DIGITAL SHUTTLE MANAGEMENT SYSTEM IN A UNIVERSITY CAMPUS

BY

OLAJIDE SEBIOBA CHUKWUEBUKA

(PSC2105382)

FACULTY OF COMPUTING

DEPARTMENT OF COMPUTER SCIENCE,

UNIVERSITY OF BENIN,

BENIN CITY,

EDO STATE, NIGERIA.

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FRONTEND IMPLEMENTATION OF A DIGITAL SHUTTLE MANAGEMENT SYSTEM IN A UNIVERSITY CAMPUS

BY

OLAJIDE SEBIOBA CHUKWUEBUKA

PSC2105382

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CERTIFICATION

This is to certify that this project titled “DIGITAL SHUTTLE MANAGEMENT SYSTEM IN A UNIVERSITY CAMPUS” was carried out by OLAJIDE SEBIOBA CHUKWUEBUKA with Matriculation number: PSC2105382 and submitted to the Department of Computer Science, Faculty of Computing, University of Benin, Benin City, under the supervision of PROF. F. AMADIN.

______________________ ____________________

PROF. F. AMADIN **Date**

Supervisor

APPROVAL PAGE

This project titled **"DIGITAL SHUTTLE MANAGEMENT SYSTEM IN A UNIVERSITY CAMPUS"** by **OLAJIDE SEBIOBA CHUKWUEBUKA** with Matriculation number: **PSC2105382** has been approved as meeting the requirements for the award of Bachelor of Science Degree in the Department of Computer Science, Faculty of Computing, and University of Benin, Benin city.

________________________ ______________________

DR. MAXWELL OSAGIE **Date**

Project Coordinator

________________________ ______________________

DR. ROSEMARY USIOBAIFO **Date**

Head of Department

________________________ ______________________

EXTERNAL EXAMINER **Date**

DEDICATION

This work is dedicated to the Almighty God, the source of life and giver of grace and strength, who, by his mercies and grace, saw to the finishing of this project work, and this milestone in this academic journey.

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ABSTRACT

This project addresses the inefficiencies of managing shuttle services in university campuses. The study aimed to develop operational efficiency and improve passenger experience by leveraging advanced technology. The solution was designed to provide users with accurate arrival times and route information through an intuitive web application, minimizing wait times and increasing satisfaction using a three tier client-server architecture and UML modeling to define clear interactions between Student, Drivers and Administrators. Implementations utilized PHP, XAMPP, and my SQL to deliver a responsive platform. Key functionalities of the system includes real-time tracking, automated scheduling, and effective communication channels for passengers and operators. Digital Shuttle Management System serves as a sustainable transportation solution, aimed at optimizing fuel consumption and reducing manual appointment scheduling system. By integrating these elements, the project facilitates a smarter, more responsive shuttle service tailored to meet the evolving demands of mobility.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Transportation plays a vital role in supporting mobility and daily activities within academic environments. In most universities, shuttle buses serve as an essential mode of transportation for students and staff, connecting hostels, lecture halls, and administrative buildings (Adewumi & Allopi, 2020). However, in many Nigerian campuses, shuttle operations are still managed manually. Students often wait for long periods without knowing when a shuttle will arrive, while drivers make movement decisions based on personal judgment rather than structured scheduling (Ogunleye & Olatunji, 2021).

Manual shuttle coordination results in delays, miscommunication, overcrowding, and inefficient resource usage. Transport officials often depend on verbal communication and handwritten logs, which are prone to errors and inconsistencies (Abayomi-Alli et al., 2020). The absence of real-time information makes it difficult for administrators to monitor shuttle locations, assign drivers effectively, or track trip status, leading to reduced service delivery and dissatisfaction among commuters (Eze & Onuoha, 2019).

With the rise of digital systems, universities around the world are adopting technology-based transportation management solutions. Tools such as Global Positioning Systems (GPS), web applications, and automated scheduling algorithms are now used to improve communication, optimize routes, and provide real-time service updates (Ganesh et al., 2012). A **Digital Shuttle Management System (DSMS)** can automate shuttle request handling, enhance driver assignment, and support real-time trip monitoring, ultimately improving accountability, transparency, and user satisfaction (Nwosu & Ibem, 2021).

Therefore, this study focuses on the development of a Digital Shuttle Management System to address the inefficiencies of manual shuttle coordination and improve transportation service delivery within Nigerian university environments.

1.2 Statement of the Problem

In many university shuttle systems, including those observed in Nigerian campuses, the allocation of shuttle buses and drivers is carried out manually. Transport officials and drivers often rely on verbal communication, personal judgment, or rough estimation when deciding when and where shuttles should operate. This manual approach becomes inefficient particularly during peak hours, when passenger demand is high.

The lack of a structured system for managing shuttle operations leads to several challenges. First, shuttle scheduling becomes inconsistent, causing either overcrowding or insufficient shuttle availability. Second, administrators lack real-time visibility of shuttle locations and trip progress, which affects decision-making and resource planning. Third, students are unable to request shuttle services in advance or track trip status, resulting in uncertainty and dissatisfaction.

Furthermore, without a centralized record system, monitoring shuttle usage, managing driver assignments, and evaluating operational performance becomes difficult. These challenges highlight the need for a **Digital Shuttle Management System** that can automate shuttle request handling, resource allocation, and real-time trip tracking to improve efficiency and user experience.

1.3 Aim and Objectives of the Study

1.3.1 Aim of the Study

The aim of this study is to develop a **Digital Shuttle Management System (DSMS)** that automates the coordination of shuttle services within a university environment. The system is intended to improve communication between students, drivers, and transport administrators, provide real-time updates on trip status, and ensure efficient allocation of shuttles and drivers in order to reduce waiting time, enhance operational transparency, and improve overall commuter experience.

1.3.2 Objectives of the Study

To achieve the stated aim, the following objectives were pursued:

1. To analyze the existing shuttle management process
2. To design a database system
3. To develop a web-based shuttle request interface for students
4. To implement an administrative dashboard
5. To provide a driver interface
6. To evaluate the system

1.4 Significance of the Study

The development of a Digital Shuttle Management System holds significant value for students, drivers, administrators, and the university community as a whole. Efficient mobility is essential for academic productivity and campus logistics, yet many Nigerian universities still depend on manual shuttle coordination methods that lack structure and real-time communication (Ogunleye & Olatunji, 2021). By digitalizing shuttle operations, the system addresses key operational challenges and improves service delivery.

For **students**, the system reduces uncertainty by allowing them to request shuttle services online and receive updates on trip status. This helps minimize waiting time, reduces stress, and contributes to better time management, which enhances academic productivity (Adewumi & Allopi, 2020).

For **drivers**, the system provides clear trip assignments and structured movement schedules. This reduces confusion, eliminates overlapping pickups, and promotes a more organized transportation workflow (Eze & Onuoha, 2019).

For **transport administrators**, the system offers real-time visibility into shuttle usage, driver activities, and trip status. This supports informed decision-making, resource planning, and accountability in daily operations (Nwosu & Ibem, 2021).

At the institutional level, the system supports digital transformation initiatives within the education sector. It helps promote transparency, operational efficiency, and data-driven development planning key elements in modern campus management (Abayomi-Alli et al., 2020).

Overall, the system contributes to improving mobility experience, optimizing shuttle resource allocation, and promoting efficient campus transportation management.

1.5 Scope of the Study

This study focuses on the design and implementation of a **Digital Shuttle Management System (DSMS)** specifically for use within a university campus environment. The system is intended for managing shuttle movements between hostels, lecture halls, faculties, and other campus facilities. The scope of the system is limited to three primary user groups: **students** who request shuttle services, **drivers** who receive and update assigned trips, and **transport administrators** who coordinate shuttle operations.

The system provides the following functionalities:

- A **student interface** for submitting shuttle requests and tracking trip status.
- An **administrative dashboard** for assigning drivers and shuttles based on availability.
- A **driver panel** for viewing assigned trips and updating trip progress.

- A **centralized database** that stores shuttle records, trip logs, and user details.

The system is developed as a **web-based application**, making it accessible through desktops and mobile browsers. The study does not cover external city-wide transportation networks or financial fare processing systems. Instead, it focuses solely on improving communication, coordination, and scheduling within the university setting (Adewumi & Allopi, 2020; Nwosu & Ibem, 2021).

1.6 Limitations of the Study

Although the Digital Shuttle Management System improves shuttle coordination, its practical effectiveness is influenced by certain limitations. First, the system depends on **stable internet connectivity** for real-time communication between students, drivers, and administrators. In areas with weak network coverage, system performance may be affected (Ogunleye & Olatunji, 2021).

Second, the system requires **device literacy and willingness to adopt new technology**. Some drivers or users who are accustomed to manual operations may initially resist transitioning to a digital workflow (Eze & Onuoha, 2019).

Third, the system does not currently include **GPS-based live map tracking**. Shuttle location updates rely on driver input rather than automated tracking. Finally, the system does not manage fare billing or electronic payment, as the focus is on **trip management and communication**, not financial transactions.

These limitations do not reduce the system's usefulness but highlight areas for possible improvement in future development cycles (Abayomi-Alli et al., 2020).

1.7 Definition of Terms

Term	Definition
Digital Shuttle Management System (DSMS)	A software-based platform used to coordinate shuttle operations, including trip requests, driver assignments, and status monitoring.
Real-Time Tracking	The process of receiving updates on shuttle trip status or location at the moment events occur.
Automated Scheduling	The allocation of drivers and shuttles using system logic instead of manual decision-making.
Administrator	A transport management official responsible for assigning trips and monitoring shuttle activities.
Driver	A system user responsible for executing assigned shuttle trips and updating trip status.
Commuter / Student User	A student who utilizes the platform to request shuttle services and monitor trip progress.

