the proposed system significantly improves operational efficiency by centralizing fleet information, automating approval workflows, and providing real-time visibility of vehicle usage. The system also lays the foundation for future enhancements such as mobile application support, GPS vehicle tracking, and cloud deployment.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Fleet management refers to the coordinated management of vehicles, drivers, maintenance schedules, and transport operations within an organization. Institutions with high transportation needs such as universities depend on efficient fleet management to support administrative work, academic field activities, staff travel, and student programs. Effective fleet management helps ensure proper vehicle utilization, timely trip scheduling, and regular maintenance, which reduces operational costs and improves service delivery.

Traditionally, fleet management in many institutions has relied on manual processes involving paper documentation, telephone communication, and physical record keeping. While these methods can work for small organizations, they become inefficient as the size of the fleet and the number of transport requests increase. Manual systems often lead to delays in processing requests, difficulties in checking vehicle availability, and poor storage of trip records.

Advances in information systems and web technologies have enabled the development of digital fleet management platforms that automate booking processes, improve record keeping, and enhance monitoring of fleet activities. Modern fleet management systems integrate vehicle databases, scheduling tools, role-based access control, and reporting features to improve transparency and accountability (Nguyen & Kim, 2022).

Universities around the world are increasingly adopting digital systems to streamline internal processes such as student registration, finance management, and transport coordination (Osei & Boateng, 2023). Implementing a digital fleet management platform helps institutions reduce administrative workload, improve communication between departments, and ensure proper allocation of transportation resources.

Uganda Christian University (UCU), located in Mukono District, operates a fleet of vehicles that supports academic fieldwork, administrative travel, and logistics activities. However, the existing transport management process relied heavily on manual procedures. Vehicle requests were submitted using printed forms that required approval from department heads before being forwarded to the Facilities and Capital Projects Office for processing.

Although this process provides basic coordination, it creates several challenges such as delays in approvals, difficulty in tracking vehicle availability, and lack of centralized digital records. As the university continues to grow, the demand for transportation services also increases, creating the need for a more efficient and automated system.

This project focused on the design and implementation of a web-based fleet management system tailored for Uganda Christian University. The system digitizes the vehicle request process, automates scheduling, improves monitoring of vehicle usage, and enhances coordination between departments, drivers, and facilities staff.

1.2 Institutional Context

Uganda Christian University operates multiple departments that frequently require transport services for activities such as field research, academic trips, administrative duties, and logistics operations. These services are managed by the Directorate of Facilities and Capital Projects.

Departments requesting vehicles complete physical request forms that include details such as trip purpose, destination, travel date, number of passengers, and departmental approval. After completion, the form is endorsed by the Head of Department and submitted to the Facilities Office. The Facilities Office reviews the request, checks vehicle availability, assigns a driver, and communicates the decision to the requester.

When a vehicle leaves campus, a motor vehicle gate pass is issued and presented to security personnel at the university gate to confirm authorization.
Although this process provides basic control, it involves several manual steps that increase the time required to process requests. Paper-based records also make it difficult to maintain complete and accurate transport history.

A digital system that integrates booking requests, approvals, driver assignment, and trip monitoring can significantly improve this workflow by providing centralized access to fleet information and automating administrative tasks.

1.3 Problem Statement.

The current fleet management process at Uganda Christian University relies heavily on manual procedures involving paper-based request forms, physical approvals, and manual coordination between departments and the Facilities Office. While this process enables the allocation of vehicles for institutional use, it presents several operational challenges.

First, the manual approval process often causes delays in the allocation of vehicles, particularly when multiple departments submit requests simultaneously. Request forms must pass through several administrative stages before final approval, increasing the likelihood of processing delays.

Second, the lack of a centralized digital database makes it difficult for administrators to monitor vehicle availability in real time. As a result, there is a risk of scheduling conflicts or inefficient utilization of fleet resources.

Third, manual record keeping reduces transparency and makes it difficult to track historical trip data, maintenance records, and fuel usage patterns. This lack of accessible information limits the ability of administrators to make informed decisions regarding fleet operations.

Furthermore, communication between requesters, drivers, and facilities staff often relies on phone calls or informal messaging, which can lead to miscommunication and operational inefficiencies.

These challenges highlight the need for an integrated digital solution that automates the fleet management process, improves record keeping, and enhances coordination among stakeholders. The proposed Digital Fleet Management System seeks to address these limitations by providing a centralized web-based platform for managing vehicle requests, approvals, and fleet operations.

1.4 Main Objective

The main objective of this project was to develop and implement a web-based UCU Fleet Management System that automates vehicle booking, approval workflows, and trip management.

1.5 Specific Objectives

The project seeks to achieve the following specific objectives:
To design the architecture and database of the web-based fleet management system.
To develop and implement the web-based fleet management application.
To test and evaluate the usability and effectiveness of the developed system.

1.6 Scope of the Study

Functional Scope

The system provides functionality for vehicle browsing, submission of transport requests, trip assignment, vehicle availability checks, and monitoring of fleet activities through administrative dashboards.

Geographical Scope

The system is designed specifically for Uganda Christian University and initially supports transport management activities within the main campus in Mukono.

Technical Scope

The system is implemented as a web-based platform using React for the frontend interface, Node.js with Express for backend services, and MySQL for data storage.

Time Scope

The project is carried out within the academic timeline allocated for final year projects, covering requirement analysis, system design, development, and testing phases.

1.7 Justification of the Study

The implementation of a Digital Fleet Management System significantly improves transport coordination within Uganda Christian University. By automating vehicle booking and approval workflows, the system reduces administrative delays and improves transparency in fleet operations.

The system also provides a centralized digital record of transport activities, enabling administrators to monitor vehicle usage, maintenance schedules, and trip histories. This information supports better decision-making and ensures more efficient utilization of fleet resources.

Additionally, the system contributes to the university's broader digital transformation initiatives by replacing manual paper-based processes with modern information systems that enhance operational efficiency.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed existing literature related to fleet management systems, workflow automation in organizations, and the use of information systems to improve operational efficiency in institutional environments. The purpose of the literature review was to examine previous studies, technologies, and systems that addressed transportation management and digital workflow automation. By analyzing these studies, it became possible to identify the strengths and limitations of existing solutions and determine the gap that the proposed Digital Fleet Management System aimed to address at Uganda Christian University.

The literature review also examined the role of information technology in improving resource management within organizations. Particular emphasis was placed on how web-based systems, role-based access control, and centralized databases have been used to streamline administrative processes. The findings of this review provided a conceptual foundation for the design and development of the proposed system.

2.2 Fleet Management Systems

Fleet management systems refer to technological platforms designed to monitor, coordinate, and optimize the operation of vehicles within an organization. These systems typically integrate vehicle tracking, scheduling, maintenance monitoring, driver management, and fuel consumption analysis to improve operational efficiency. According to Smith and Gonzales (2019), digital fleet management platforms have significantly improved how organizations coordinate transportation resources by enabling real-time access to vehicle information and automated scheduling processes.

Traditional fleet management approaches relied heavily on manual record keeping and physical documentation to coordinate vehicle usage. In many institutions, transport requests were submitted through paper forms which were later reviewed and approved by administrative offices responsible for transport coordination. Although this process allowed institutions to maintain basic control over vehicle allocation, it often resulted in inefficiencies such as delayed approvals, lack of accurate vehicle usage records, and scheduling conflicts.

Modern fleet management systems have addressed many of these challenges by introducing digital platforms that automate vehicle booking, driver assignment, and trip monitoring. These systems allow administrators to monitor fleet activities through centralized dashboards while users can submit transport requests electronically. Research conducted by Brown (2020) showed that organizations that adopted digital fleet management solutions experienced improved fleet utilization, reduced administrative workload, and better monitoring of vehicle maintenance

schedules.
Despite the widespread availability of digital fleet management technologies, many institutions in developing countries continue to rely on manual transport management procedures. Limited technological infrastructure, lack of specialized systems tailored for institutional environments, and resistance to change have slowed the adoption of automated fleet management platforms in several organizations.

