DEVELOPMENT OF CLOUD-BASED INTEGRATED INFORMATION SYSTEM FOR CAR RENTAL SERVICES: A CASE OF SOLIDARITY CAR RENTAL LIMITED

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A Project Report Submitted in Partial Fulfillment of the Requirements of the Award of the Degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology

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ABSTRACT

Car rental businesses increasingly adopt digital technologies to enhance their operations, particularly through mobile applications and integrated information systems. This project focuses on addressing the specific operational challenges faced by Solidarity Car Rental, which, despite its use of digital tools, continues to encounter issues like overlapping bookings, weak system coordination, and limited customer feedback management. To resolve these challenges, a cloud-based, all-in-one information system was designed and implemented for the company. The project followed a mixed-methods approach, utilizing interviews, focus group discussions, and structured surveys for data collection. Quantitative data were analyzed using descriptive statistics with Microsoft Excel. Findings indicated that the developed system enables customers to easily browse car options, reserve vehicles, and complete secure payments via a mobile app. Internally, it enhances efficiency by automating tasks such as invoicing, generating real-time reports, and managing fleet operations. Data protection is ensured through encryption and secure payment systems. The use of Microsoft Azure supports scalability and integration, while SMS notifications improve communication with clients. As a result, Solidarity Car Rental has experienced reduced delays, higher customer satisfaction, and streamlined processes. The system proves to be a transformative tool that not only modernizes operations but also boosts competitiveness and revenue generation in Tanzania's car rental sector

DECLARATION

I, Thacianne Tuyambaze, hereby declare to the Senate of the Nelson Mandela African Institution of Science and Technology that this project report is my original work and that it has neither been submitted nor concurrently submitted for a degree award in any other institution.

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the Nelson Mandela African Institution of Science and Technology a project report titled "Development of a Cloud-Based Integrated Information System for Car Rental Services: A Case of Solidarity Car Rental Limited", in partial fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology.

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DEDICATION

I dedicate my work to my family, especially my mother Ms. Donatha Namukujije, my late father Mr. Vital Mutabaruka and my Brother Mr. Lambert Nzivugira, whose unwavering support has been my anchor, and to the countless individuals who contributed in ways seen and unseen, your encouragement has been the driving force behind this journey.

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LIST OF ABBREVIATIONS AND SYMBOLS

API	Application Programming Interface
CEO	Chief Executive Officer
CENIT@EA	Center of Excellence for ICT in East Africa
CSS	Cascading Style Sheets
DAAD	Deutscher Akademischer Austauschdienst
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HTTP	Hypertext Transfer Protocol
HTML	Hypertext Markup Language
ICT	Information Communication and Technology
IoT	Internet of Things
IT	Information Technology
MIS	Management Information System
MVC	Model View Controller
MySQL	My Structured Query Language
NM-AIST	Nelson Mandela African Institution of Science and Technology
PHP	Hypertext Preprocessor
SMS	Short Message Service
TDD	Test Driven Development
UAT	User Acceptance Testing
UI	User Interface

CHAPTER ONE

INTRODUCTION

1.1 Background of the problem

Information and Communication Technology (ICT) has advanced globally and has contributed significantly to the commercial and economic progress that is frequently seen as the beginning of the Fourth Industrial Revolution (Pratt, 2019).

The use of ICT has allowed businesses to improve profitability by streamlining processes, boosting productivity, and cutting costs (Bizmanualz, 2023). Effective ICT use is now essential to an organization's success in the modern corporate world. Business organizations can use management information systems (MIS) to manage and simplify their operations by utilizing ICT (Marker, 2021). Particularly mobile devices have been integrated into ICT in business, enabling increased flexibility and mobility (Sheldon, 2019).

IT integration has been crucial in car rental companies for the creation of innovative solutions to raise customer satisfaction and operational effectiveness (Seacom, 2022). An integrated information system is a comprehensive and interconnected software solution that connects diverse software programs, databases, or subsystems to efficiently interact and share data. The goal is to build a unified, integrated system that improves overall functioning and data flow while decreasing redundancy and increasing productivity. Managers, employees, and customers benefit most from integrated information systems because they provide a centralized and organized view of the organization's data (Milašauskaitė, 2023). Cloud-based integration is a strategic approach that employs cloud-computing to integrate applications, systems, and IT environments. This provides real-time data and process sharing, giving businesses more access to their data, increased flexibility, and scalability (Snaplogic, 2023).

The emergence of cloud computing has significantly transformed the delivery and application of IT services, especially in terms of infrastructure solutions that businesses depend on for daily operations. This technology has increasingly become a preferred approach for data management and storage (Rashwan, 2022). Its adoption helps organizations save time while improving system integration, maintenance, and technical support.

In the car rental industry, digital tools such as mobile apps and management systems are increasingly used to enhance operational efficiency. Nevertheless, managing rental operations remains challenging due to factors like overlapping reservations, vehicle tracking, delayed returns, limited system coordination, and poor handling of customer feedback. Traditional manual approaches to rental services are often inefficient, time-consuming, and susceptible to mistake (MyRent, 2022).

To address these challenges and enhance the effectiveness of car rental operations, this project developed a cloud-based integrated information system tailored for car rental services. The platform includes a mobile application that allows customers to book vehicles, monitor reservations, access customer support, make payments, and manage their accounts.

The core objective of the developed system is to simplify the booking process, streamline vehicle management, and automate payments, ultimately enabling car rental providers to enhance operational performance and customer satisfaction. Users can easily schedule and manage bookings, receive SMS alerts, complete secure payments, and share feedback through the app. Leveraging cloud infrastructure, the system offers scalability, adaptability, and cost efficiency, making it a practical choice for car rental businesses of various sizes

1.2 Statement of the problem

Car rental companies encounter a variety of operational issues, including car management, customer bookings and reservations where there is overbooking or double-booking. These difficulties can result in inefficiencies, inaccuracies, and delays in fulfilling customer requests, affecting the customer experience and, ultimately, the business's revenue (Timmermann, 2018).

Solidarity car rental is a Tanzanian car rental company established in 2012 with headquarters in Dar es Salaam. It offers different services such as short and long-term car rentals, fleet management, Airport Transfers, Taxi services, and Driver Hire services. Solidarity car rental Limited provides these services to individuals, small and large companies, national and international organizations, non-government organizations, and government institutions.

The existing technological gaps at Solidarity Car Rental are multifaceted and impede the efficiency and effectiveness of their operations. On the front-end, reliance on a basic website platform limits the user experience, forcing clients to resort to email, phone calls, or in-person

visits for inquiries. This not only hinders accessibility but also results in time-consuming processes and potential loss of customers due to inadequate online interaction.

Additionally, the absence of a dedicated mobile app further exacerbates these front-end challenges, as it overlooks the evolving preferences for mobile-based interactions. The lack of a streamlined, intuitive platform for reservations and other customer services leaves Solidarity Car Rental at a disadvantage in the competitive car rental industry.