CHAPTER TWO

LITERATURE REVIEW

2.0. Introduction to Shuttle Systems in University Environments

Shuttle management systems encompass a suite of digital technologies and algorithms designed to manage shuttle services efficiently, optimizing passenger transportation while minimizing operational costs. The modern University campuses in developing countries like Nigeria face a variety of transportation challenges that significantly affect students, faculties, and staffs. These challenges include inadequate infrastructure, growing campus populations, and the complexities of managing traffic within limited spaces. Existing transport networks often cannot keep up with the increasing demands, resulting in congestion, delays, and longer travel times. With rapid economic growth, accommodating passenger and freight traffic capacity also becomes more difficult S. K. Malhotra (et al.) 2021. As universities continue to expand, ensuring efficient and dependable transport becomes vital. The lack of sufficient transportation options limits wellbeing and causes what is known as “transport poverty,” disproportionately impacting those dependent on public transit or private vehicles by subjecting them to long commutes, high costs, and restricted access to campus facilities. This growing demand amid limited resources emphasizes the need for sustainable, affordable mobility solutions within Nigerian university campuses.

Shuttle systems are vital in addressing these problems by providing dedicated, reliable transit within the university setting. Their role is multifaceted, offering several advantages to the campus community. Effective transport management increasingly relies on integrating sensing technologies for real-time data analysis. A well-planned shuttle network reduces congestion by cutting down personal vehicle use on campus, improving traffic flow and lowering parking pressure. Shuttle systems also enhance access by connecting key campus areas such as classrooms, residence halls, libraries, and recreational spots. These intra-urban circulator systems support better campus connectivity and promote sustainability by encouraging public transit over private vehicle use, which helps reduce carbon emissions and improve air quality. By providing a safe, reliable, and efficient mobility option, shuttle systems contribute to a better quality of life for the university community and foster a more accessible and dynamic campus environment.

Digital shuttle management systems offer promising opportunities to further boost shuttle service efficiency on campuses. Digital technologies enable transformative improvements in how shuttle operations are managed and run. Features such as real-time vehicle tracking, route optimization, mobile ticketing, and advanced data analytics can be integrated into these systems. Innovative intelligent systems deployed on campuses also support energy transition goals and sustainability efforts. These digital tools supply valuable insights into shuttle usage, passenger demand, and service performance, empowering university administrators to make data-driven decisions for better service delivery. Leveraging digital technologies allows universities to build more responsive, efficient, and sustainable transportation networks that can adapt to the changing needs of their communities. Incorporating digital solutions into shuttle management is a key step toward smarter, more livable, and environmentally responsible university campuses in Nigeria.

2.1 Existing Shuttle Systems: A Global Perspective

To fully understand digital shuttle management systems, it is important to look at existing shuttle services in universities beyond Nigeria, as well as shuttle operations in other global contexts (I. Klk, "Educating Future Energy Engineers for Sustainability"). Studies of university shuttle systems worldwide show a wide variety of strategies and technologies aimed at enhancing campus transportation. For example, projects like electric buses are used to train future energy engineers while also improving city-campus transit. Many universities in developed countries have adopted comprehensive shuttle networks that feature real-time vehicle tracking, mobile applications, and data analytics to optimize routes and schedules. Subsidized student fares are known to influence transportation choices positively. Shuttle systems often integrate with other campus functions such as parking and security to create a seamless travel experience. Additionally, some universities have embraced cutting-edge solutions like autonomous shuttles and smart mobility platforms to boost efficiency and sustainability. Flexible online learning environments also complement shuttle systems by providing convenience for students (Muhdi, Nurkolis, Y. Yuliejantiningsih, 2020).

Looking beyond campus systems, shared mobility services globally offer valuable lessons for digital transport management. Urban areas worldwide increasingly rely on ride-hailing, bike-sharing, and scooter-sharing to provide accessible and flexible transit options. Smart city initiatives use mobility data and modeling to improve transportation quality and efficiency (J. Sperling, S. Young, V. Garikapati, A. Duvall, J. Beck, 2019). Advanced digital platforms enable real-time tracking, dynamic pricing, and efficient vehicle dispatching in these services. Public transit agencies in many cities incorporate digital management tools to streamline bus routes, refine schedules, and provide passengers with real-time updates. Data analytics help identify improvement opportunities and enhance transportation system performance.

Key insights and best practices from these examples can guide Nigerian universities in developing their own digital shuttle management systems. Effective stakeholder engagement during planning and execution fosters sustainability culture and ensures user needs are met. Providing an intuitive, accessible digital platform with real-time information, easy booking and payment, and integration with other campus services is essential. Prioritizing data security and privacy safeguards user information. By adopting these lessons, Nigerian universities can build shuttle systems that are efficient, sustainable, and responsive to their communities' evolving transportation needs.

2.2. Current Shuttle System Analysis in Nigerian Universities

Despite numerous studies on Digital Shuttle Management System, Nigerian universities currently face significant challenges in providing efficient shuttle services, largely due to limited resources, aging infrastructure, and minimal use of modern technologies. Most shuttle services operate on fixed routes and schedules with little to no real-time tracking or communication for passengers. This results in inefficiencies such as long wait times, overcrowding, and unreliable service. Moreover, broader systemic issues like poor road conditions, traffic congestion, and insufficient funding exacerbate these problems, making it difficult for institutions to optimize shuttle operations or respond flexibly to the needs of their campus communities. The lack of digital integration severely limits administrators' ability to monitor performance and tailor services effectively.

Case studies of specific Nigerian universities (e.g., University of Lagos, Obafemi Awolowo University) provide concrete examples of the transportation challenges and opportunities within the Nigerian higher education landscape. Infrastructure development and urban policies in Lagos have faced fascinating and depressing issues for town planners (A. Olukoju, 2003.). The University of Lagos, for instance, faces significant transportation challenges due to its large student population and limited campus space. Lagos, Nigeria, is one of the few cities with more than five million inhabitants without a mass transit system. The existing shuttle services are often overcrowded and unable to meet the demand, leading to long waiting times and frustration among students and staff. Understanding the needs of ferry service commuters is critical for satisfaction in urban planning for Lagos (E. C. HART, S. O. Adebiyi, O. G. Oyenuga, 2020.). Similarly, Obafemi Awolowo University, located in a more rural setting, faces challenges related to accessibility and connectivity between different parts of the campus. These case studies highlight the need for tailored transportation solutions that address the specific needs and context of each university. By analyzing the successes and failures of existing shuttle services, and by understanding the unique challenges faced by Nigerian universities, it is possible to develop digital shuttle management systems that are effective, sustainable, and responsive to the needs of the campus community.

2.3. Proposed Digital Shuttle Management System: An Overview

This study addresses the transportation challenges faced by Nigerian university campuses, a proposed digital shuttle management system offers a comprehensive and technologically advanced solution. The proposed system's architecture and components are designed to provide efficient, reliable, and data-driven transportation services. Efficient management of smart transport systems requires integrating various sensing technologies. System's architecture includes a central management platform, mobile apps for passengers and drivers, real-time tracking devices on shuttle vehicles, and data analytics tools. A service-driven middleware architecture is proposed to acquire, store, and integrate information from data sources to support strategic decision-making. A central management platform serves as the nerve center of the system, enabling university administrators to monitor shuttle operations, manage routes and schedules, and respond to passenger requests in real-time. The system offers adaptive and scalable services for acquiring and delivering data in real-time. The proposed digital shuttle management system incorporates several key features to enhance efficiency and convenience for passengers and drivers on Nigerian university campuses. Mobile apps provide passengers with real-time shuttle locations, estimated arrival times, and options for booking and cashless payments, reducing wait times and streamlining trip planning. Drivers use the app to receive route assignments, track passenger pick-ups and drop-offs, and communicate with central management, improving operational coordination. Real-time tracking is pivotal, allowing passengers to monitor shuttle positions and enabling administrators to respond dynamically to demand using adaptive, scalable services powered by predictive models and advanced data visualization. Mobile ticketing offers a quick and convenient payment alternative, eliminating the hassle of physical tickets and speeding up transactions. Data analytics tools empower university authorities to analyze shuttle usage, identify inefficiencies, and optimize routes and schedules based on actual demand.

Integration with existing university systems is essential for seamless operation. The shuttle platform should connect with campus security systems to enhance passenger safety via real-time monitoring, with parking management systems to inform passengers of parking availability and alternative transport, and possibly with student information systems for smoother service coordination. An example from Middle East Technical University in Ankara, Turkey, illustrates such integration efforts, showcasing solutions like electric vehicle charging station optimization, autonomous shuttle design, and bus network electrification. This approach leverages emerging mobility technologies and data platforms to provide a sustainable, user-friendly, and data-driven shuttle service, significantly improving the quality of transport within Nigerian university campuses.

2.4. Benefits of Implementing a Digital Shuttle Management System

Implementing digital shuttle management systems in Nigerian universities brings numerous advantages that go well beyond just improving transportation. One of the biggest benefits is greater efficiency, which leads to shorter waiting times for both students and staff. Safety also improves significantly through real-time tracking and monitoring, allowing campus security to keep a close eye on shuttles and respond swiftly to emergencies or incidents. This is particularly important because fears around crime on public transport can limit mobility for some groups. A digital system empowers passengers to report safety concerns or request help through mobile apps, and added features like security cameras and emergency alerts further enhance passenger protection, giving everyone peace of mind.