2.3 Workflow Automation in Organizations

Workflow automation refers to the use of digital systems to manage and execute business processes with minimal human intervention. These systems enable organizations to replace manual procedures with automated workflows that improve efficiency, transparency, and accountability. According to Davenport (2018), workflow automation systems have become an essential component of modern organizational management because they reduce repetitive administrative tasks and improve coordination between departments.

In traditional organizational environments, administrative processes such as approval requests, document submissions, and resource allocation were handled through paper documentation and manual approvals. While these processes allowed organizations to maintain procedural control, they often introduced delays due to the time required to physically transfer documents between departments.

Digital workflow systems addressed these challenges by enabling users to submit requests electronically while supervisors review and approve them through centralized platforms. Such systems also maintain digital records of all transactions, which improves transparency and allows administrators to track historical activities.

Within the context of transportation management, workflow automation plays a critical role in coordinating the approval process for vehicle requests. By digitizing this workflow, organizations can reduce delays associated with manual approvals while ensuring that all stakeholders involved in the process have access to the same information.

2.4 Role-Based Access Control in Information Systems

Role-Based Access Control (RBAC) is a security model used in information systems to regulate user access based on their assigned roles within an organization. Instead of granting permissions to individual users, RBAC assigns permissions to roles, and users are then assigned to those roles. According to Sandhu et al. (2017), RBAC improves system security and simplifies access management by ensuring that users only access resources necessary for their responsibilities.

In web-based applications, RBAC is commonly implemented to protect sensitive data and restrict

system functionalities based on user privileges. For example, administrators may have access to system configuration tools, while regular users may only access limited features related to their specific tasks.

Within a fleet management environment, RBAC ensures that different stakeholders interact with the system according to their responsibilities. Administrators may manage vehicles and drivers, requesters may submit transport requests, and drivers may only access information related to assigned trips. Implementing RBAC improves system security while also enhancing operational efficiency by clearly defining user responsibilities within the platform.

2.5 Transport Management in Institutional Environments

Transportation services are an essential operational component for institutions such as universities, government agencies, and large organizations. These institutions often maintain fleets of vehicles that support administrative travel, academic fieldwork, logistics operations, and community outreach programs. Effective management of these vehicles is necessary to ensure that transportation resources are allocated efficiently and used responsibly.

Research conducted by Ochieng (2021) highlighted that many universities in developing countries still manage transport services using manual administrative procedures. In these institutions, staff members are required to submit written requests for vehicles through departmental channels before approvals are granted by administrative offices responsible for transport management. Although this approach ensures procedural accountability, it often results in delays due to multiple approval stages and limited visibility of vehicle availability.

Furthermore, manual transport management systems make it difficult to maintain comprehensive records of vehicle usage, maintenance schedules, and trip histories. This lack of centralized information limits the ability of administrators to monitor fleet performance and plan resource allocation effectively.

The introduction of digital fleet management systems in institutional environments has been shown to significantly improve operational coordination by providing centralized access to vehicle information, automated request processing, and improved reporting capabilities.

2.6 ICT Adoption Challenges in Developing Countries

While digital systems have transformed many administrative processes globally, the adoption of information and communication technologies (ICT) in developing countries has faced several challenges. These challenges include limited technological infrastructure, financial constraints, lack of technical expertise, and resistance to organizational change.

According to Mbarika et al. (2018), many institutions in developing regions continue to rely on manual administrative processes despite the availability of digital alternatives. This situation often occurs because existing systems have been used for many years, making staff reluctant to transition to new technologies. Additionally, the cost associated with implementing enterprise software solutions can be a barrier for some organizations.

Despite these challenges, the gradual expansion of internet access, improved computing infrastructure, and increased awareness of the benefits of digital systems have encouraged many institutions to adopt web-based information systems. Universities in particular have begun investing in digital platforms to manage academic administration, financial systems, and internal operations.

2.7 Research Gap

Although several studies have examined the benefits of digital fleet management systems and workflow automation technologies, many institutions in developing countries still rely on manual transport management processes. In universities such as Uganda Christian University, transport requests are typically processed using paper forms that must pass through multiple approval stages before vehicles are assigned.

Existing commercial fleet management solutions are often designed for logistics companies and transportation businesses rather than academic institutions. As a result, these systems may not align with the specific workflow requirements of universities where vehicle requests must pass through departmental approvals before being processed by a central facilities office.

This gap highlighted the need for a customized digital fleet management system designed specifically for the operational environment of Uganda Christian University. The proposed system aimed to digitize the transport request process, automate approval workflows, and provide a centralized platform for managing fleet operations within the university.

2.8 Conceptual Framework

The conceptual framework for this study was based on the integration of three key components: user interaction, system processing, and fleet management outputs. Users such as administrators, drivers, and requesters interact with the system through web-based interfaces that allow them to perform tasks such as submitting transport requests, assigning trips, and monitoring vehicle availability.

The system processes these requests through backend services that validate user credentials, check vehicle availability, and record trip information within the database. Once processed, the system produces outputs including approved transport schedules, assigned drivers, and trip records that

can be monitored by administrators.

This interaction between users, system processes, and operational outputs forms the foundation of the Digital Fleet Management System developed in this project.

CHAPTER THREE

SYSTEM ANALYSIS AND REQUIREMENTS

3.1 Introduction

This chapter presents the analysis of the existing transport management system used at Uganda Christian University and identified the requirements for the Digital Fleet Management System. System analysis was conducted to understand how transport requests were processed, how vehicles were allocated, and how communication between departments and the Facilities Office was handled.

The analysis process involved reviewing the existing vehicle request documentation used by the Directorate of Facilities and Capital Projects as well as gathering information regarding the workflow followed when requesting vehicles for official university activities. By examining the current procedures, several limitations associated with the manual system were identified. These findings provided the foundation for defining the functional and non-functional requirements of the proposed system.

3.2 Existing Transport Management System

The existing fleet management process at Uganda Christian University relied primarily on a manual paper-based system. Staff members or departments requiring transportation services were required to complete a physical vehicle request form provided by the Directorate of Facilities and Capital Projects. This form captured important information about the trip including the purpose of travel, destination, number of passengers, and the requested travel dates.