On the back-end, the reliance on manual methods, including paper forms and excel spreadsheets, introduces inefficiencies, errors, and security vulnerabilities. Manual reservation management, payment processing, and reporting contribute to delays and inaccuracies, impacting customer satisfaction and operational effectiveness. To bridge these technological gaps, the proposed project introduces a cloud-based integrated information system. On the front-end, HTML, CSS, and Bootstrap are employed to create a modern, responsive, and user-friendly web application. The integration of a mobile app using Flutter caters to the increasing demand for mobile-centric services.

On the back-end, the manual methods are replaced by a comprehensive system that manages reservations, payments, and reporting seamlessly. The cloud functionality ensures real-time data access, while the implementation of SMS alerts enhances customer communication and reduces the risk of overdue returns. By addressing these front-end and back-end technological gaps, the proposed system adds significant value by optimizing operations, improving the client experience, and fortifying security measures for Solidarity Car Rental.

1.3 Rationale of the study

In recent years, the car rental industry has grown significantly, with an increasing number of customers looking for convenient and efficient ways to rent cars (Roberts, 2023). Solidarity car rental aims at improving the car rental industry in Tanzania through the principles of solidarity. Clients was visiting the company's website to know some of the services and they use phone calls or send emails in order to know more information about the services, the reservation processes as well as the payment processes.

The current manual management operations, which use excel spreadsheets and paper records, have been identified as a bottleneck that leads to mistakes and data loss. This coincides with industry concerns, as many businesses continue to struggle with outmoded systems. The lack

of automatic client reminders, as well as the management team's difficulties with timely preparation, reflect widespread concerns in the automobile rental industry (Pedia, 2023). Therefore, the developed cloud-based integrated information system for car rental services assists Solidarity Car Rental in optimizing its car rental management processes, improving customer experience, and increasing revenue, all while addressing the challenges faced by the car rental industry in managing operations through disparate systems or manual processes.

1.4 Objectives of the study

1.4.1 General objective

The main objective of this project was to develop a cloud-based integrated information system for car rental services.

1.4.2 Specific objectives

The study aimed to achieve the following specific objectives:

(i) To identify requirements for developing the cloud-based integrated information system for car rental services.

(ii) To develop a cloud-based integrated information system for car rental services.

(iii) To validate the developed cloud-based integrated information system for car rental services.

1.5 Research questions

(i) What are the requirements needed for developing a cloud-based integrated information system with a mobile app interface for optimizing car rental management?

(ii) What are the right materials and methodologies for developing a cloud-based integrated information system with a mobile app interface for optimizing car rental management?

(iii) Did the developed cloud-based integrated information system with a mobile app interface meet the specified requirements?

1.6 Significance of the study

Solidarity Car Rental has gained considerable benefits from the deployment of a cloud-based integrated information system. This system enhances the efficiency of rental management processes by combining several functional components such as the web application, mobile interface, payment integration, and SMS notifications. Together, these modules support key operations including vehicle tracking, booking management, automated invoicing, and real-time reporting. This helps the company to streamline its operations, and increasing customer satisfaction. Providing a user-friendly mobile application interface improves the customer experience by making vehicle rentals more convenient and accessible. This has assisted Solidarity car rental in distinguishing itself from its competitors and gaining a competitive advantage.

The company has improved data security and reduce the risk of data loss by storing customer and rental data in the cloud. Furthermore, because a cloud-based system is easily scalable, Solidarity car rental manages growth more effectively and efficiently. The developed project aimed to achieve specific outcomes, such as increased revenue, profitability, and customer loyalty, by addressing specific challenges or issues confronting the company, such as outdated systems or manual processes. The implementation of a cloud-based integrated information system has significantly improved Solidarity car rental ’s operations and aid the company’s long-term growth and success.

1.7 Delineation of the study

Due to given the limitations in budget and time, the scope of this project was restricted to the development of a cloud-based integrated information system specifically for car rental services. The system emphasizes the integration of key components such as a web application, payment processing, SMS notifications, and a mobile interface. As a result, aspects like vehicle maintenance, fuel tracking, and driver management were excluded from the current implementation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the existing information system and mobile application for car rental businesses with their classifications for managing the car rental companies' operations. Finally, the chapter articulates the related works to identify what has been done in previous studies on car rental systems by identifying their limitations.

2.2 Related works

Numerous studies have explored ways to address the inefficiencies of manual car rental systems, leading to the development of several digital solutions. For instance, Acebedo (2021) proposed a car rental management system equipped with a scheduling algorithm to streamline business transactions, inventory handling, and scheduling tasks. The system included user access levels for security and allowed clients to manage bookings and check vehicle availability online. However, the system lacked integration across components and did not utilize cloud storage for enhanced data security.

Similarly, Ahmed *et al*. (2021) introduced a mobile application aimed at modernizing car rental services in Malaysia, offering users including both locals and tourists the ability to rent various types of vehicles such as cars, vans, and motorcycles. Although the app improved the convenience of vehicle rental, it did not support digital payments, which is increasingly demanded by customers. Furthermore, the app lacked essential features like reporting, invoicing, and comprehensive data security measures. It also failed to offer a backend system that would assist rental businesses in managing their operations seamlessly.

Mahi *et al*. (2020) developed a web and mobile platform that enables users to buy, sell, and rent cars. This system not only allowed car rentals but also helped individuals rent out or sell their idle vehicles, providing a potential income stream. It featured both a website and Android app, offering flexibility in use. Despite its practical design, the platform did not support cashless payment options such as mobile money or online banking. It also lacked cloud storage, raising concerns about data security, and did not facilitate secure communication between buyers and sellers during rental or sales transactions.

Thakur (2021) worked on a car rental platform designed to allow users to register, book cars online, and even receive home delivery. The platform also aimed to simplify rental operations for businesses. New users could register and obtain membership cards to access services. While the system allowed for vehicle reservations and home delivery, it did not include an electronic payment feature, relied solely on local data storage, and lacked integration with internal business systems. Features like automated invoicing, vehicle management, and reporting were also absent, making it less suitable for streamlined business operations.

In another effort, Hendersen *et al*. (2020) built a mobile app focused on the rental of cars and motorcycles. The application made it easier for customers to select vehicles and complete bookings efficiently. However, despite its user-friendly design, the app did not support digital payment options, did not offer cloud storage for real-time data access and security, and was not integrated with other management systems. Additionally, the absence of key business tools such as vehicle management, invoicing, and reporting limited its usefulness for operational decision-making.

A mobile-based car hiring application was proposed by Ihedioha *et al*. (2020) to support users in booking vehicles online, particularly those in need of short-term rentals such as tourists or individuals with vehicles under repair. The aim was to enhance traditional systems by automating key functions, thereby easing the workload on administrative staff and reducing customer inconvenience by eliminating the need for physical visits to rental offices. Although the system employed Firebase for real-time data storage, it lacked integration with critical features like digital payment, web access, SMS alerts, and broader mobile platform functionality. Additionally, the system did not include a communication tool for customer inquiries or automated reminders for return dates features that are crucial for service coordination and accountability. Furthermore, it did not offer secure cloud-based storage for long-term scalability and data protection.

Nasr *et al*. (2020) created a web-based car rental and tracking system utilizing GPS to enable both clients and rental businesses to monitor rented vehicles and manage rentals efficiently. The solution enhanced service quality by offering location tracking, improving rental control for agencies. However, the system fell short in areas such as real-time usage monitoring, return reminders through SMS, and secure cloud-based data storage limitations that affect operational reliability and data protection.