Another key advantage is the ability to make smarter decisions based on data. By collecting and analyzing real-time information on shuttle usage, passenger needs, and overall operational performance, university administrators can fine-tune routes and schedules, allocate resources more effectively, and ensure services run smoothly. This data-driven approach relies on integrating different sensing technologies and processing large volumes of information quickly to optimize the entire system.

2.5. Methodology: Data Collection and Analysis

To effectively analyze the current state of shuttle services and evaluate the potential impact of a proposed digital shuttle management system, a robust methodology for data collection and analysis is essential. Datasets to be used for system analysis and performance evaluation should encompass a wide range of relevant information. Collected textual data from three sources: scientific publication abstracts, news blog posts, social media entries (A. Kousis, C. Tjortjis, 2023). This includes data on shuttle routes, schedules, passenger ridership, waiting times, operational costs, and maintenance records. Used quantitative qualitative techniques. Additional data sources may include student and staff surveys, traffic counts, and geographic information system (GIS) data on campus infrastructure and demographics. Used data to identify ten distinct aspects paradigm, encompassing mobility, energy, infrastructure, environment, IoT, business, planning administration, security, people. By collecting comprehensive data, researchers and university administrators can gain a clear understanding of the current transportation landscape and identify areas for improvement.

Methods for collecting data on current shuttle usage patterns should be carefully designed to ensure accuracy and reliability. Case research methodology was applied, referencing single firm operating oil energy industry representing one best practices international context, even if some efforts are still required reduce downstream emissions. Passenger surveys can be used to gather feedback on shuttle service quality, passenger preferences, and any unmet transportation needs. Automated data collection techniques, such as GPS tracking and passenger counters, can provide real-time data on shuttle locations, ridership, and travel times. By employing a combination of these methods, researchers can obtain a comprehensive and accurate picture of current shuttle usage patterns.

Analytical techniques for assessing the proposed system's impact should be selected based on the specific goals and objectives of the analysis. Analysis goals identifies aspects SDGs: (urban, rural, affordable all), type/efficiency; quality, reliable, resilient, infrastructure; regional trans-border all; vehicle emissions/air cities; reform fossil-fuel subsidies; rural/urban logistics, supply efficiency; mitigation adaption climate change. Statistical analysis can be used to compare shuttle ridership, waiting times, and operational costs before and after the implementation of the digital management system. Assessed performance existing, operational, large-scale bus network European capital city. Simulation modeling can be used to predict the impact of different route and schedule optimization strategies on passenger travel times and system efficiency. This can be supported by improving relations with relevant stakeholders, engaging comprehensively them, and creating strong awareness about issues such as ecosystem protection, health-related safeguards, and careful use of resources. Cost-benefit analysis can be used to evaluate the economic viability of the proposed system and compare it to alternative transportation solutions. By applying these analytical techniques, researchers can rigorously assess the impact of the digital shuttle management system and provide evidence-based recommendations for improvement.

2.6. Case Studies: Successful Digital Shuttle Implementations

Examining case studies of digital shuttle management implementations around the world offers valuable insights into what works and the challenges to anticipate. Various universities have adopted technologies such as real-time tracking apps that let users monitor shuttle locations and estimated arrival times. They have also introduced mobile ticketing and payment features to streamline boarding and reduce transaction time. Beyond transportation, some universities integrate shuttle systems into broader smart campus initiatives that support energy transition and sustainability goals, including electric buses, efficient lighting, and renewable biofuel sources.

Success factors in these deployments typically include strong leadership support, active stakeholder engagement, user-friendly digital platforms, and an emphasis on data security and privacy. However, challenges such as infrastructure constraints, resistance to change, and the need for ongoing maintenance must be addressed to ensure sustainability. Innovative approaches like digital twins have been proposed to tackle operational issues and improve system adaptability.

One example is a university that implemented an electric shuttle system combined with renewable energy projects and smart infrastructure upgrades to create a sustainable transportation ecosystem. Another deployment focused on simplifying fleet management and passenger services through GPS tracking and mobile applications, improving trip planning and operational efficiency. These practical experiences underscore the importance of clear implementation frameworks that balance technological complexity with ease of adoption.

2.7. Proposed System Analysis: Adaptation to Nigerian Context

To ensure the successful implementation of a digital shuttle management system in Nigerian university campuses, it is essential to analyze how the proposed system addresses the specific needs and context of the Nigerian higher education landscape. How the proposed system addresses the specific needs of Nigerian university campuses requires careful consideration of the unique challenges and opportunities present in the Nigerian context. Discussed challenges inclusion programmes (W. L. Filho et al., 2023). This includes factors such as limited resources, aging infrastructure, unreliable power supply, and cultural considerations.

The findings emphasize pressing necessity Nigeria instate rigorous efficiency policies, further supported by enhanced structures (O. F. Orikpete, N. M. Gungura, E. Ehimare, D. R. E. Ewim). The proposed system should be designed to be cost-effective, energy-efficient, and adaptable to the local infrastructure. The findings underline contributing played values principles compliant protection community wellbeing. It should also take into account the cultural norms and preferences of Nigerian students and staff, ensuring that the system is user-friendly, accessible, and culturally appropriate. Modifications and adaptations required for successful implementation may include the use of locally sourced materials and technologies, the development of culturally relevant user interfaces, and the integration of mobile payment options that are widely used in Nigeria. This role positively impacted me by helping me integrate what I had learnt in my residency training program, with the dynamic nature of field epidemiology and enhanced my managerial and technical capabilities under the supervision of the main Incident Manager. The 10- week internship in 2019 for the pilot cohort of community medicine/ public health resident doctors from various teaching hospitals in Nigeria was an immersion into field epidemiology, rumor surveillance, risk communication, digital tools for surveillance, developing strategic documents, line lists interpretation, weekly presentations and outbreak response coordination alongside working briefly as an incident manager for the Yellow Fever technical working group. Furthermore, the system should be designed to be resilient to power outages and other infrastructure limitations, with backup power sources and offline capabilities to ensure continued operation during emergencies. By carefully considering these modifications and adaptations, Nigerian universities can ensure that the digital shuttle management system is effectively tailored to the local context and maximizes its potential impact.

Addressing potential challenges such as infrastructure limitations and user adoption is crucial for the successful implementation of a digital shuttle management system in Nigerian universities. Early childhood education is threatened to enter into the lost generation, due to distance learning, which causes confusion for teachers and parents to be able to provide the best stimulation for them. Infrastructure limitations, such as unreliable power supply and limited internet access, can hinder the operation of the system and limit user adoption. There are five obstacles in in applying this in the field, namely the

- Ability Of Teachers,
- The Ability Of Parents,
- Economic Capability,
- Facility Constraints,
- Pedagogical Constraints.

To address these challenges, universities should invest in backup power sources, such as solar panels and generators, to ensure continued operation during power outages. The ability of teachers, the ability of parents, economic capability, facility constraints, and pedagogical constraints. They should also provide free Wi-Fi access in key locations on campus to encourage user adoption and ensure that all students and staff have access to the digital platform. Universities should conduct training and awareness campaigns to educate students and staff on the benefits of the digital shuttle system and provide technical support to address any user issues. By proactively addressing these potential challenges, Nigerian universities can increase the likelihood of successful implementation and maximize the benefits of the digital shuttle management system.

2.8. Implementation Strategy and Policy Recommendations

To ensure the effective and sustainable implementation of a digital shuttle management system in Nigerian universities, a well-defined implementation strategy and supportive policy framework are essential. A phased approach to implementing the digital shuttle system allows for a gradual rollout, enabling universities to test and refine the system before full-scale deployment. Due wide mechanisms, simple formalize individuals groups, regulation quite useful. This approach involves starting with a pilot project in a limited area of the campus, such as a single faculty or residential area. At same explained brought purpose document studies, sectors, analyses interventions. During the pilot phase, data can be collected on system performance, user feedback, and any challenges encountered. This requires participation review updates metropolitan organization plan improvement program well comprehensive plans. The feedback can then be used to refine the system and address any issues before expanding the implementation to other parts of the campus. By adopting a phased approach, universities can minimize risks, optimize resource allocation, and ensure that the digital shuttle system meets the specific needs of the campus community.

Policy recommendations for university administrators and government can play a crucial role in supporting the implementation and sustainability of digital shuttle management systems. This paper contributes to the current debate in field of critical urban and regional studies on meanings "regional" "urban". University administrators should develop policies that promote the use of the digital shuttle system, such as providing incentives for students and staff to use the system and integrating it into the campus transportation plan. The Organization provides setting can compare policy experiences, seek answers common problems, and identify good practice co-ordinate domestic international policies. Government policies can support the development of digital infrastructure, such as providing funding for Wi-Fi access and promoting the use of renewable energy sources to power the shuttle system. Policy-relevant access, arrangements. Furthermore, government regulations can promote the adoption of digital transportation technologies and ensure that universities have access to the resources and expertise needed to implement these systems effectively. By creating a supportive policy environment, university administrators and government can foster the widespread adoption of digital shuttle management systems and improve transportation services for students and staff across Nigerian universities.