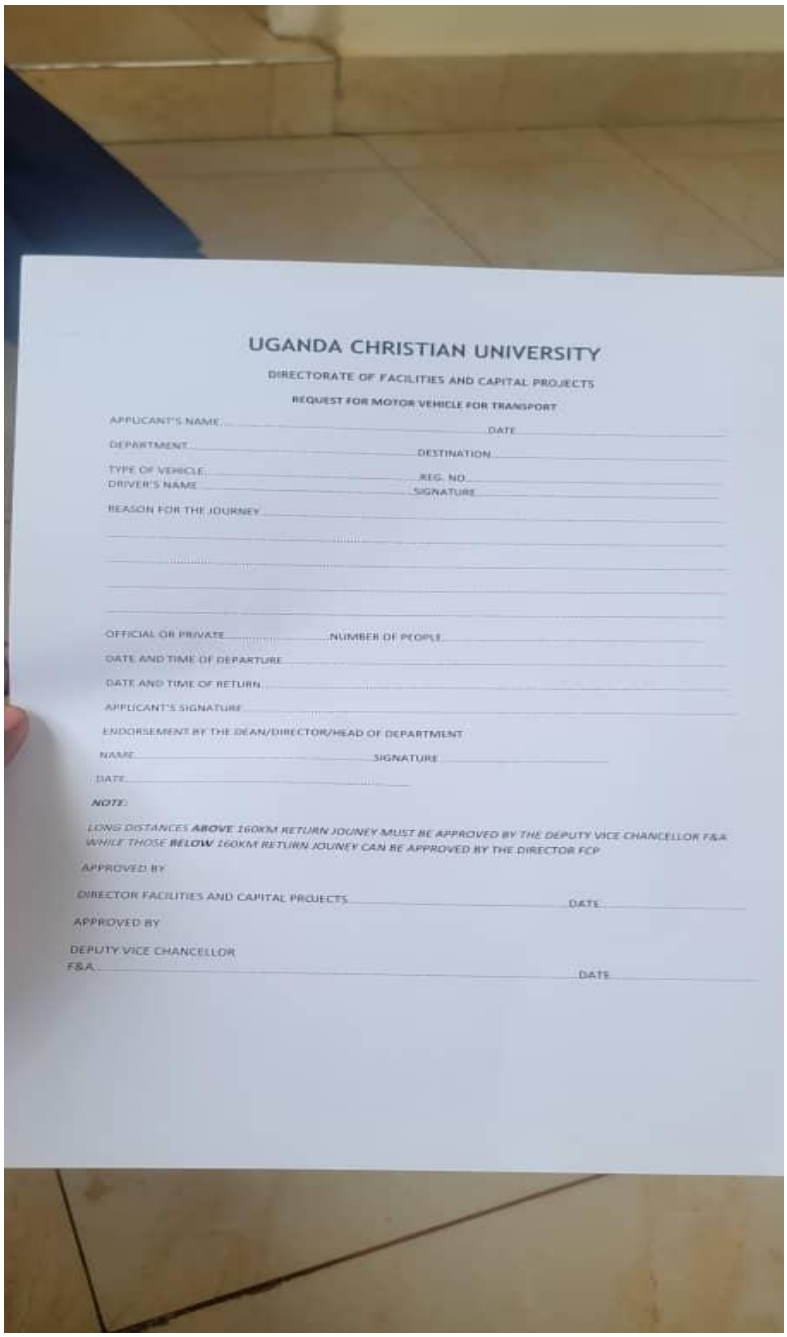
Once completed, the request form was submitted to the Head of Department (HOD) for approval. The departmental head reviewed the request and determined whether the travel was necessary and aligned with departmental activities. After approval, the request was forwarded to the Facilities Office where administrators assessed vehicle availability and determined whether the request could be accommodated.

If the request was approved by the Facilities Office, a driver and vehicle were assigned for the trip. The requester was then informed about the assigned driver and vehicle details so that preparations for the journey could be made. In addition to this process, when a university vehicle was leaving the campus, a motor vehicle gate pass was issued to authorize movement through the security gate.

Although this process enabled the university to coordinate vehicle usage, it involved multiple manual steps that required physical movement of documents between offices. The lack of a centralized digital system also made it difficult to track vehicle availability in real time.

3.3 Vehicle Request Documentation

The vehicle request process at Uganda Christian University relied on printed forms that captured trip information and approval signatures from authorized personnel. These documents served as official records used by the Facilities Office to coordinate transport services.



UGANDA CHRISTIAN UNIVERSITY

DIRECTORATE OF FACILITIES AND CAPITAL PROJECTS

REQUEST FOR MOTOR VEHICLE FOR TRANSPORT

APPLICANT'S NAME ..... DATE .....

DEPARTMENT ..... DESTINATION .....

TYPE OF VEHICLE ..... REG. NO .....

DRIVER'S NAME ..... SIGNATURE .....

REASON FOR THE JOURNEY .....

OFFICIAL OR PRIVATE ..... NUMBER OF PEOPLE .....

DATE AND TIME OF DEPARTURE .....

DATE AND TIME OF RETURN .....

APPLICANT'S SIGNATURE .....

ENDORSEMENT BY THE DEAN/DIRECTOR/HEAD OF DEPARTMENT

NAME ..... SIGNATURE .....

DATE .....

NOTE:

*LONG DISTANCES **ABOVE** 160KM RETURN JOURNEY MUST BE APPROVED BY THE DEPUTY VICE CHANCELLOR F&A WHILE THOSE **BELOW** 160KM RETURN JOURNEY CAN BE APPROVED BY THE DIRECTOR FCP*

APPROVED BY

DIRECTOR FACILITIES AND CAPITAL PROJECTS ..... DATE .....

APPROVED BY

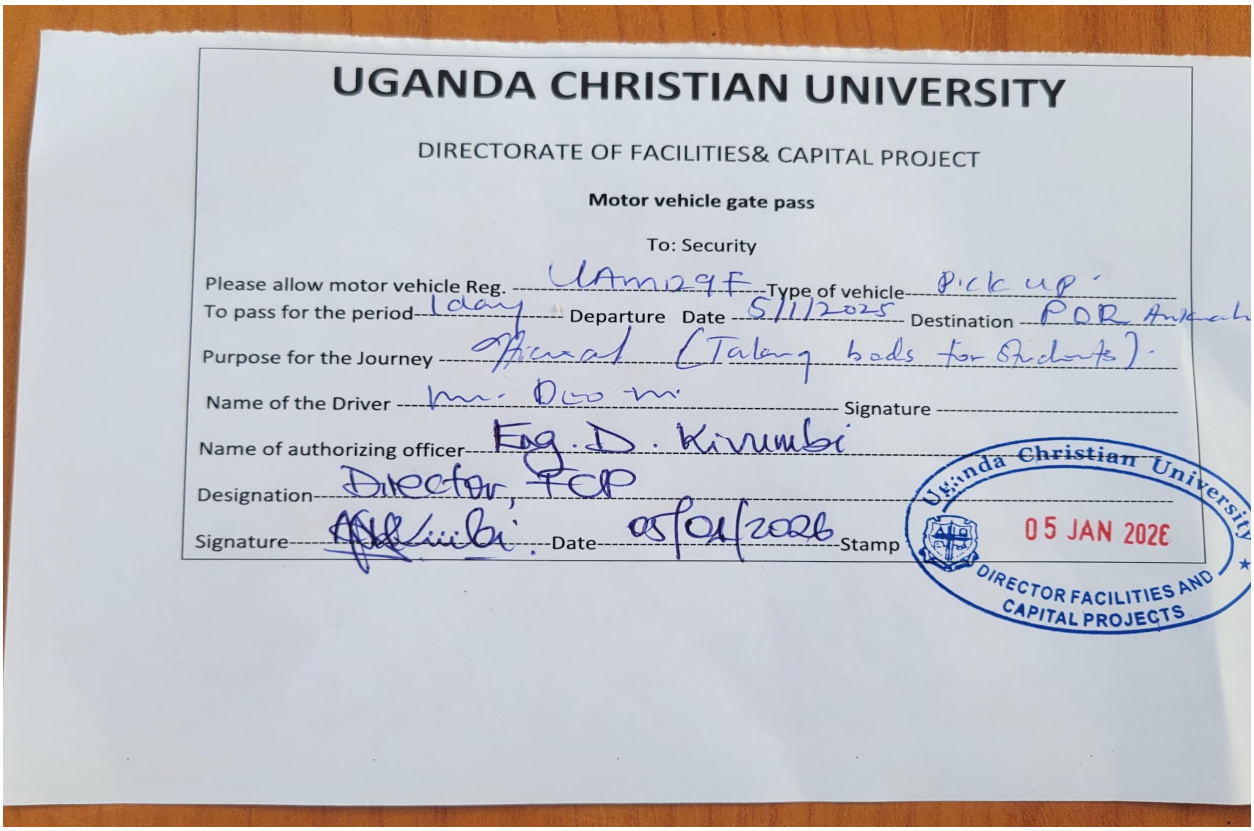
DEPUTY VICE CHANCELLOR

F&A ..... DATE .....

Figure 1: Vehicle Request Form used by the Directorate of Facilities and Capital Projects

The vehicle request form included fields such as the applicant's name, department, destination, purpose of the trip, number of passengers, and the dates of travel. The form also included spaces for signatures from the Head of Department and the Facilities Office to indicate approval of the request.

In addition to the vehicle request form, a gate pass document was issued to vehicles leaving the university premises. This document was presented to security personnel at the gate to confirm that the vehicle had been authorized to leave the campus.