Mohite *et al*. (2022) introduced an online car rental platform using web technologies compatible with multiple devices, allowing customers to view services and make bookings on tablets, smartphones, and desktops. The administrator interface enabled management of car listings and pricing. Users could browse and even book without registration. However, the platform did not include a mobile application for improved accessibility. It also lacked cloud storage, as well as management tools like reporting and vehicle tracking, which are essential for informed decision-making. In a separate effort, Rashmi *et al*. (2022) built a car rental web portal that allowed users to select and reserve vehicles online, automating much of the manual booking process. The system used XAMPP and PHP for backend development. Despite its effectiveness in reservation management, the system lacked cloud functionality and integration with other critical modules such as payment systems, SMS alerts, and mobile apps limiting its scope and utility in a business setting.

Khan (2020) too developed a car rental management framework to streamline vehicle allocation and rental operations. Built using PHP and MySQL, and accessible via a Wide Area Network, the system enabled car owners to manage rental transactions efficiently. Nevertheless, it was limited to a web-based interface and lacked essential integrations like mobile app access for customers, SMS alerts for returns, and a unified platform to manage various operational tasks. The absence of cloud storage also raised concerns regarding data security and system scalability.

2.3 Technical gap

Numerous car rental management information systems have been introduced to streamline the rental process. However, existing systems often exhibit notable technical shortcomings, such as the absence of integration between essential modules reservation handling, payment processing, vehicle management, SMS notifications, invoicing, and reporting. These systems also typically lack real-time monitoring of vehicle usage and rental availability, and do not implement adequate data protection mechanisms for sensitive customer information (Fexco, 2023). One of the major limitations is the insufficient use of cloud-based infrastructure. Without robust cloud functionality, rental platforms face challenges related to data security, scalability, and operational efficiency. Insecure systems risk data breaches, compromise client confidentiality, and can harm a company's credibility. The highlights that adopting cloud-based systems can considerably lower the costs and complexity associated with managing IT infrastructure. Furthermore, another critical weakness in many current rental platforms is the

fragmented nature of core modules such as mobile apps, web portals, payment gateways, and alert systems. When these components operate independently, the lack of integration leads to inefficiencies and incomplete data visibility, which hinders informed decision-making (Gartner, 2023).

Another technical flaw in existing car rental management systems was the lack of integration of key modules. There are different modules like web application, payment and invoicing, car SMS Alerts, and mobile app in many existing car rental systems. Due to a lack of integration among various modules, this frequently resulted in inefficiencies and incomplete data for decision making purposes. According to Kaseya (2022), effective system integration not only simplifies internal communication within an organization but also improves coordination with external stakeholders. Integration enhances data flow, boosts efficiency, and cuts operational expenses. The system developed in this project addressed these challenges by combining essential modules into a unified platform, thereby minimizing manual processes and increasing both precision and operational effectiveness for Solidarity Car Rental.

Existing car rental systems sometimes struggle with a significant technological barrier between front-end and back-end functionalities. While front-end user interfaces (UIs) strive for usability and visual appeal, the underlying back-end infrastructure has issues in maintaining data, executing business logic, and assuring seamless interaction (Medium, 2023). This difference frequently leads to operational inefficiencies, data inaccuracies, and an inadequate user experience. Moreover, the lack of a defined communication interface, such as APIs, hinders integration across different system components. According to Stephan's (2023) research, APIs enable a wide range of unrelated software products to interact and interoperate with other applications and data (Bigelow, 2023).

The project aimed to fill the gap by developing cloud-based integrated information system for car rental services. The integration as a key feature as well as cloud-based functionality, web application, payment, and mobile app. By filling these gaps, the developed system improved user experience, efficiency, and overall business performance for Solidarity Car Rental Limited.

2.4 Proposed system

The system introduced in this project (Fig. 1) is a cloud-enabled car rental management solution aimed at simplifying rental operations through a mobile app for users and a web portal for

company staff. Built with Flutter, the mobile app enables clients to view available vehicles, make reservations, and complete payments digitally. The web application, built with PHP and the CodeIgniter framework, enables employees to manage bookings, monitor rental durations, process payments, and handle other administrative tasks. The entire system is deployed on Microsoft Azure, leveraging cloud services for hosting, storage, and scalability. To facilitate secure and efficient transactions, the system integrates multiple mobile payment options, including M-Pesa, Tigo Pesa, and Airtel Money. When a customer books a vehicle, they can choose their preferred payment method and complete the transaction within the mobile app. Upon successful payment, the system automatically updates the booking status, ensuring that only confirmed bookings are processed. Additionally, the system incorporates an SMS notification service powered by Beem Africa API, which sends real-time alerts at key stages of the rental process. Customers receive confirmation messages upon booking and additional reminders as the rental period nears its end.

Moreover, the system generates reports and invoices for Solidarity Car Rental's internal usage, providing insights into rental activities and expenses. The dotted lines in the proposed system represent the dynamic interaction between users and the web and mobile applications, illustrating user engagement paths. The bidirectional connector symbolizes a versatile information exchange between the back-end and front-end components, emphasizing a two-way data flow that is critical for effective system operation. This connection extends to the data layer, ensuring comprehensive data management across the system. Additionally, it links to external services such as the SMS gateway and payment APIs, demonstrating seamless interaction with third-party features. For security and accessibility, the system takes advantage of Azure's built-in Reverse Proxy, which ensures secure authentication and traffic management. Since the web application is hosted on Azure App Services, all access requests pass through the reverse proxy before reaching the application, providing an additional layer of security. With this integrated approach, the proposed system addresses key limitations found in existing solutions, particularly the lack of online payments, SMS notifications, and cloud integration.