The role of public-private partnerships in funding and managing the system can provide a sustainable and cost-effective approach to implementing digital shuttle management systems in Nigerian universities. Corruption restrictive practices drive public private partnerships (PPPs) end costing than planned. Public-private partnerships (PPPs) can leverage the expertise and resources of private companies to design, implement, and manage the digital shuttle system, while the university provides the infrastructure and policy support. Both national insofar affects LMICs. PPPs can also provide a mechanism for sharing the costs and risks associated with the system, making it more financially viable for universities. This should forefront, vulnerable groups women, children, persons disabilities elderly. The private sector partner can also bring innovative technologies and management practices to the system, improving efficiency and service quality. By establishing well-structured PPPs, Nigerian universities can create sustainable and effective digital shuttle management systems that benefit the entire campus community.

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

3.0 Introduction

This chapter discusses the analysis and design aspects of the Digital Shuttle Management System (DSMS). It begins by examining how shuttle operations are currently carried out, the challenges associated with the manual process, and the benefits of implementing a digital solution. It then outlines the roles of the system's users, as well as the functional and non-functional requirements of the proposed system. Finally, the chapter presents the system design through UML diagrams which show how different components of the system interact.

3.1 Analysis of the Existing System

The existing shuttle management approach in most Nigerian university environments is largely **manual**. Students who need shuttle transportation physically wait at shuttle points without knowledge of shuttle arrival times, while drivers manage their trips based on verbal arrangements or personal judgment. Shuttle logs, if recorded at all, are written by hand. There is **no centralized system** that connects students, drivers, and administrators for real-time communication.

Key characteristics of the existing system include:

- Shuttle trip records are written manually or not documented at all.
- Students wait without knowing when shuttles will arrive or be available.
- Administrators rely on assumptions rather than real data when allocating shuttles.
- Communication between students, drivers, and administrators is informal and inconsistent.

This method leads to **delays, inefficiency, user frustration, lack of transparency, and poor resource coordination**.

3.2 Disadvantages of the Existing System

Problem	Explanation
Long Waiting Time	Students spend unnecessary time waiting because shuttle arrival times are unknown.
Poor Scheduling	Without a structured system, shuttles may be underused or overcrowded.
No Real-Time Tracking	Administrators and students cannot monitor shuttle or trip status.
Miscommunication	Information shared verbally is often inaccurate or misunderstood.
Lack of Accountability	Missing or inaccurate records make it difficult to evaluate performance.
Low Operational Efficiency	Manual handling slows down procedures and increases human errors.

These challenges emphasize the need for a **digital, automated management system**.

3.3 Benefits of the Proposed System

The proposed Digital Shuttle Management System introduces automation and transparency into shuttle operations.

Benefit	Description
Real-Time Shuttle Tracking	Users can monitor shuttle movement and trip status.
Automated Trip Scheduling	The system assigns drivers and shuttles based on availability.
Improved Service Efficiency	Reduces delays and speeds up communication.
Better Information Flow	Students and drivers receive accurate updates instantly.
Accurate Data Storage	Records are securely stored in a structured database.
Clear Accountability	Every trip action is recorded and traceable.

Overall, the system increases **convenience, speed, transparency, and service reliability**.

3.4 Analysis of the Proposed System

The system involves three main user roles:

User	Role in System		Key Features
Student	Requests shuttle and monitors trip progress		Request shuttle, view trip status, rate trips
Driver	Receives assigned trips and reports trip progress		Start trip, complete trip
Administrator	Manages user accounts and assigns trips		Assign drivers and shuttles, monitor operations

Functional Requirements

The system should:

- Authenticate users before access.

- Allow students to request shuttle services.
- Allow administrators to assign drivers and shuttles.
- Allow drivers to update the status of trips.
- Store and display trip records.

Non-Functional Requirements

Requirement	Description
Performance	System should handle requests quickly and efficiently.
Security	Access should be based on user login roles.
Usability	Interface must be simple, clean, and mobile-friendly.
Scalability	System should support future expansion.

3.5 Design of the Proposed System

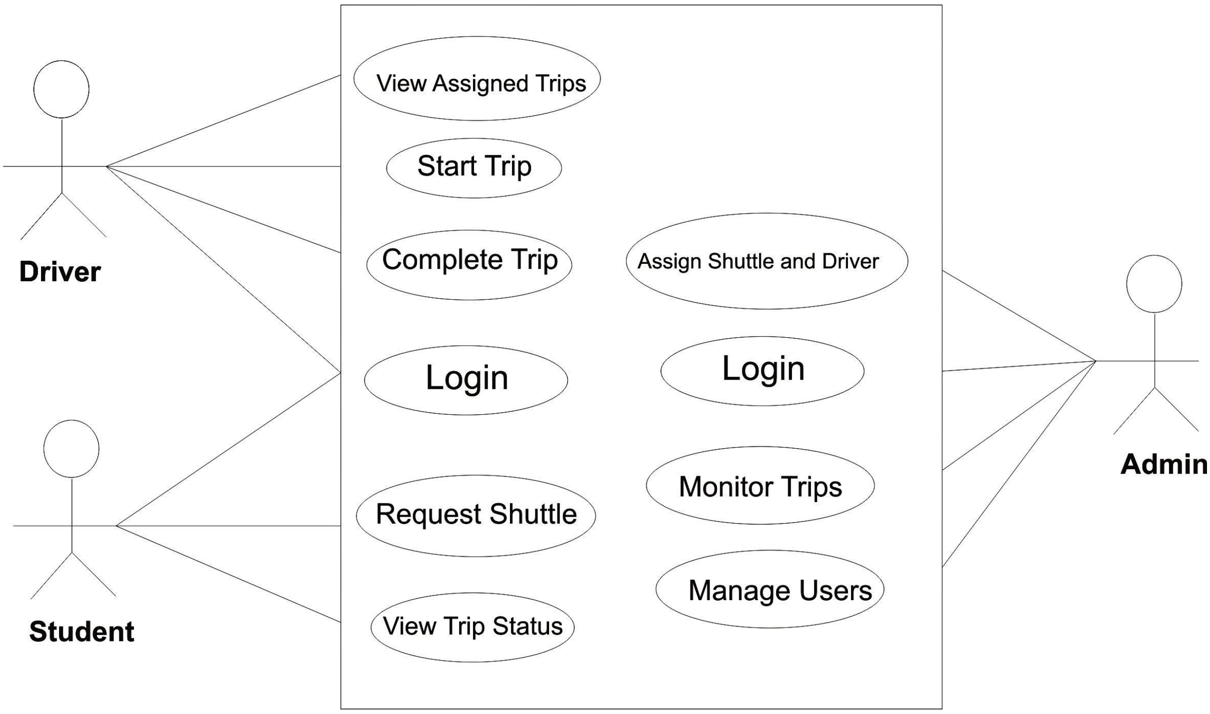

Figure 3. 1: Use Case Diagram of the Digital Shuttle Management System

3.5.1 Use Case Diagram

3.5.2 Class Diagram

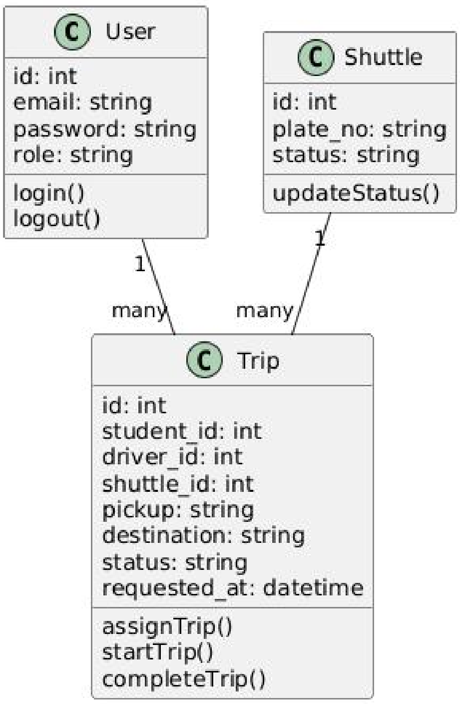

Figure 3. 2: Class Diagram of the Digital Shuttle Management System

3.5.3 Sequence Diagram (Trip Workflow)

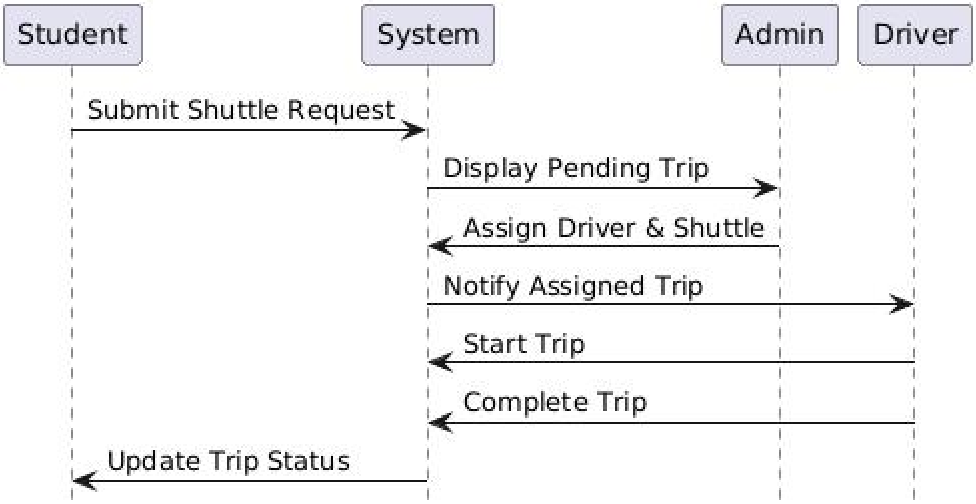

Figure 3. 3: Sequence Diagram of Trip Request and Completion

CHAPTER FOUR

SYSTEM IMPLEMENTATION, TESTING AND EVALUATION

4.0 Introduction

This chapter discusses the practical implementation of the Digital Shuttle Management System (DSMS). It describes the software and hardware environments used during development, the tools and technologies applied, as well as the structure and deployment of the system. The chapter also explains how different components of the system interact and how the user interface was built to support the operations of students, drivers, and administrators. Later sections include screenshots that demonstrate the system's functionality and workflow in real usage scenarios.