UGANDA CHRISTIAN UNIVERSITY

DIRECTORATE OF FACILITIES& CAPITAL PROJECT

Motor vehicle gate pass

To: Security

Please allow motor vehicle Reg. UAM29F Type of vehicle Pick up

To pass for the period 1 day Departure Date 5/1/2025 Destination PDR Arukesh

Purpose for the Journey official (Taking beds for Students).

Name of the Driver Mr. Dan M Signature

Name of authorizing officer Eng. D. Kiyumbi

Designation Director, FCP

Signature Kiyumbi Date 05/01/2026 Stamp

Uganda Christian University

05 JAN 2026

DIRECTOR FACILITIES AND CAPITAL PROJECTS

Figure 2: Motor Vehicle Gate Pass used at the University Security Gate

The gate pass contained information such as the vehicle registration number, driver details, destination, and authorization signatures. Security personnel used this document to verify that the vehicle movement had been officially approved.

3.4 Analysis of the Existing Workflow

The analysis of the existing manual system revealed several steps involved in processing transport requests. Initially, a staff member or department representative filled out the vehicle request form indicating the purpose of travel, destination, and number of passengers. The completed form was then submitted to the Head of Department for approval.

Once the Head of Department approved the request, the document was delivered to the Directorate of Facilities and Capital Projects for further review. The Facilities Office evaluated vehicle availability and determined whether the request could be fulfilled. If a suitable vehicle was available, a driver was assigned and the requester was informed about the transport arrangements.

Before the vehicle departed from the university premises, a gate pass document was issued and presented to security personnel at the campus gate. The gate pass served as proof that the trip had been authorized by the appropriate university office.

Although the workflow ensured that transport activities were properly authorized, the manual handling of documents introduced several inefficiencies. Requests often took time to process due to the physical movement of forms between offices. Additionally, administrators had limited visibility of vehicle availability, which increased the possibility of scheduling conflicts.

3.5 Identified Problems in the Existing System

The analysis of the current fleet management process revealed several operational challenges associated with the manual system.

One of the major problems identified was the delay in processing transport requests. Since request forms had to pass through multiple approval stages, the time required to complete the process could be significant, especially when the responsible officers were unavailable.

Another challenge was the lack of centralized digital records. Transport request forms and trip details were stored physically, making it difficult to retrieve historical information regarding vehicle usage, trip schedules, and maintenance records.

The manual system also limited visibility of vehicle availability. Administrators had to rely on personal knowledge or manual records to determine whether a vehicle was available at a given time. This increased the likelihood of scheduling conflicts and inefficient utilization of fleet resources.

Communication between requesters, drivers, and facilities staff was also not centralized. In many cases, updates regarding trip approvals or vehicle assignments were communicated through phone calls or informal messaging, which could lead to miscommunication.

These limitations highlighted the need for an automated system capable of digitizing the transport request process and improving coordination between all stakeholders involved in fleet management.

3.6 Functional Requirements

Functional requirements describe the specific system capabilities that the Digital Fleet Management System was required to provide. Based on the analysis conducted, the system was designed to support several core functions.

The system was required to allow users to register and authenticate using secure login credentials. Once authenticated, users could access system features based on their assigned roles within the platform.

The system was also required to allow requesters to submit vehicle booking requests electronically through an online interface. These requests would include information such as travel destination, purpose of the trip, number of passengers, and travel dates.

Administrators were required to have the ability to manage vehicles, assign drivers to trips, review booking requests, and monitor fleet activities through an administrative dashboard.

The system was also required to automatically check vehicle availability before confirming a booking. This feature would prevent double booking by verifying whether a vehicle was already assigned to another trip within the requested time period.

Drivers were required to access a dashboard where they could view assigned trips, route information, and trip schedules. This feature would improve communication between administrators and drivers.

3.7 Non-Functional Requirements

Non-functional requirements describe the quality attributes that the system was expected to meet in order to ensure reliable performance and usability.

The system was required to provide a secure authentication mechanism to protect user accounts and system data. Password encryption using bcrypt and token-based authentication using JSON Web Tokens were implemented to enhance system security.

The system was also required to provide fast response times when processing booking requests and retrieving vehicle information. Efficient database queries and optimized backend logic were used to ensure smooth system performance.

Usability was another important requirement for the system. The user interface was designed to be intuitive and easy to navigate so that users with limited technical expertise could interact with the platform without difficulty.

Additionally, the system was required to maintain accurate records of transport activities including trip history, vehicle assignments, and maintenance information.

3.8 System Users and Roles

The Digital Fleet Management System was designed to support multiple user roles that correspond to different responsibilities within the fleet management process.

The administrator role was responsible for managing vehicles, assigning drivers, monitoring trip records, and managing system users. Administrators had the highest level of access within the system.

Drivers were provided with access to a driver dashboard where they could view assigned trips, route details, and travel schedules.

Requesters were allowed to browse available vehicles and submit transport requests through the system interface.

Additional roles such as Head of Department and Facilities Office staff were planned for implementation in order to support the approval workflow required by the university's transport management process.

3.9 Feasibility Analysis

A feasibility analysis was conducted to determine whether the proposed Digital Fleet Management System could realistically be implemented within the university environment.

The technical feasibility of the system was confirmed through the availability of modern web technologies such as React, Node.js, and MySQL which were capable of supporting the required system functionality. These technologies also provided scalability for future system expansion.

Operational feasibility was also considered. The proposed system was designed to replicate the existing workflow used by the university while replacing manual processes with automated digital interactions. This approach ensured that the system would align with the operational procedures already familiar to staff members.

Economic feasibility was evaluated by considering the use of open-source technologies during system development. By utilizing freely available development frameworks and tools, the cost of implementing the system was significantly reduced.

The feasibility analysis concluded that the development of the Digital Fleet Management System was both practical and beneficial for improving fleet management operations at Uganda Christian University.

CHAPTER FOUR

SYSTEM DESIGN

4.1 Introduction

This chapter presents the design of the Digital Fleet Management System for Uganda Christian University. The chapter describes the architecture of the system, the database design, system components, and the models that guided the development process. The purpose of the system design was to translate the requirements identified in the previous chapters into a structured blueprint that guided the development of the system. The design stage ensured that the system would effectively address the limitations of the existing manual fleet management approach and provide an efficient, reliable, and scalable solution for managing university vehicles, drivers, maintenance schedules, and trip records.

4.2 System Architecture

The system was designed using a three-tier architecture consisting of the presentation layer, application layer, and data layer. This architectural model was selected because it allows separation of concerns, improves system maintainability, and enhances scalability.

The presentation layer was responsible for the user interface through which users interacted with the system. This layer provided forms and dashboards that allowed administrators and transport officers to manage fleet operations. The application layer handled the core system logic including trip scheduling, vehicle allocation, maintenance tracking, and report generation. The data layer managed the storage and retrieval of system data through a relational database.

The architecture ensured that each component of the system operated independently while still maintaining communication with the other layers. This design improved the efficiency of the system and reduced the risk of system failures affecting the entire platform.