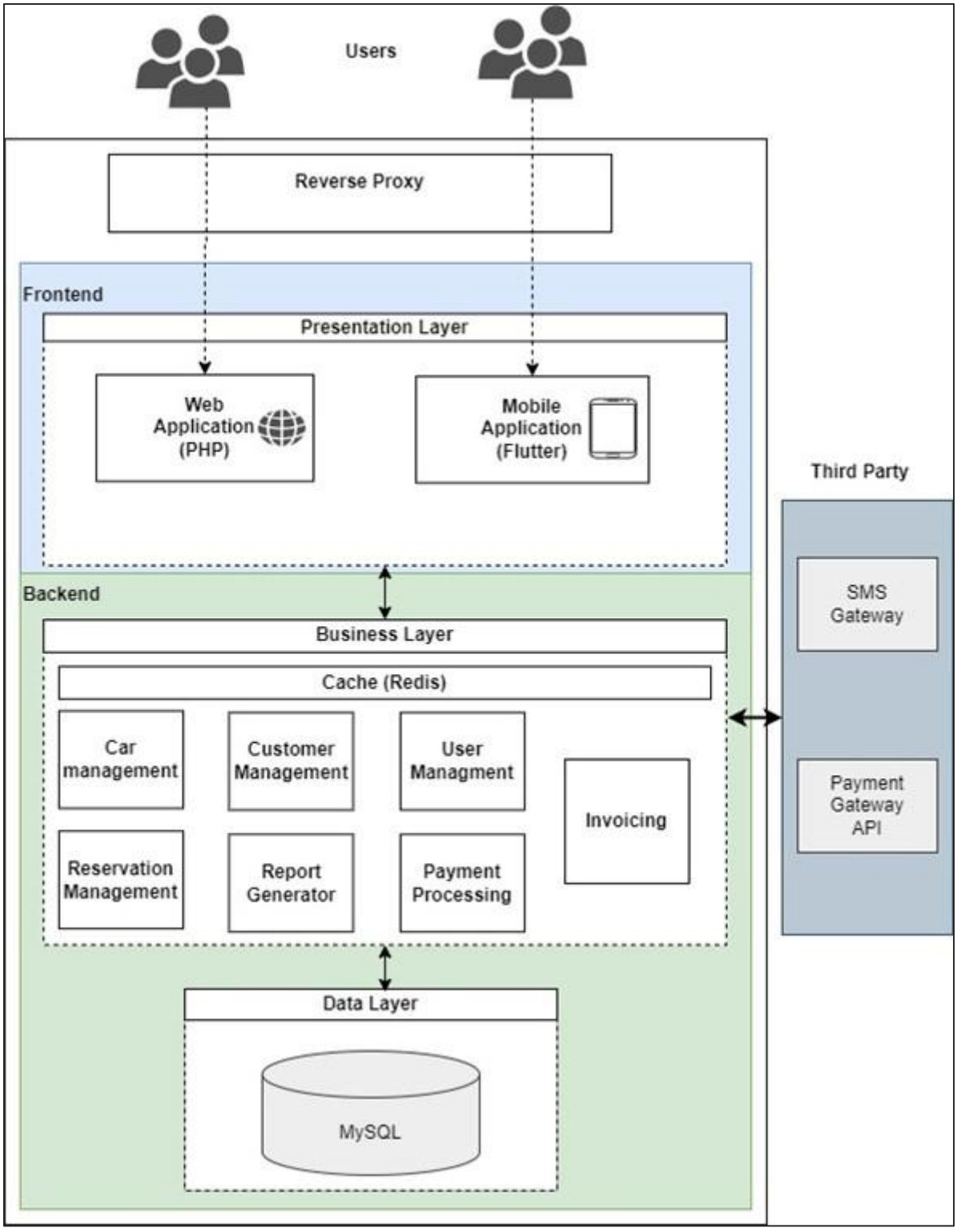

Figure 1: Framework

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter outlines the tools and methodologies employed in the execution of this project. It details the processes involved in the development, testing, and validation of the system. Additionally, it covers the project's case study, research design, methods of data collection and analysis, as well as the approach used for system development.

3.2 Project case study

This project was implemented at Solidarity Car Rental, a vehicle rental company located in Dar es Salaam, Tanzania, where the internship took place. The company was selected due to its over ten years of experience in the industry and its strong reputation for delivering reliable and cost-effective rental services. Despite its success, the company faced several operational challenges, including difficulties in managing vehicles, handling reservations, processing payments and invoices, and generating reports. The goal of this project was to enhance the company's operational efficiency by developing a cloud-based, integrated information system tailored for car rental management.

3.3 Research methods

In this project, both qualitative and quantitative approaches were utilized for data collection. This is because there was a need to understand Solidarity Car Rental's behavior with the previous car rental system and how the company ought to adapt to the new system, and to demonstrate the system's experiments and to get extra system design ideas. Quantitative data was gathered from participants using structured survey questionnaire as shown in Appendix 3 and qualitative data were gathered using interview guide and focus group discussions guide as shown in Appendix 1 and Appendix 2.

3.4 Target population

The developed project's target population was Solidarity car rental's customers, operations manager, finance manager, and other relevant staff members. This company was managing its operations manually and the mobile application has not been used within the company together

with the information system. The primary target population for this project encompasses car rental companies situated in Dar es Salaam, Tanzania. The selection criteria focus on companies facing operational challenges related to manual management systems and a lack of integration between mobile applications and information systems. Specifically, Solidarity Car Rental serves as a representative case within this broader group. The intention is to extend the findings and proposed solutions to benefit a wider range of car rental entities in the region. The study aims to provide insights and recommendations applicable to various stakeholders within the car rental industry including customers, employees, and management staff of Solidarity Car Rental, thereby contributing to the advancement of operational efficiency and technological integration in this sector.

3.5 Sampling technique and sample size

3.5.1 Sampling technique

This project utilized purposive sampling, a type of non-probability sampling technique. In this method, participants are selected based on specific, non-random criteria, meaning not all individuals have an equal chance of being chosen (McCombes, 2022). The rationale for using purposive sampling was to target individuals who could offer the most relevant and insightful information needed to meet the project's objectives.

3.5.2 Sample size

The project engaged a diverse sample size of 56 participants, including both employees and customers associated with Solidarity Car Rental in Dar es Salaam, Tanzania. Among these, 29 participants were employees, distributed across various departments: 6 from Operations, 4 from Finance, 7 from ICT, and 12 from Marketing and Sales. This composition allowed for a comprehensive understanding of perspectives from different organizational functions.

On the customer side, 27 participants were involved, comprising 8 corporate customers and 19 individual customers of Solidarity Car Rental. The inclusion of both corporate and individual customers provided a well-rounded view of the user experience across distinct segments. These employees and customers were sampled based on employment positions, marital status, and age. This sample size of participants was applied during the requirements gathering process and during the validation process

3.6 Data collection methods

For this project, data were gathered from customers as well as key internal departments essential to the company's operations, including Operations, Finance, ICT, Marketing, and Sales. A range of qualitative data collection methods, such as interviews and focus group discussions, were employed. These sources played a vital role in identifying and validating system requirements that are practical and aligned with the company's operational needs.

An interview guide with open-ended questions was developed Appendix 1 to gather participants' needs, preferences, and expectations regarding the proposed system. A separate guide for focus group discussions was also prepared Appendix 2 to further explore these aspects. The data collected from both methods informed the identification of system requirements. For the validation of the developed system, a survey questionnaire was utilized Appendix 3.

Additionally, other data were collected from journals, websites, books, and technical reports about existing systems, as well as on recent related works in mobile applications, car rental management information systems, and cloud computing.

3.7 Data analysis

After gathering data from interviews and focus group discussions, the following step was to organize, structure, and analyze the data to meet the project's objectives. The qualitative data obtained from interviews and focus group discussions were transcribed and analyzed using the thematic analysis approach. This method involved reviewing the data to identify recurring patterns and derive key themes. To enhance data clarity and presentation, the results were visualized using charts. For the quantitative data, Microsoft Excel was utilized to conduct the analysis. The findings highlighted a clear and compelling need for a cloud-based integrated information system tailored for car rental services.

3.8 System development approach

The Agile software development methodology specifically Extreme Programming (XP) was selected for building the cloud-based integrated car rental system due to its high adaptability, collaborative nature, and effectiveness in accommodating evolving requirements.

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3.8.1 Why agile over traditional development models?