4.1 System Development Environment

The successful implementation of the Digital Shuttle Management System required both hardware and software resources. The development environment was selected to ensure performance efficiency, portability, and ease of deployment for end-users.

4.1.1 Hardware Requirements

The minimum and recommended hardware specifications used during development are shown in the table below.

Component	Minimum Requirement	Recommended
Processor	Dual Core 1.8 GHz	Core i5 / Ryzen 5 or higher
RAM	4 GB	8 GB or higher
Storage	20 GB free space	50 GB free space
Display	1280 × 720 resolution	1920 × 1080 (Full HD)
System Type	64-bit capable device	64-bit windows/macOS

Table 4. 1: Hardware Requirements

The system can run smoothly on standard laptop configurations as typically owned by students and university ICT departments.

4.1.2 Software Requirements

The following software tools were used to develop and run the system:

Software	Purpose
XAMPP (Apache + MySQL + PHP)	Local hosting and database management
PHP 8+	Server-side scripting / backend logic
MySQL Database	Storage of user, shuttle, and trip records
VS Code / Sublime Text	Source code editing
Google Chrome / Firefox	System testing and interface rendering
Bootstrap 5	Frontend styling and responsive layout

Table 4. 2: Software Requirements

These tools were chosen because they are open-source, widely supported, and easy to deploy in institutional environments.

4.1.3 Programming Languages and Frameworks Used

The Digital Shuttle Management System was developed using a combination of web development languages and a styling framework:

Technology	**Functionality**
HTML5	Defines the structure of the web pages
CSS3 / Bootstrap 5	Enhances visual layout and responsiveness
PHP	Implements server-side logic and request processing
MySQL	Provides database storage and structured query operations

PHP and MySQL were specifically chosen for their reliability, compatibility with local intranet environments, and suitability for academic deployment.

4.2 System Architecture

The Digital Shuttle Management System follows a **three-tier client–server architecture**, which separates the system into presentation, application logic, and data management layers. This structure allows the system to remain scalable, maintainable, and easy to update or extend.

1. **Presentation Layer (Front-End)**
   This layer consists of the user interface displayed in the browser. It is responsible for collecting user input and displaying system output. The interface is built using **HTML**, **CSS**, and **Bootstrap** to ensure a responsive and user-friendly environment.

2. **Application Layer (Back-End / Server Logic)**
   This layer performs all core operations such as request processing, session control, assigning trips, validating user login, and updating trip status. It is implemented using **PHP**, which handles communication between the user interface and the database.

3. **Data Layer (Database Storage)**
   The database layer stores all system data including user details, shuttles, and trip records. **MySQL** is used to organize and manage this data securely and consistently.

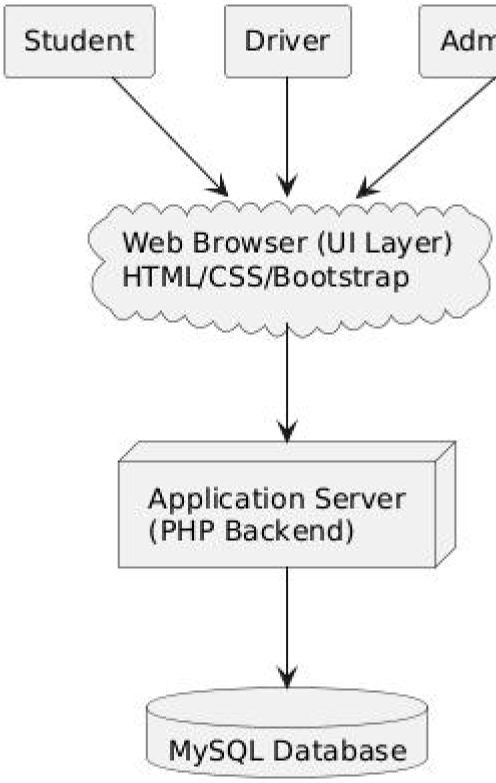

Figure 4. 1: System Architecture Diagram

4.3 Database Design

The database is designed to support reliable and secure storage of shuttle request records, user authentication, and trip processing. The core entities in the system are:

- **Users** – Stores login and identity information for students, drivers, and administrators.
- **Shuttles** – Contains details about available shuttle vehicles.
- **Trips** – Stores shuttle request records and tracks trip status from request to completion.

4.3.1 Entity Descriptions+++

Table	Description
users	Stores user details (student, driver, admin) and login credentials.
shuttles	Contains information about available shuttle vehicles.
trips	Records shuttle requests and tracks the assigned driver, shuttle, and status.

Table 4. 3: Entity Descriptions

4.3.2 Entity Relationship Diagram (ERD)

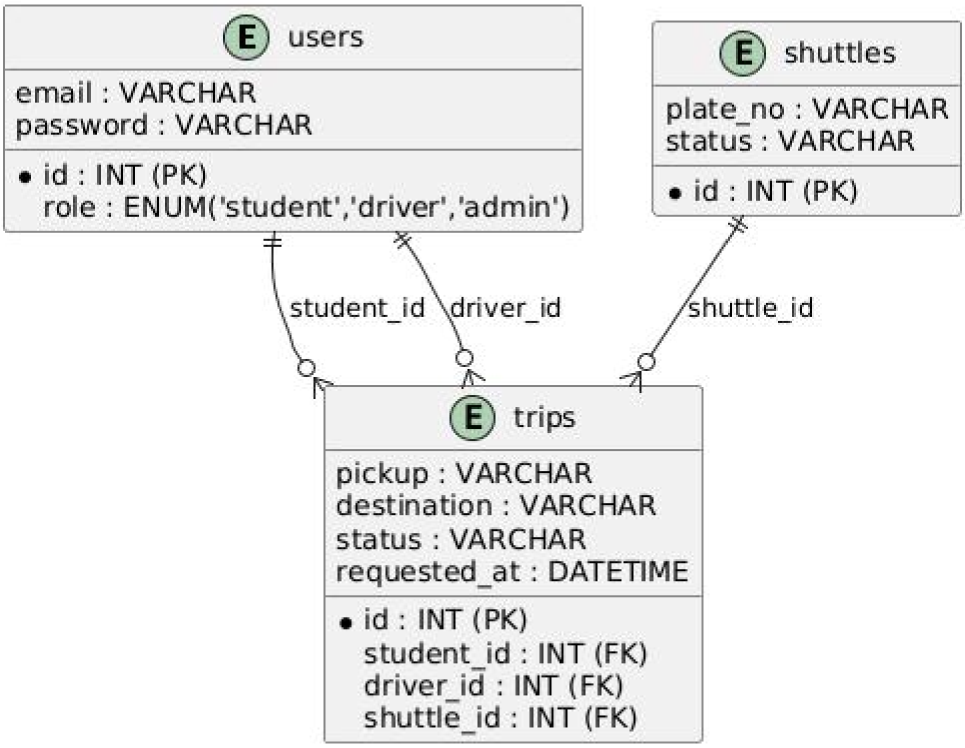

Figure 4. 2: Entity Relationship Diagram

4.4 User Interface Implementation

The Digital Shuttle Management System features a simple and user-friendly interface designed using HTML, CSS, and Bootstrap. The interface is organized to meet the needs of three categories of users: **Students**, **Drivers**, and **Administrators**. Each user is presented with dashboard views and operation screens specific to their role in the system.

Below are the main interfaces and their corresponding descriptions.

4.4.1 Login Page

This page is the entry point for all system users. It verifies user credentials and grants access based on role.