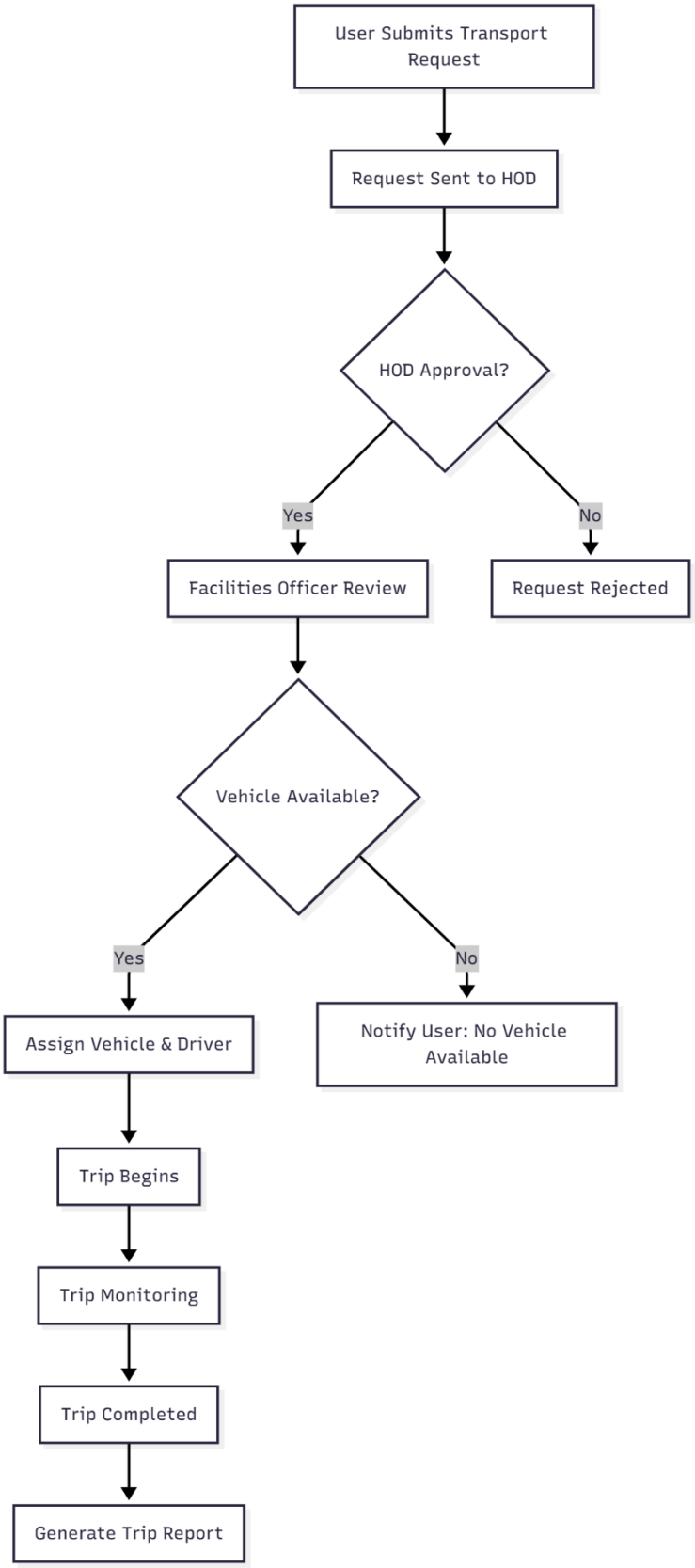


Figure 3: System Architecture of the Digital Fleet Management System

4.3 System Modules

The system was divided into several functional modules that handled different aspects of fleet management. These modules were designed to ensure that all major transport management activities at Uganda Christian University could be performed within the system.

The vehicle management module was responsible for storing and managing information about all university vehicles including registration numbers, vehicle types, capacity, and operational status. This module allowed administrators to add, update, and track vehicle information.

The driver management module was designed to manage driver records including driver identification details, assigned vehicles, license information, and employment status. This module ensured that only authorized drivers could be assigned to university vehicles.

The trip management module handled the scheduling and monitoring of trips. Through this module, transport officers could allocate vehicles and drivers for specific trips, record trip destinations, and monitor trip progress.

The maintenance management module was developed to track vehicle servicing and maintenance schedules. The module allowed administrators to record maintenance activities, monitor service intervals, and ensure that vehicles remained in good operating condition.

The reporting module generated operational reports such as vehicle usage reports, maintenance reports, and trip history reports. These reports supported decision-making and improved transparency within the transport department.

4.4 Database Design

The database design defined how data would be structured and stored within the system. A relational database model was used because it allows efficient organization of structured data and supports data integrity through relationships between tables.

The database contained several entities including vehicles, drivers, trips, maintenance records, and users. Each entity represented a table in the database and stored information relevant to fleet operations.

The vehicles table stored information such as vehicle identification number, registration number, vehicle type, and status. The drivers table stored details about drivers including name, contact information, license number, and assigned vehicle. The trips table recorded trip information such as trip date, destination, assigned driver, and vehicle used. The maintenance table stored records

of vehicle servicing and repairs. The users table managed authentication and authorization for system users.

Relationships between these entities ensured that data remained consistent and properly linked across the system.

4.5 Entity Relationship Diagram (ERD)

The Entity Relationship Diagram illustrated the logical relationships between the major entities in the system database. The diagram showed how vehicles, drivers, trips, maintenance records, and users interacted within the system.

The vehicles entity had a relationship with the trips entity because each trip required a vehicle. The drivers entity was also related to trips since a driver was assigned to each trip. Maintenance records were linked to vehicles to ensure that maintenance activities were properly tracked for each vehicle. The users entity managed system access and defined roles such as administrators and transport officers.

This relational structure ensured efficient data management and minimized redundancy within the database.

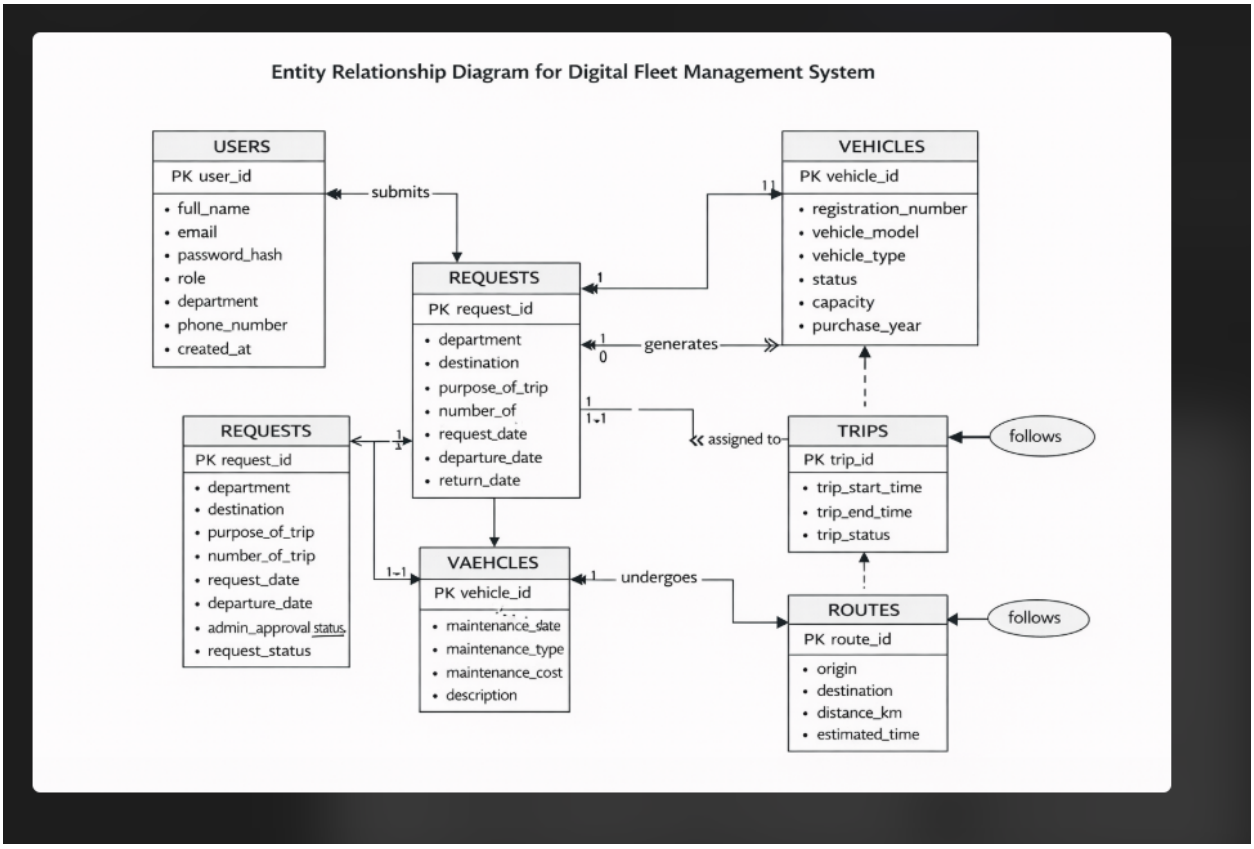


Figure 4: Entity Relationship Diagram of the Fleet Management Database

4.6 System Flow Design

System flow diagrams were used to illustrate how data moved through the system during different operations. The flow began when a user logged into the system using valid credentials. After authentication, the user accessed the dashboard where they could perform tasks such as registering vehicles, assigning drivers, scheduling trips, or recording maintenance activities.