Traditional Conventional models like the Waterfall and V-Model follow a linear, phase-by-phase process, where each stage must be fully completed before the next begins. While suitable for projects with stable, well-defined requirements, these models lack the flexibility needed for dynamic environments such as car rental systems, where user expectations and technological demands are constantly changing.

The V-Model, an extension of the Waterfall model, emphasizes strict validation and verification at each development phase, ensuring a structured approach with well-defined testing stages. While this model improves software quality and reliability, it does not allow for frequent modifications once development begins. Given the evolving nature of the car rental industry where features like mobile accessibility, automated invoicing, and real-time tracking need continuous updates the rigid structure of the V-Model would have posed limitations.

In contrast, Agile promotes iterative development, frequent stakeholder feedback, and continuous improvement, making it a more suitable approach for this project. The ability to make adjustments throughout development ensured that the system remained aligned with business needs and user expectations.

3.8.2 Why extreme programming (XP)?

Among Agile methodologies, **Extreme Programming (XP)** was chosen due to its high adaptability and flexibility, which made it particularly suitable for the development of a cloud-based integrated information system for car rental services. XP fosters a collaborative environment where developers and stakeholders engage in ongoing discussions, ensuring that evolving user needs and insights are consistently incorporated into the development process. Given that this project required continuous changes and updates to meet the dynamic demands of both the business and its customers, XP's principles were critical in ensuring the system’s success.

Key aspects of XP, including customer satisfaction, frequent releases, continuous testing, and integration, were crucial to maintaining high quality and reliability. These principles ensured that the system effectively served the needs of the car rental business and its customers. Below are additional reasons why XP was chosen over other methodologies, such as the V-Model or Waterfall model:

(i) **Rapid and Continuous Development:** XP promoted frequent releases with small, incremental updates, ensuring that the system evolved based on real-world usage and feedback. This was crucial for the car rental system, where user needs, integration with payment gateways, and cloud-based functionalities required continuous enhancement. The iterative approach allowed for the quick implementation, testing, and refinement of features, ensuring that the system remained functional and up to date with business requirements.

(ii) **Customer Collaboration and Feedback:** XP emphasized continuous communication with stakeholders, allowing for timely adjustments based on their feedback. The development process incorporated frequent reviews and refinements based on user input, which was essential in refining system features such as mobile accessibility, automated invoicing, and real-time car tracking. Unlike the V-Model, which follows a predefined testing and feedback phase only after development, XP ensured that feedback was integrated at every stage.

(iii) **Test-Driven Development (TDD) for High Reliability:** XP enforced Test-Driven Development (TDD), where test cases were written before implementing a feature. This approach significantly improved system reliability, particularly in financial transactions, customer data security, and system integrity, which are critical in car rental services. Unlike the V-Model, which conducts testing after each development phase, XP's continuous testing helped identify and resolve potential issues early, reducing the risk of major defects later in the development cycle.

(iv) **Pair Programming:** While XP encourages pair programming as a core practice, this project was developed by a single developer. Despite this, the principles behind pair programming, such as maintaining high coding standards, improving problem-solving efficiency, and ensuring high-quality code, were still applied. During the development process, I adopted a self-review approach, frequently revisiting and refactoring the code to maintain consistency and avoid defects. Additionally, I relied on tools and resources that supported best coding practices, ensuring that complex functionalities such as real-time car tracking, and cloud storage integration were implemented with high quality code. Regular code reviews, even if conducted individually, helped identify potential issues early, reducing the likelihood of software defects and ensuring maintainability.

(v) **Refactoring for Improved System Performance:** Continuous code refactoring in XP ensured that the system remained scalable, maintainable, and free of unnecessary complexity. This was especially important for integrating external APIs, such as payment gateways, SMS alerts, and cloud services, ensuring seamless communication between system components. Regular code optimization helped maintain high performance while allowing for future scalability.

(vi) **Adapting to Changing Requirements:** Unlike Waterfall and the V-Model, where requirements must be well-defined at the start, XP allowed the system to accommodate last-minute changes without disrupting overall functionality. This level of flexibility ensured that the software remained compliant with industry standards while still meeting business needs

3.8.3 The phases of Extreme Programming (XP)

Planning, designing, coding, and testing are all part of the Extreme Programming methodology as shown in Fig. 2.

(i) Planning phase

The Planning phase in XP focuses on understanding the user requirements and defining the scope for development. In this project, planning began with discussions with stakeholders to identify the essential features needed for the cloud-based car rental system, such as car reservation management, payment processing, real-time car tracking, mobile app integration, and cloud storage functionality.

I gathered these requirements and prioritized them, using an iterative approach where features were regularly reassessed to reflect the evolving needs of both the business and customers. Planning also included setting timeframes for releases and determining the tasks to be completed in each iteration.

(ii) Design phase

The Design phase in XP emphasizes creating simple, flexible, and adaptable designs that can evolve over time. For this system, I adopted a modular design, where each feature (payment gateway integration, SMS alerts, user authentication) was treated as a separate module. This allowed for easy modification and scalability as requirements changed.

During this phase, I focused on keeping the design as simple as possible to avoid unnecessary complexity, ensuring that each component would easily integrate with others. A core principle of XP is to design only what is needed at the moment, avoiding over-engineering, and this approach guided my decisions.

(iii) Coding phase

The Coding phase in XP is where the majority of development work takes place. Given that XP encourages continuous development, I implemented features through small, incremental updates, regularly testing and refining them. I made sure to follow coding standards and best practices to maintain quality and consistency throughout the project.

Throughout the coding phase, I frequently revisited and refactored the code. This helped to ensure that the system remained clean, simple, and efficient, especially when integrating external services like payment APIs and SMS gateways.

(iv) Testing phase

Testing is a fundamental phase in XP, with a strong emphasis on Test-Driven Development (TDD), where tests are written before code is implemented. This phase was crucial for ensuring the reliability of the system, especially for critical features like payment processing and customer data security.

Unit tests were written for individual functions, and integration tests were conducted for system-wide features. This approach ensured that all components functioned as intended and facilitated the identification of potential issues before they could affect the system's overall performance.

(v) Release phase

In the Release phase, XP promotes frequent releases with small, incremental updates. After completing each iteration, I deployed the new features to a testing environment and performed user acceptance testing (UAT) to ensure the system met the requirements.

Since the car rental system was cloud-based, the deployment process was streamlined to ensure that updates could be pushed without significant downtime. Releases were made frequently,

allowing users to provide feedback on the system and enabling adjustments to be made based on their input.