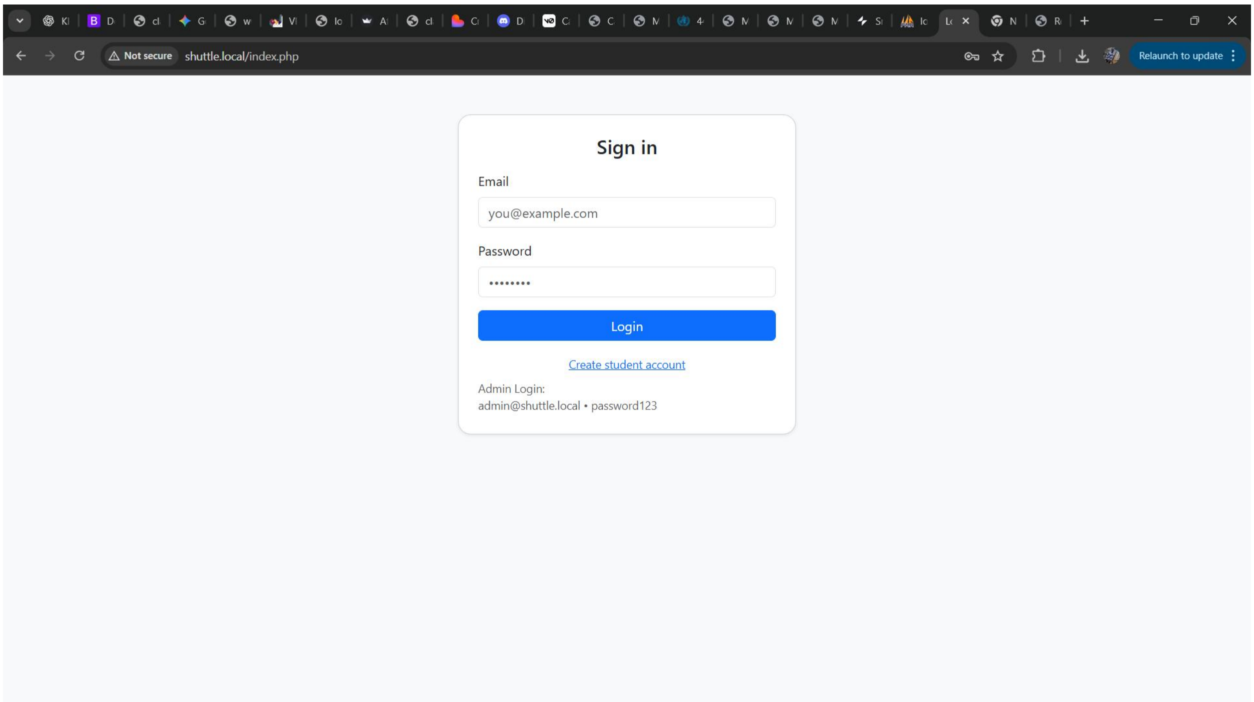

Figure 4. 3: Login page of the Digital Shuttle Management System

4.4.2 Student Dashboard

When a student logs in, the dashboard displays system options such as requesting a shuttle and viewing trip status.

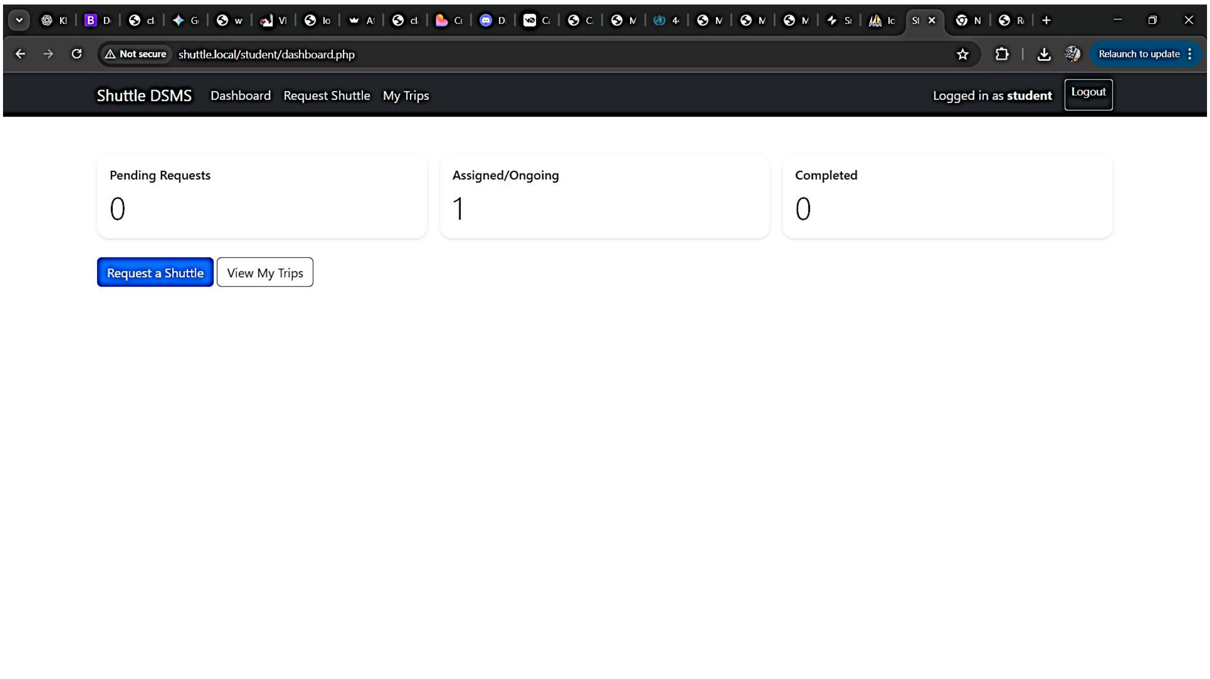

Figure 4. 4: Student dashboard showing main navigation options

4.4.3 Shuttle Request Form (Student)

This interface allows students to request shuttle services by providing pickup and destination information.

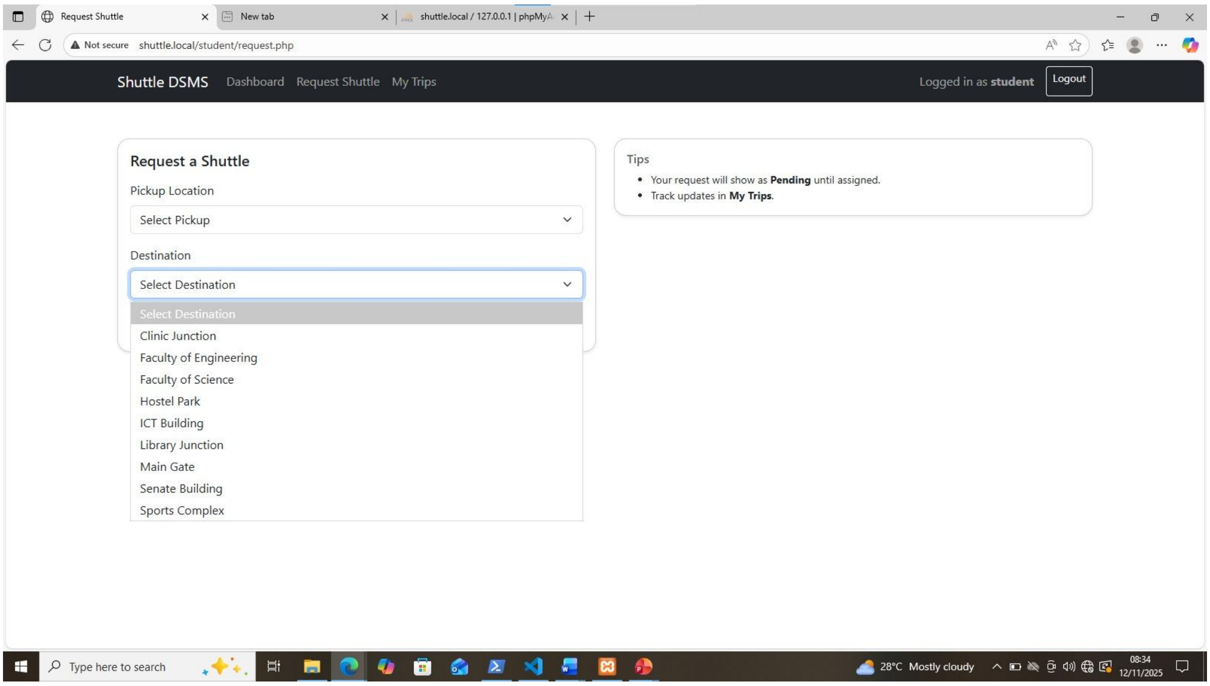

Figure 4. 5: Request shuttle form interface used by students

4.4.4 Student Trip History Page

This page displays all trip requests made by the student along with their statuses (pending, assigned, ongoing, or completed, rating of drivers).

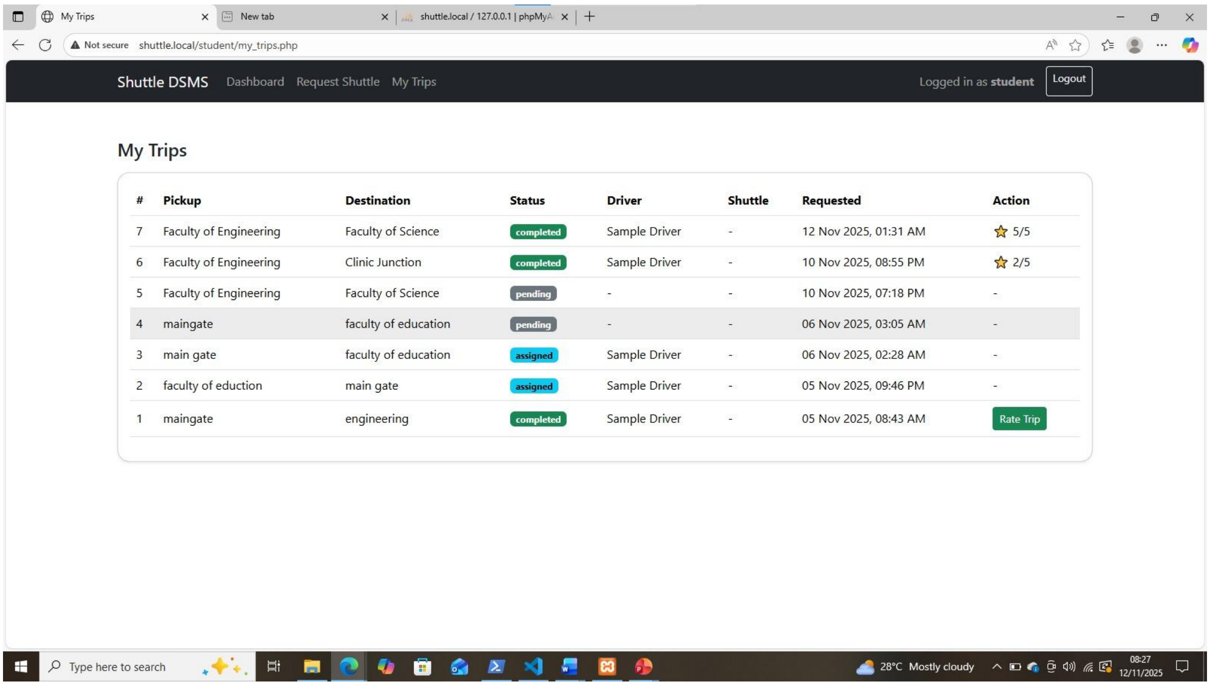

Figure 4. 6: Student trip history showing status updates

4.4.5 Administrator Trip Management Page

This page displays all pending and active shuttle requests. It also includes controls for assigning drivers and shuttles.