When a trip was scheduled, the system verified vehicle availability and driver assignment before recording the trip in the database. Similarly, when maintenance was recorded, the system updated the vehicle's maintenance history and notified administrators about upcoming service requirements.

These flows ensured that all operations followed a structured process that maintained accuracy and efficiency.

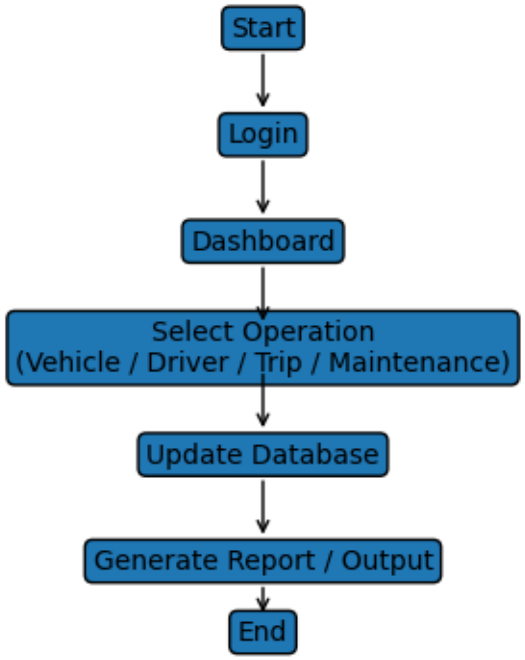


Figure 5: System Operational Flowchart

4.7 User Interface Design

The user interface was designed to be simple, intuitive, and accessible to users with basic computer skills. The system provided a dashboard interface that displayed key fleet management information such as vehicle availability, scheduled trips, and maintenance alerts.

Forms were designed for adding vehicles, registering drivers, scheduling trips, and recording maintenance activities. The interface also included navigation menus that allowed users to easily move between system modules.

This design ensured that the system remained user-friendly while still supporting the complex operations required for fleet management.

4.8 Security Design

Security was an important consideration in the system design. User authentication mechanisms were implemented to ensure that only authorized personnel could access the system. The system used role-based access control to restrict system functions based on user roles.

Administrators were granted full access to manage vehicles, drivers, and system configurations, while transport officers were allowed to manage trips and operational records. Password protection and database security measures were implemented to safeguard sensitive information.

These security features ensured that the system protected institutional data and maintained operational integrity.

4.9 Summary

This chapter presented the system design for the proposed Digital Fleet Management System. The design included the system architecture, functional modules, database structure, system flows, and user interface components. The design process ensured that the system would effectively address the challenges identified in the existing manual fleet management process. The next chapter presents the implementation and testing of the system.

CHAPTER FIVE

SYSTEM IMPLEMENTATION AND TESTING

5.1 Introduction

This chapter presents the implementation progress of the Digital Fleet Management System developed to improve vehicle request and allocation processes at Uganda Christian University. The chapter describes the development environment used, system architecture implementation, database design implementation, and the development of system modules. It also explains the testing procedures that were conducted to verify system functionality.

Since the project is still under development, some modules have already been fully implemented while others are still in progress. Therefore, this chapter describes the components that have already been developed and outlines the remaining system features that will be implemented before the final system deployment.

5.2 Development Environment

The system was developed using modern web technologies that support secure, scalable, and maintainable applications. The development environment consisted of both hardware and software components that enabled the development and testing of the Digital Fleet Management System.

5.2.1 Hardware Requirements

The development of the system was carried out using personal computers capable of supporting modern web development tools. The development machines used processors equivalent to Intel Core i5 with at least 8GB of RAM. These specifications were sufficient to run the development environment, database server, and browser-based testing tools simultaneously.

Reliable internet connectivity was also required for installing development packages, accessing documentation, and testing system behavior under network conditions similar to real deployment environments.

5.2.2 Software Requirements

The system was implemented as a web-based application using a layered architecture consisting of a frontend interface, backend application services, and a relational database.

The backend component was developed using server-side programming technologies responsible for handling business logic, authentication processes, and database communication. The frontend component was implemented using modern web interface technologies that allowed the development of interactive dashboards for different system users.

The system database was implemented using MySQL, which provided a relational database management system capable of storing structured fleet management data. The database design implemented primary keys, foreign keys, and relational constraints to ensure data integrity.

Additional libraries were used to enhance system security. User passwords were hashed using bcrypt before being stored in the database. JSON Web Tokens (JWT) were implemented to manage secure user authentication sessions and protect access to system resources.

5.3 System Implementation

The implementation phase involved translating the system design models presented in Chapter Four into functional software modules. The system architecture consisted of three main components: the frontend interface, the backend services, and the relational database.

Currently, several major components of the system have already been implemented and integrated successfully. These include the database structure, backend logic, authentication mechanisms, and several user dashboards. However, some system modules are still under development and will be completed during the next phase of the project.

5.3.1 Backend Implementation

The backend component of the system has already been implemented and is responsible for processing system requests, enforcing business logic, and managing communication between the frontend interface and the database.

The backend currently supports several core functionalities including vehicle management, driver management, trip tracking, and vehicle request processing. These functionalities are exposed through secure API endpoints that allow the frontend dashboards to interact with the system.

Security mechanisms have already been implemented in the backend to protect system data. Passwords are securely stored using bcrypt hashing to prevent unauthorized access to user credentials. In addition, JSON Web Tokens (JWT) have been implemented to manage authentication sessions. These tokens include expiration configurations that require users to re-authenticate after a specified period.

Route protection middleware has also been implemented to enforce role-based access control. These middleware functions verify user authentication tokens and ensure that users can only access system features assigned to their specific roles.

5.3.2 Database Implementation

The database component of the Digital Fleet Management System has already been fully implemented using MySQL. The database structure follows the relational model designed during the system design phase.

Several database tables were created to support the operations of the system. The users table stores information about system users including administrators, drivers, and requesters. The vehicles table stores fleet information such as vehicle identification, vehicle status, and availability.

The trips table stores trip records including assigned drivers, vehicle details, and travel schedules. The bookings or requests table stores vehicle request information submitted by system users.

Additional tables such as maintenance records and fuel logs have also been implemented to support fleet monitoring and maintenance tracking.

Relationships between these tables were implemented using foreign keys to ensure data consistency and integrity across the system.

5.3.3 Frontend Implementation

The frontend component of the system has been partially implemented and currently provides interactive dashboards for different system users.

The login interface has already been implemented and allows authenticated users to securely access the system using their credentials. After authentication, users are redirected to dashboards that correspond to their assigned system roles.

The administrator dashboard has already been implemented and provides system administrators with access to fleet management features such as vehicle registration, driver management, trip tracking, and system monitoring.

The driver dashboard has also been implemented and allows drivers to view assigned trips, route details, and travel schedules.

However, additional dashboards are still under development. These include the Head of Department dashboard and the requester dashboard which will allow departmental users to submit vehicle requests and monitor the approval process.