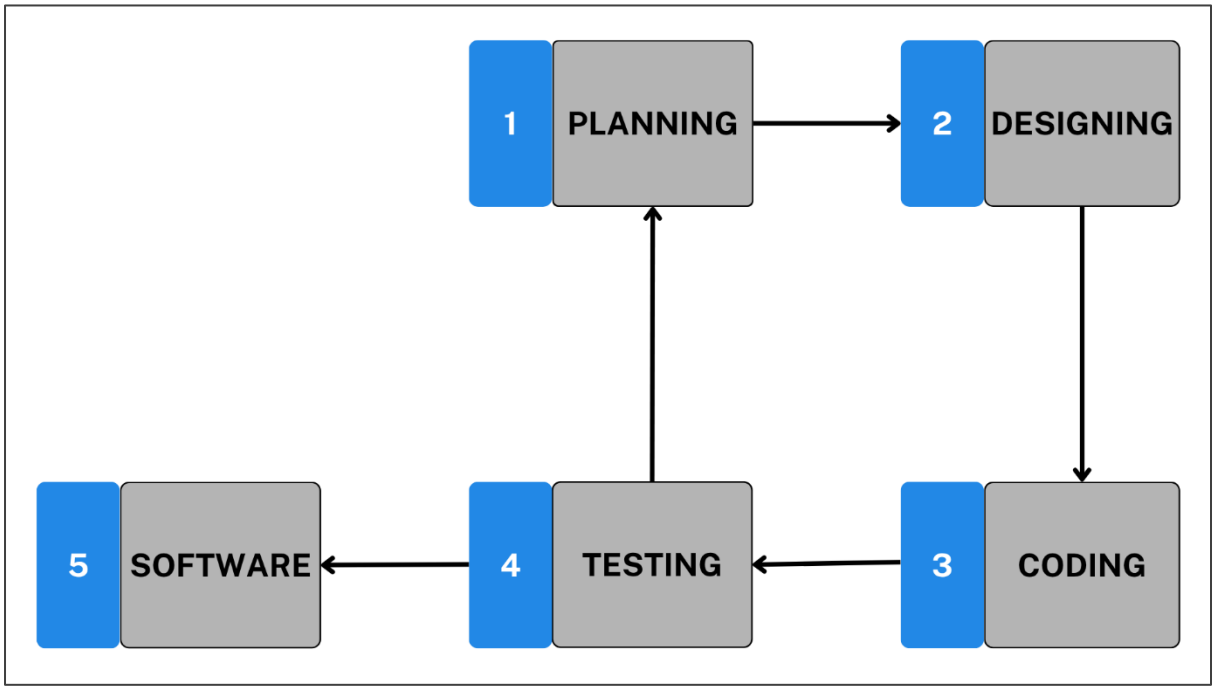


Figure 2: Phases of eXtreme programming

3.9 System design

3.9.1 Use case diagram

Figure 3 illustrates the use case diagram for the developed cloud-based integrated car rental system. The system supports four primary user roles: admin, staff, manager, and customer. Each user gains access through registration and login, with options to log out and update their password.

The admin role is responsible for managing users, updating the system's information, managing vehicles, and overseeing all transaction records. The staff can register drivers, create and manage invoices and payments, oversee car rental entries, manage system notifications, and respond to customer requests.

The customer can submit support requests, receive notifications, make payments, and view invoices. Meanwhile, the manager oversees the broader management of car rentals and customer reports.

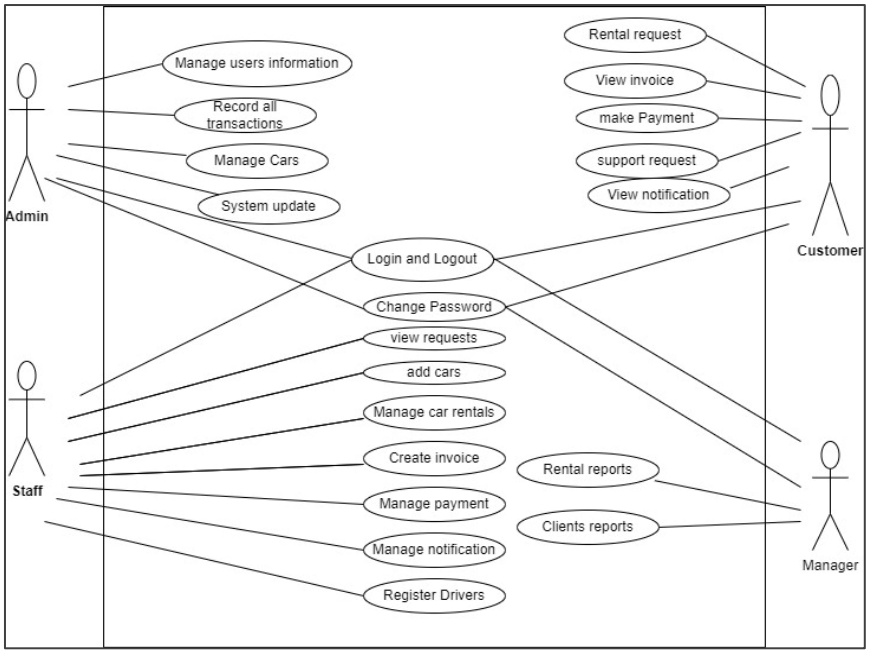


Figure 3: Use case diagram

3.9.2 Data flow diagram

Figure 4 presents the Data Flow Diagram (DFD) of the cloud-based integrated car rental information system. Upon successful registration, a client's details are authenticated and linked to their rental activity. Clients can browse available vehicles and proceed with payments through the system. Once payment is completed, the details are sent to the assigned staff, who then register the car and driver information before authorizing the car for release.