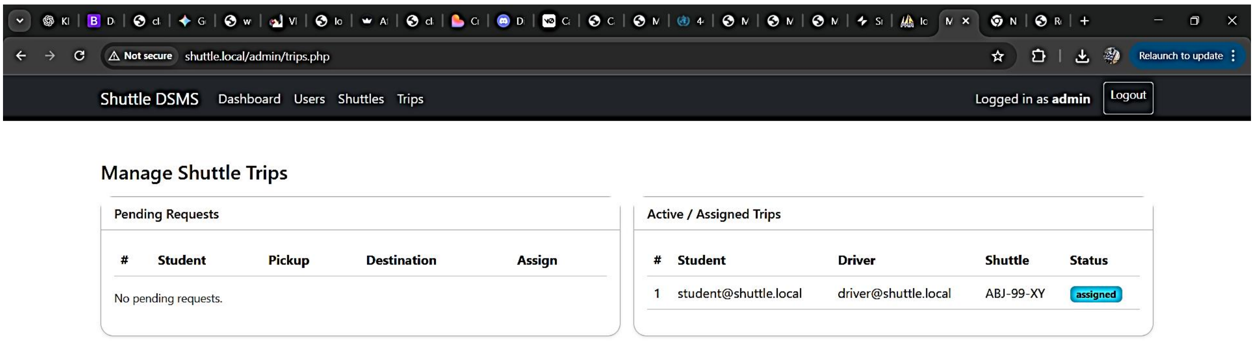

Figure 4. 7: Administrator interface for managing shuttle trip requests

4.4.6 Assigning Driver and Shuttle (Admin)

The admin selects both a driver and a shuttle, then assigns the request.

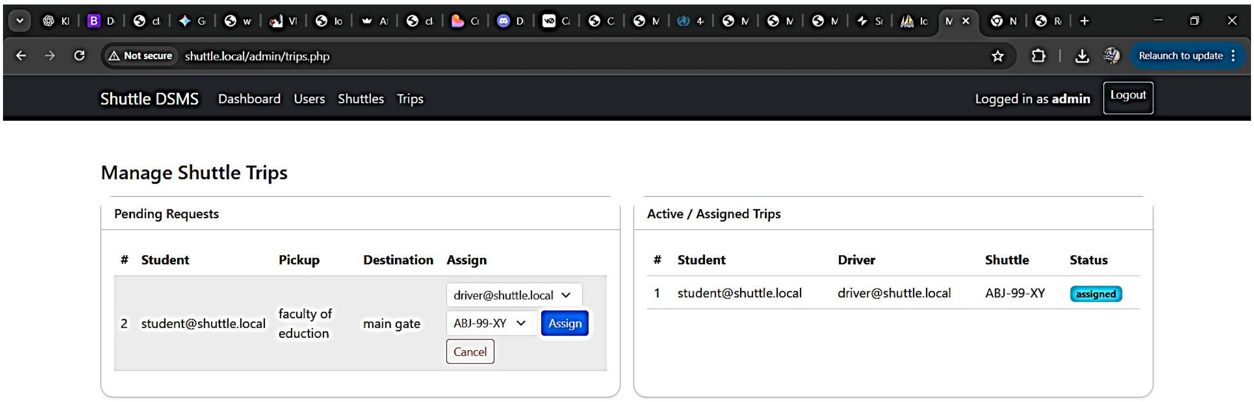

Figure 4. 8: Admin assigning a shuttle and driver to a student trip request

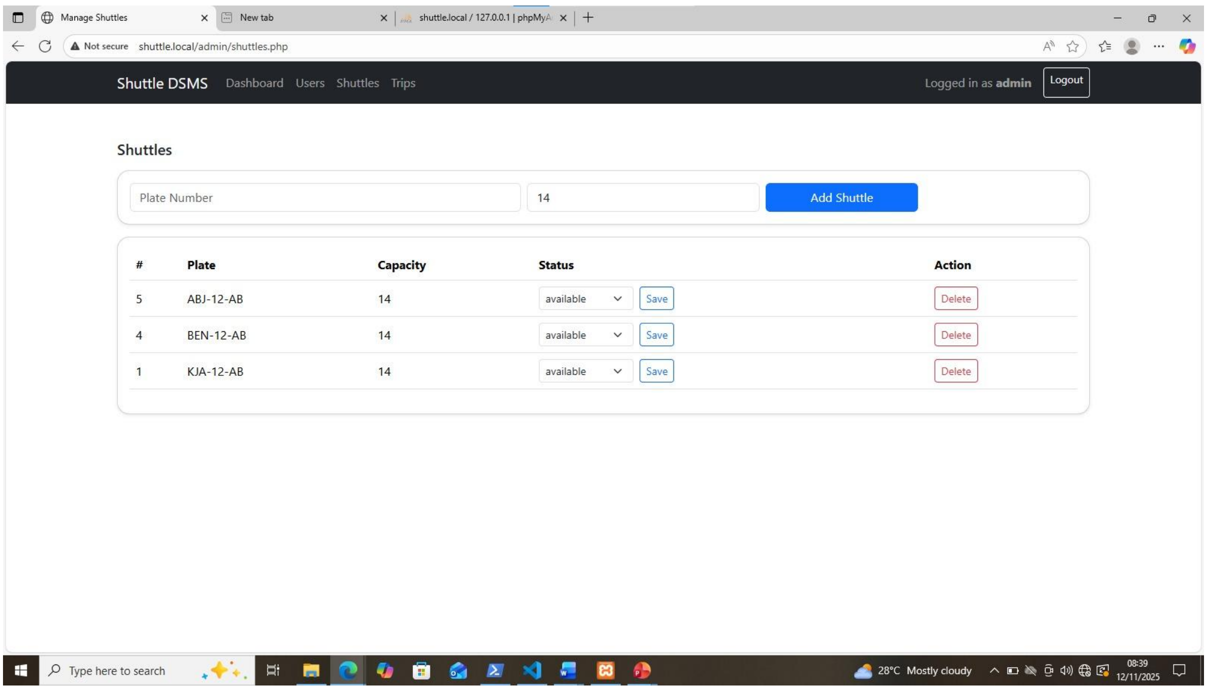

Figure 4. 9: Admin assigning a shuttle number to driver

4.4.8 Driver Trip Update Page

This interface allows the driver to start and complete trips.

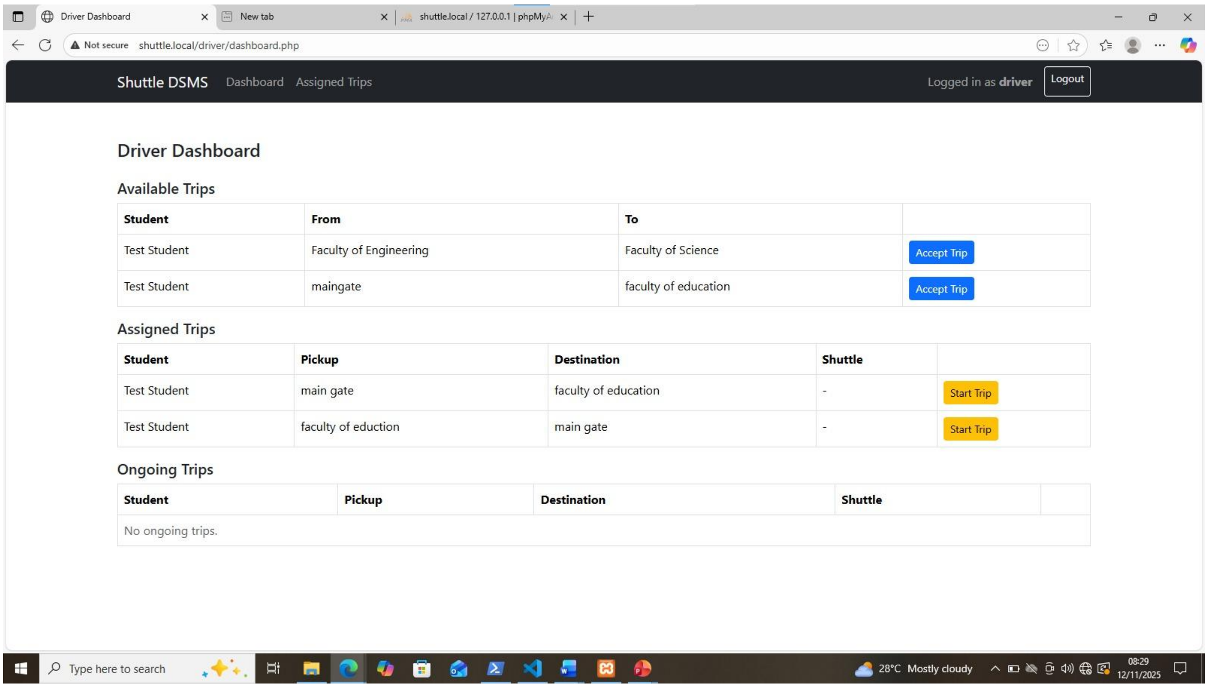

Figure 4. 10: Driver interface for starting and completing trip operations

4.5 System Workflow Demonstration

This section explains how the system processes a shuttle request from start to finish:

1. The student logs into the system and submits a shuttle request.
2. The admin views pending requests and assigns a driver and shuttle.
3. The assigned trip appears in the driver's dashboard.
4. The driver starts the trip when movement begins.
5. The driver completes the trip upon arrival.
6. The student's trip history updates, rates driver provides feedbacks.