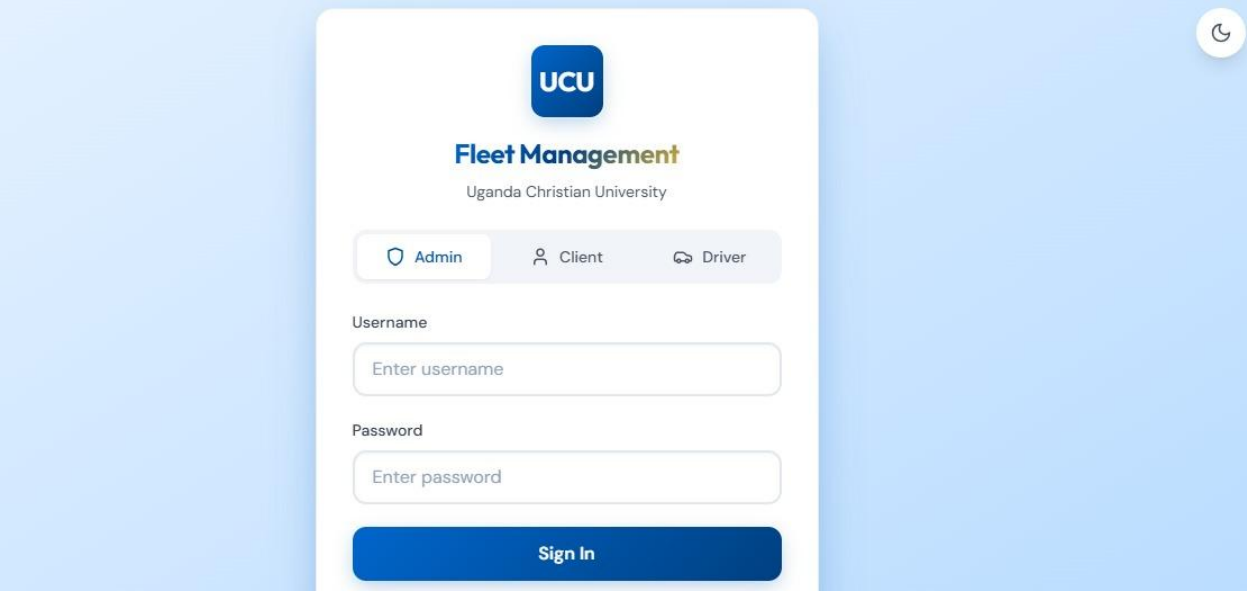
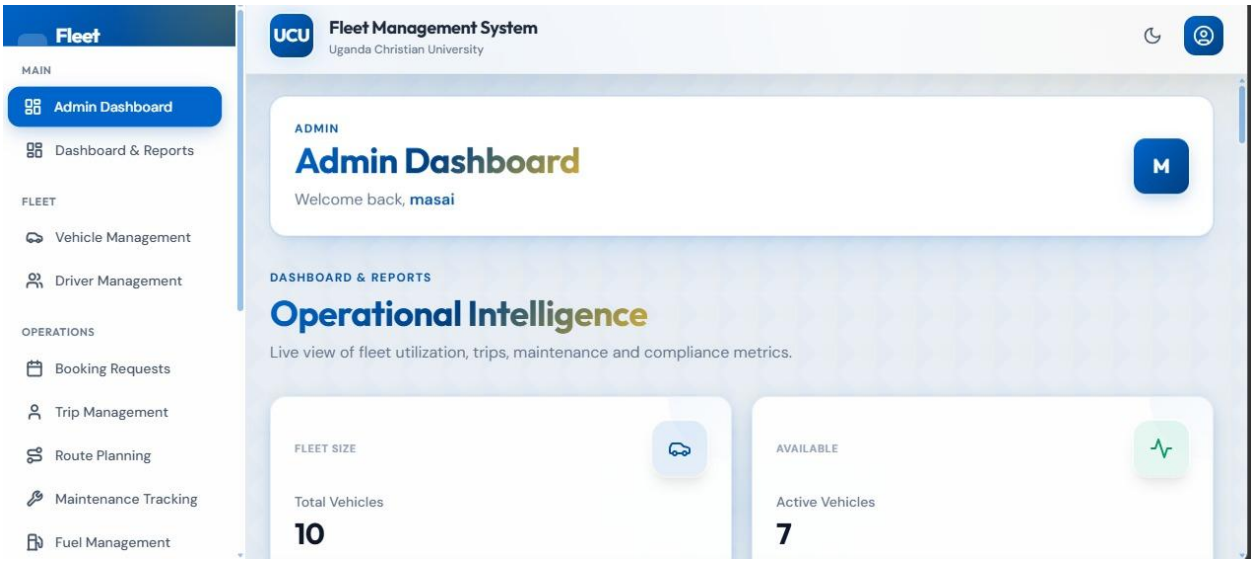