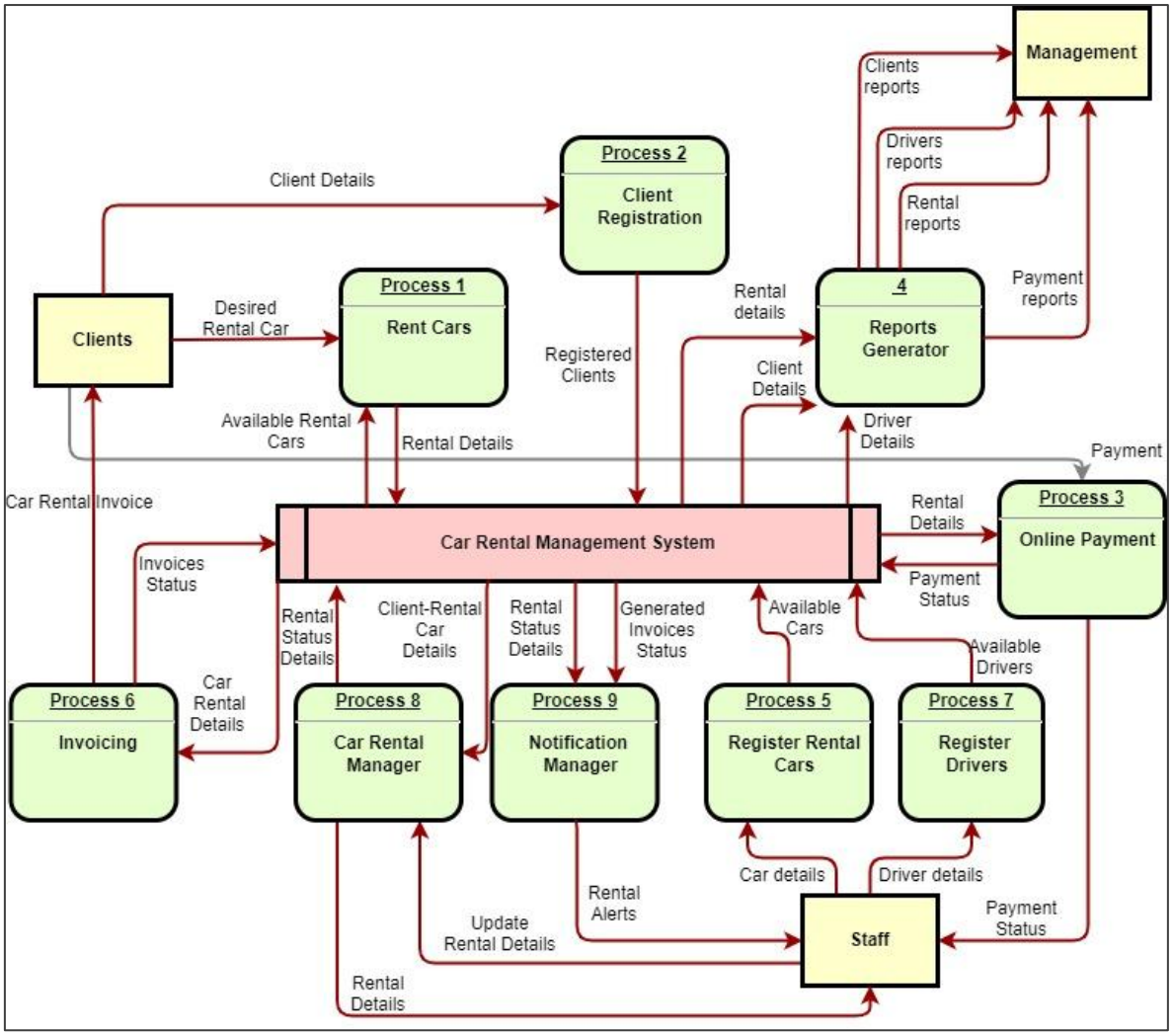


Figure 4: Data flow diagram

3.9.3 Flowchart

Figure 5 illustrates the flowchart of the proposed system, which integrates multiple modules including reservation management, payment and invoicing, and car management into a unified cloud-based car rental information system. The system handles the creation, updating, authentication, and security of client data using login credentials. Once a client logs in successfully, they can proceed to select a vehicle, view rental details, generate an invoice, and complete the payment to finalize the rental. If the login attempt fails, the system prompts re-authentication to ensure secure access to the car rental management platform.

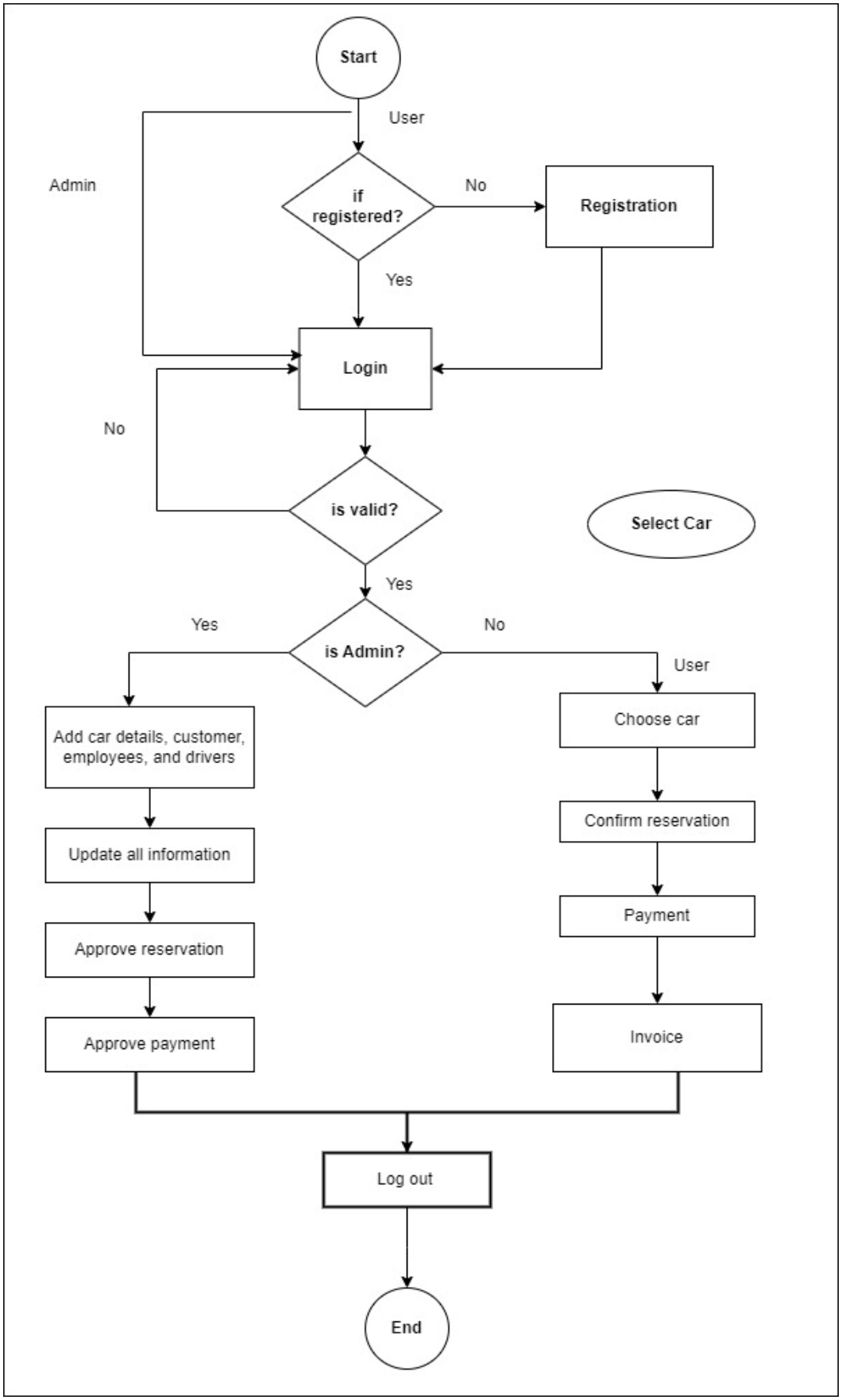


Figure 5: Flowchart of the developed system

3.9.4 Database design

The database design of this system was structured based on Class Diagrams, ensuring an object-oriented approach to data modelling. The class diagrams provided a comprehensive view of the system's entities, their attributes, and the relationships between different components. This approach ensured that the database was well-structured, scalable, and aligned with the business logic of the application.

The system consists of multiple tables that store various entities related to car rentals, employees, bookings, and financial transactions. Some of the key tables and roles include:

(i) Cars: Stores details of available rental cars, including their model, availability status, and specifications.

(ii) Car models: Defines different vehicle models, linking them to the cars table.

(iii) Employees: Contains information about staff managing rentals, bookings, and customer service.

(iv) Customers: Stores details of registered users renting vehicles.

(v) Drivers: Maintains records of company-assigned drivers for specific bookings.

(vi) Bookings: Tracks all rental reservations, linking customers to specific cars and rental durations.

(vii) Rental durations: Defines rental time periods and associated costs.

(viii) Payments: Records payment transactions for bookings, ensuring financial tracking.