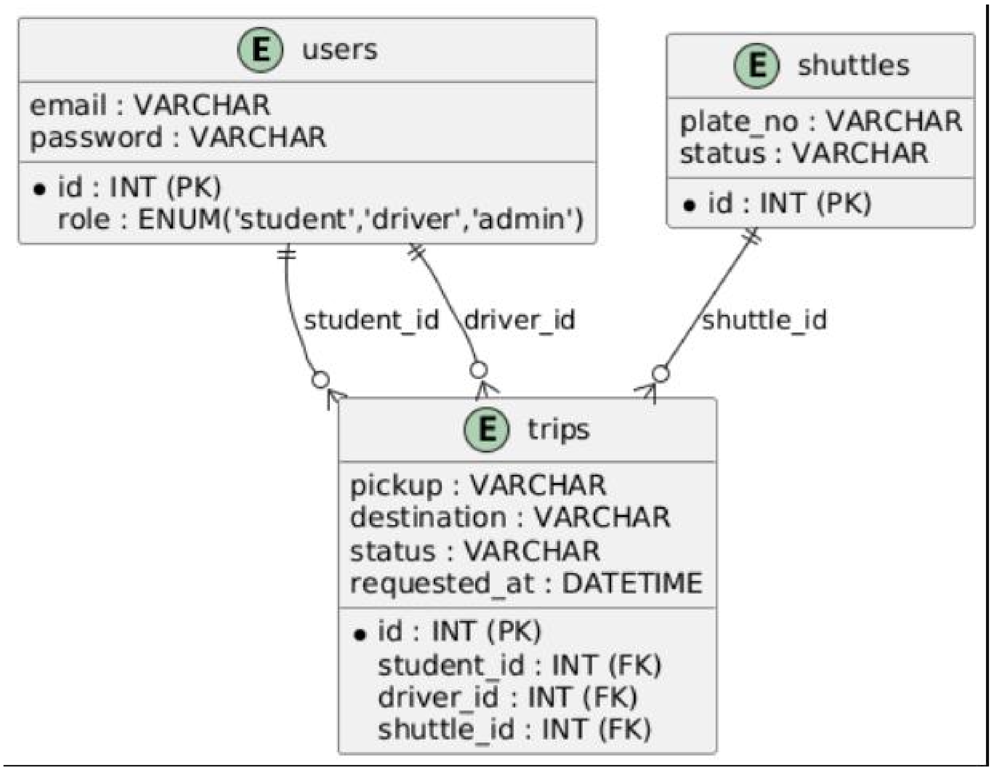

Figure 4. 10: Sequence Diagram for Trip Request and Completion

4.6 Testing and Validation

After the implementation of the Digital Shuttle Management System, a series of tests were conducted to ensure that the system works correctly and meets the requirements specified during the design stage. The testing focused on validating core system functions including user login, shuttle request submission, trip assignment, trip execution, and system record updates.

The testing approach adopted was **Functional Testing**, where each feature of the system was tested independently, followed by **Integration Testing** to confirm that the modules work together seamlessly. The results demonstrated that the system functions accurately and reliably under normal usage conditions.

4.6.1 Test Cases

Test Case	Description	Expected Result	Actual Result	Status
Student Login	Student enters correct email and password	Login successful, redirect to dashboard	Works as expected	Passed
Submit Shuttle Request	Student enters pickup and destination	Request stored and displayed as “pending”	Works as expected	Passed
Admin Assigns Shuttle & Driver	Admin selects driver and shuttle and assigns request	Request status updates to “assigned” and driver notified	Works as expected	Passed
Driver Starts Trip	Driver clicks “Start Trip”	Status updates to “ongoing”	Works as expected	Passed
Driver Completes Trip	Driver clicks “Complete Trip”	Status updates to “completed” and student sees update	Works as expected	Passed
Logout	User clicks logout	Session ends and login page loads	Works as expected	Passed

Table 4. 4: Test Cases

The results from the tests confirm that the system meets its functional requirements and operates smoothly across all user roles.

4.7 System Evaluation

System evaluation was carried out to determine the extent to which the Digital Shuttle Management System (DSMS) meets the functional and non-functional requirements established during the design phase. The evaluation focused on accuracy, usability, performance, reliability, and user satisfaction.

The system was deployed on a local server environment using XAMPP, and test users consisting of students, drivers, and an administrator interacted with the system to perform real shuttle request and trip management tasks. Students were able to register, log in, request shuttle services, view trip status, and provide ratings after trip completion. Drivers successfully viewed available trip requests, accepted or declined trips, and updated trip progress from assigned → ongoing → completed. The administrator effectively monitored shuttle activity by managing user accounts, shuttles, and viewing trip histories.

Performance tests showed that the system responded within 2–4 seconds for most operations, which meets the expected responsiveness for a web-based application. Usability evaluation indicated that the interface was simple, intuitive, and mobile-friendly, reducing the learning curve for new users. The system also demonstrated data consistency by automatically enforcing role-based access and preventing unauthorized actions such as drivers accessing student functions or vice versa.

However, minor performance fluctuations were observed when handling large data queries, suggesting that optimization or hosting on a more powerful server may be required during large-scale deployment. Despite these, the DSMS successfully met its core objectives of improving scheduling efficiency, reducing waiting time, establishing accountability, and enhancing overall commuter experience.

4.8 Limitations/Challenges

System Testing Environment Limitations:

Testing was performed on a local machine using XAMPP, which limited concurrent user testing and server load simulation. A live deployment environment with multiple users would provide more realistic stress testing conditions.

Limited End-User Training:

Some test users initially struggled to navigate the system due to unfamiliarity with web-based systems. This was addressed by providing a brief demonstration of how to log in, book appointments, and view status updates.

Real-time tracking

Implementing GPS tracking for shuttles and showing accurate locations on the web interface can be tricky.

Connectivity issues: Poor network coverage around campus can affect live updates.

Data synchronization: Keeping data consistent across different devices (driver's tablet, student's phone, admin dashboard).

Security: Protecting user data (student IDs, trip logs, and payment info) from unauthorized access.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Summary

The findings from the study revealed that the shuttle transportation framework in most Nigerian university environments is characterized by inefficiencies arising from manual operations. Students often experience long waiting times at shuttle terminals because shuttle schedules and vehicle availability are not clearly communicated. Drivers rely on personal discretion when organizing movements, while administrators lack real-time visibility into transport operations. This results in poor coordination, frustration among commuters, loss of time, and reduced productivity.

The proposed Digital Shuttle Management System was successfully designed and implemented to close this operational gap. The system digitizes end-to-end shuttle processes including shuttle request submission, driver assignment, route coordination, and trip completion reporting. Students interact with the system to request shuttles conveniently; administrators manage fleet allocation and monitor operations; and drivers update trip statuses from their interface. The centralized database ensures that necessary records are captured accurately and stored securely.

The implemented system therefore **transformed shuttle operations from an informal, unstructured model into a coordinated, transparent, data-driven process.**

5.2 Conclusion

This project demonstrates that the challenges encountered in university shuttle transportation systems can be effectively addressed using modern information system solutions. By leveraging web-based technologies and a relational database, the Digital Shuttle Management

System provides an environment where communication is seamless, decisions are data-supported, and service delivery is more structured.

The system meets all major objectives defined at the beginning of the study:

- It provides a platform for students to request shuttle services conveniently.
- It empowers administrators with a real-time management and monitoring interface.
- It provides drivers with structured trip execution and reporting workflows.
- It establishes accountability and transparency in trip records and resource usage.

The project therefore contributes both academically and practically by demonstrating how university mobility services can be modernized to improve user satisfaction, resource efficiency, and campus transportation reliability.

5.3 Recommendations

In light of the successful implementation and evaluation of the system, the following recommendations are proposed:

1. **Institutional Deployment:**
   The system should be officially deployed on the university intranet or cloud infrastructure so that it becomes accessible to all students and transport management personnel.
2. **User Training:**
   Minimal but targeted training should be provided to shuttle drivers, student union transport representatives, and administrators to ensure smooth adoption and system effectiveness.

3. **Dedicated ICT Support:**
   A technical support team should be assigned to handle system maintenance, updates, backup operations, and database performance monitoring.

4. **Policy Integration:**
   The university management should create a transport standard operating policy that integrates the system into official service workflows.

5. **Continuous Data Review:**
   Shuttle usage data should be periodically analyzed to improve route planning, bus allocation, and operational scheduling.

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