Figure 6: System Login Interface



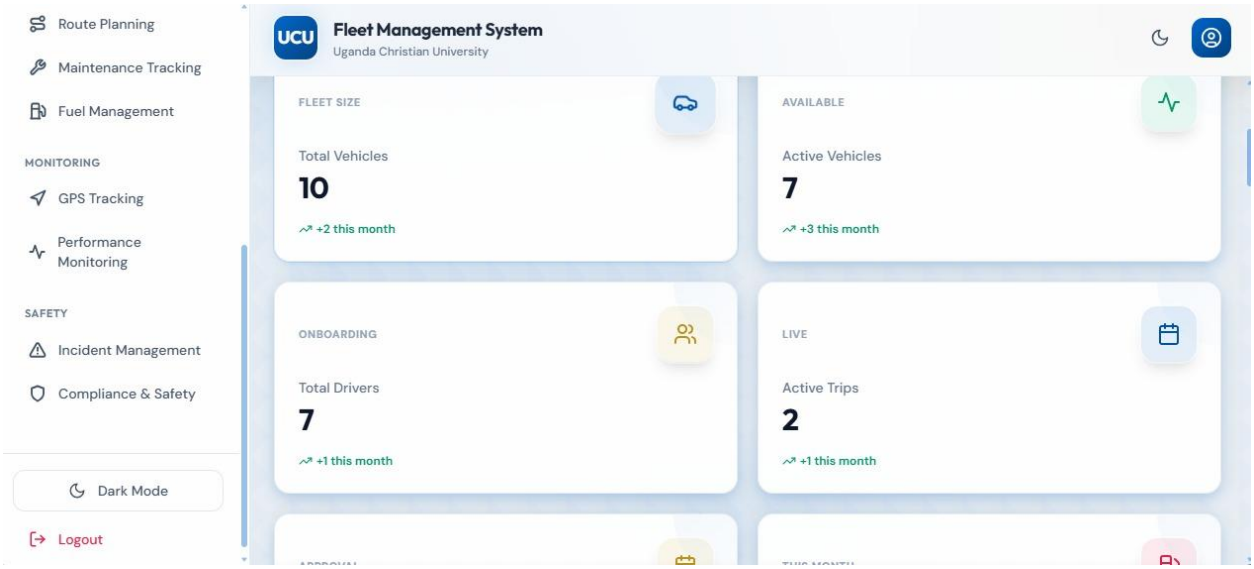


Figure 7: Administrator Dashboard

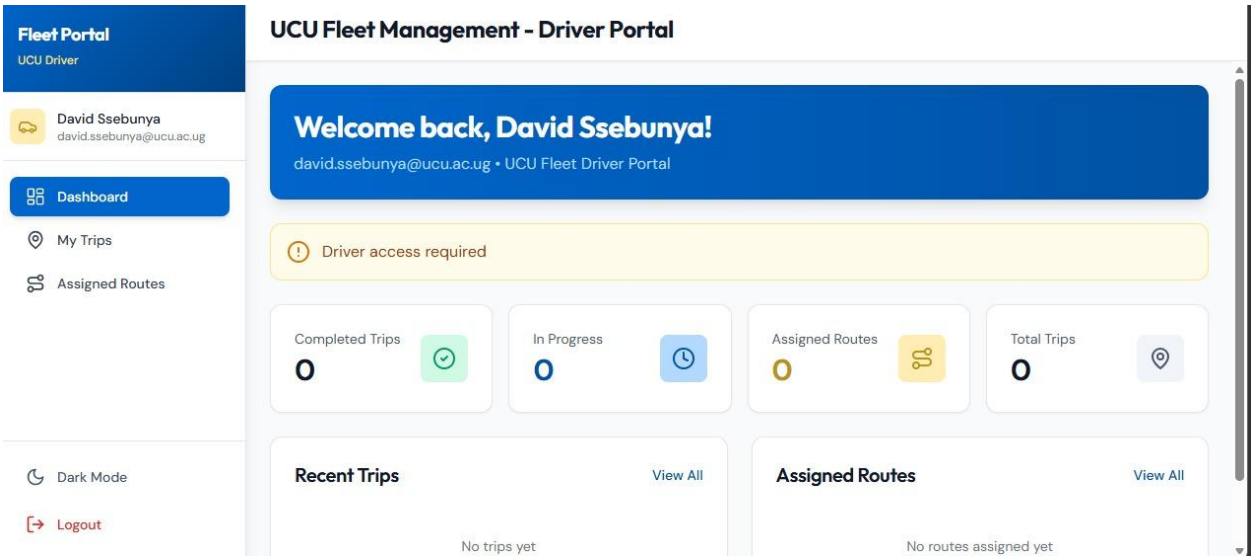


Figure 8: Driver Dashboard

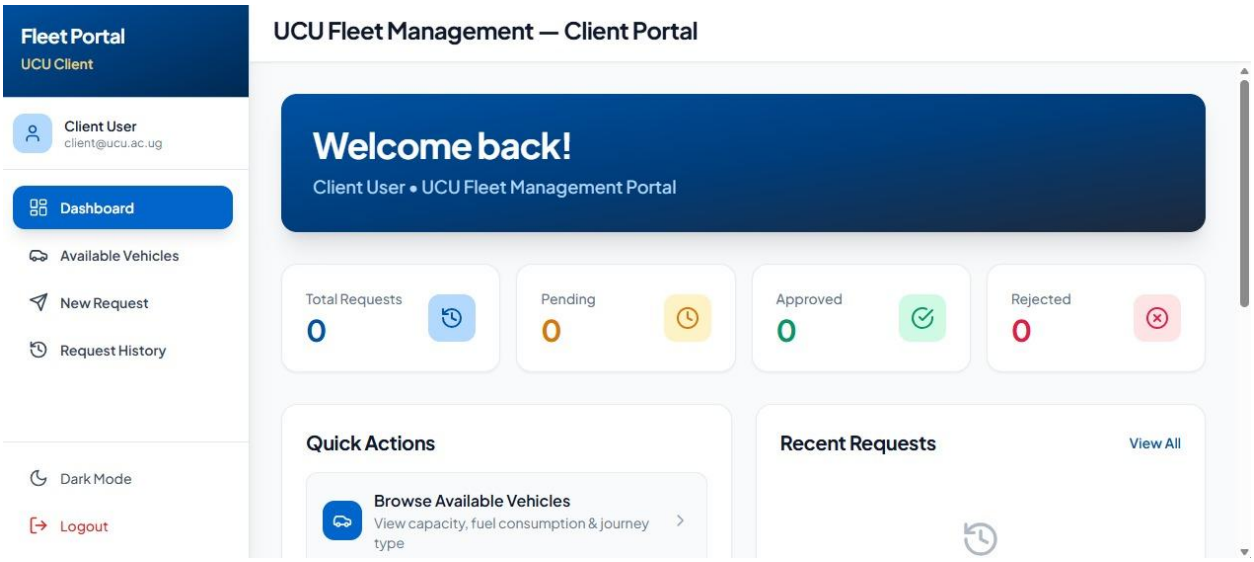


Figure 9: Client Dashboard

5.4 Vehicle Request Workflow Implementation

The vehicle request workflow implemented in the system is based on the operational procedures followed by the Directorate of Facilities and Capital Projects at Uganda Christian University.

Currently, the system supports the submission and management of vehicle requests through the administrative interface. The full automated approval workflow is still under development and will be implemented through additional dashboards.

In the planned workflow, a user will submit a vehicle request through the requester dashboard. The request will first be reviewed by the Head of Department who will either approve or reject the request.

If the request is approved at the departmental level, it will then be forwarded to the Facilities Office for final verification. The Facilities Office will review the availability and condition of vehicles before approving the request.

Once approved, the system will assign an available vehicle and driver to the trip. The assigned driver will receive trip details through the driver dashboard, while the requester will receive confirmation of the assigned vehicle and driver.

5.5 System Testing

After development was completed, the system was tested to ensure that it worked correctly and met the project objectives. Testing focused on usability, functionality, performance, and reliability

of the system.

Testing was carried out using sample users representing the main system roles:
Administrator
Department requester
Driver
The aim was to confirm that users could successfully perform their tasks without difficulty.

5.6 Functional Testing

Functional testing was conducted to verify that all system features worked as expected.
The following modules were tested:

Vehicle Management Module The administrator was able to:
Add new vehicles
Update vehicle details
View vehicle availability
The system successfully stored and retrieved vehicle information from the database.

Vehicle Request Module Department users successfully:
Submitted transport requests
Selected dates and destinations
Viewed request status
The approval workflow functioned correctly, confirming the effectiveness of the booking process.

Approval Workflow The administrator was able to:
Approve or reject requests
Assign drivers and vehicles
The system updated the request status automatically and notified users.

Driver Assignment and Trip Tracking
Drivers were assigned to trips successfully.
Trip details were displayed correctly on the dashboard.
These results showed that the system met the functional requirements.

5.7 Usability Testing

Usability testing was conducted with potential users to evaluate ease of use and navigation.
Users were asked to perform common tasks such as:

Logging into the system

Submitting a request
Approving requests
Viewing trip schedules

Feedback showed that:
The interface was easy to understand
Navigation was simple and clear
Users required minimal training

Similar studies show that user-friendly interfaces increase system adoption in organizations (Alalwan et al., 2022).

5.8 Performance Testing

Performance testing evaluated how the system responded to multiple requests and data processing.

The system demonstrated:

Fast page loading
Quick database response
Stable performance during multiple requests
This confirmed that the system could handle normal operational usage.

5.9 Discussion of Findings

The results showed that the developed system successfully solved the problems identified in Chapter One.

The manual vehicle booking process was replaced with an automated workflow. Vehicle availability could now be checked in real time. Trip records were stored in a centralized database.

These improvements aligned with findings from recent studies showing that digital fleet systems improve efficiency and transparency (Santos & Pereira, 2023).

The system also supported better communication between departments, drivers, and administrators. This reduced delays and improved coordination.

Overall, the system achieved the main project objective and proved suitable for deployment within the university environment.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The aim of this project was to develop a web-based UCU Fleet Management System to improve transport coordination and replace the manual fleet management process.

The study identified several challenges in the existing system, including delays in vehicle booking, lack of centralized records, and inefficient communication between stakeholders.

The developed system successfully automated vehicle booking, approval workflows, driver assignment, and trip monitoring. Testing confirmed that the system was functional, easy to use, and capable of improving efficiency and transparency in fleet operations.

The project therefore achieved its main objective and demonstrated that a web-based fleet management system can significantly improve transport management at Uganda Christian University.

6.2 Contributions of the Project

The project contributed to the university in several ways.

It introduced a digital solution that reduces paperwork and administrative workload.
It improved accountability through centralized data storage and reporting.
It supported the university's digital transformation initiatives.

6.3 Limitations of the System

Although the system met its objectives, some limitations were identified.

The system did not include GPS tracking for real-time vehicle location.
Mobile application support was not implemented.
The system was tested in a limited environment and not yet deployed at full scale.

6.4 Recommendations for Future Work

Future improvements may include:

Integration of GPS tracking for real-time vehicle monitoring

Development of a mobile application for drivers
Integration with university finance and authentication systems
Expansion of the system to support multiple campuses

These improvements would enhance the system’s functionality and usability.

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