(ix) Payment Methods: Lists accepted payment options (e.g., credit card, mobile money).

(x) Pricing: Stores pricing rules based on car models, rental duration, and service zones.

(xi) Proforma invoices: Generates preliminary invoices before finalizing payments.

(xii) Notifications: Manages SMS/email alerts for booking confirmations, payment reminders, and system updates.

(xiii) Logs: Tracks system activities, including user actions and booking modifications.

(xiv) Zones: Defines the geographical areas where Solidarity Car Rental operates, ensuring customers rent cars within covered locations.

As Fig. 6 illustrates, this structured database design supports seamless system operations, providing a foundation for scalability, security, and efficient rental service management.

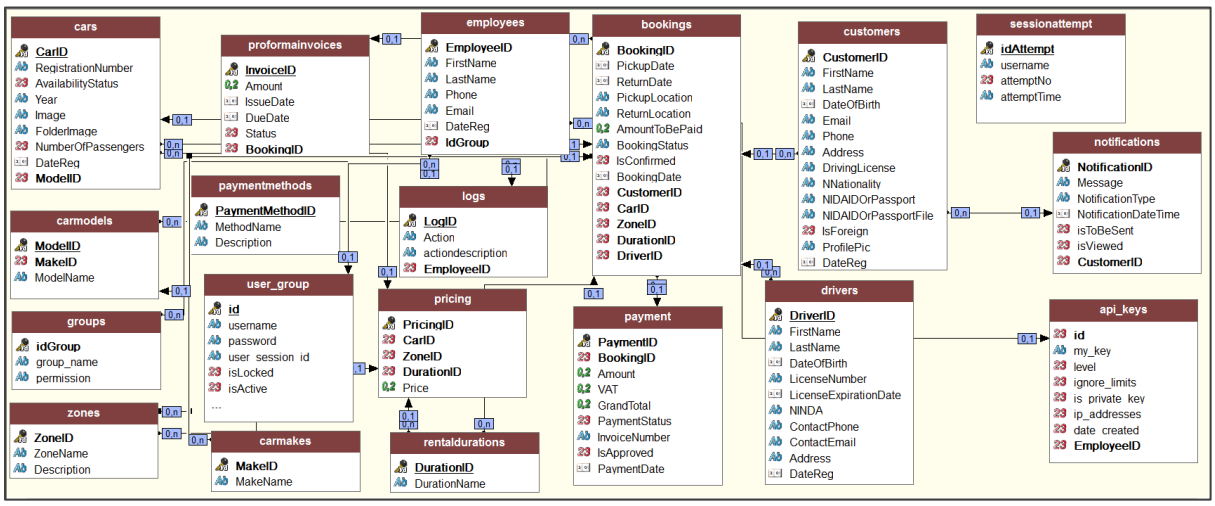


Figure 6: Database design

3.9.5 SMS gateway integration with Beem Africa

To enhance customer communication and automate notifications, the Solidarity Car Rental System integrates an SMS gateway using Beem Africa's API. This ensures that users receive real-time updates for booking confirmations, payment receipts, reminders, and promotional offers for integration process:

(i) API selection and configuration

Beem Africa was chosen due to its reliable delivery, scalable architecture, and ease of integration. An API key and secret were obtained from Beem Africa's developer portal for authentication.

(ii) Implementation in the system

The SMS service was integrated into the booking, payment, and notification modules. Messages were dynamically generated and sent via API calls using HTTP requested.

3.9.6 Payment processing and verification

The system provides customers with flexibility in choosing their preferred mobile payment method, including M-Pesa, Tigo-Pesa, or Airtel money. Instead of a direct system integration with these payment providers which requires lengthy approval processes the system follows a structured approach to verify transactions efficiently.

When a customer selects a payment method, they are guided through the necessary steps to complete the transaction externally via their chosen mobile payment service. After making the payment, the customer uploads proof of payment (such as a transaction receipt or confirmation message) into the system. At this stage, the staff is responsible for payment verification reviews the uploaded evidence through the web application to confirm its validity. Once verified, the system automatically generates and sends an invoice to the customer, ensuring a transparent and streamlined transaction process.

The screenshots of SMS payment confirmations included in the documentation illustrate how customers receive transaction details from their respective mobile payment services after completing a payment. These messages serve as proof of payment, which the system uses for manual verification. This approach allows for seamless transaction handling while bypassing the complexities of direct API integration with mobile payment providers, ensuring that customers can still make secure and efficient payments within the platform.

3.10 System development

3.10.1 Hardware requirements

The cloud-based integrated information system for car rental services was built using the tools and technologies listed:

(i) Flutter

Flutter was selected for developing the mobile application because it enables high-performance, cross-platform development using a single codebase for both Android and iOS.

This approach reduces both development time and costs while maintaining a consistent and seamless user experience across devices. Its rich set of customizable UI components allowed for a polished, responsive app, essential for complex features like real-time car tracking and payment processing. Additionally, Flutter's fast development cycle, facilitated by its hot reload feature, enabled rapid iteration and timely updates, keeping the app aligned with evolving business needs. The strong community support and a wide range of pre-built plugins for essential features further accelerated development, making Flutter the ideal choice for the project (Flutter, 2023).

(ii) PHP and CodeIgnighter PHP Framework

The CodeIgniter PHP framework were chosen for web application development due to their simplicity, performance, and scalability. PHP is a widely used server-side scripting language that is well-suited for dynamic web applications and offers excellent compatibility with various databases, especially MySQL, which was crucial for Solidarity's car rental system. PHP's extensive documentation and active community support further ensured that development could proceed smoothly.

CodeIgniter, a lightweight PHP framework, was selected for its speed, simplicity, and minimal configuration requirements. It allowed for rapid development, making it ideal for delivering a cloud-based, scalable solution with low overhead. CodeIgniter's built-in libraries and helpers, such as those for database interaction, form validation, and security, streamlined development while ensuring clean, reusable code. The framework's MVC (Model-View-Controller) architecture facilitated the separation of concerns, making the system easier to maintain and extend. This combination of PHP and CodeIgniter offered an efficient, flexible, and cost-effective solution compared to more complex frameworks, ensuring that the car rental system could evolve with minimal technical debt and maintainable code.

(iii) Project Development Lifecycle

The Project Development Lifecycle of this system followed a structured approach, beginning with system planning, where the project's objectives, scope, and requirements were identified. This phase involved gathering user needs and defining the functional and non-functional requirements. Next, during the system analysis phase, the collected requirements were thoroughly examined to establish a clear blueprint for development. This was followed by the

system design phase, where the system architecture, database schema, and user interface layouts were developed, ensuring an efficient and scalable structure.

The system implementation phase involved the actual development of both the web and mobile applications, integrating core functionalities such as booking management, payment processing, and SMS notifications. Once implemented, the system testing phase was conducted to validate functionality, performance, security, and user experience, ensuring that the system met all specified requirements. After successful testing, the system was deployed using cloud-based infrastructure, ensuring reliability and scalability. Post-deployment, the maintenance phase commenced, focusing on monitoring system performance, addressing potential issues, and implementing necessary updates or improvements over time. The various stages of this project development lifecycle are visually represented in Fig. 7.

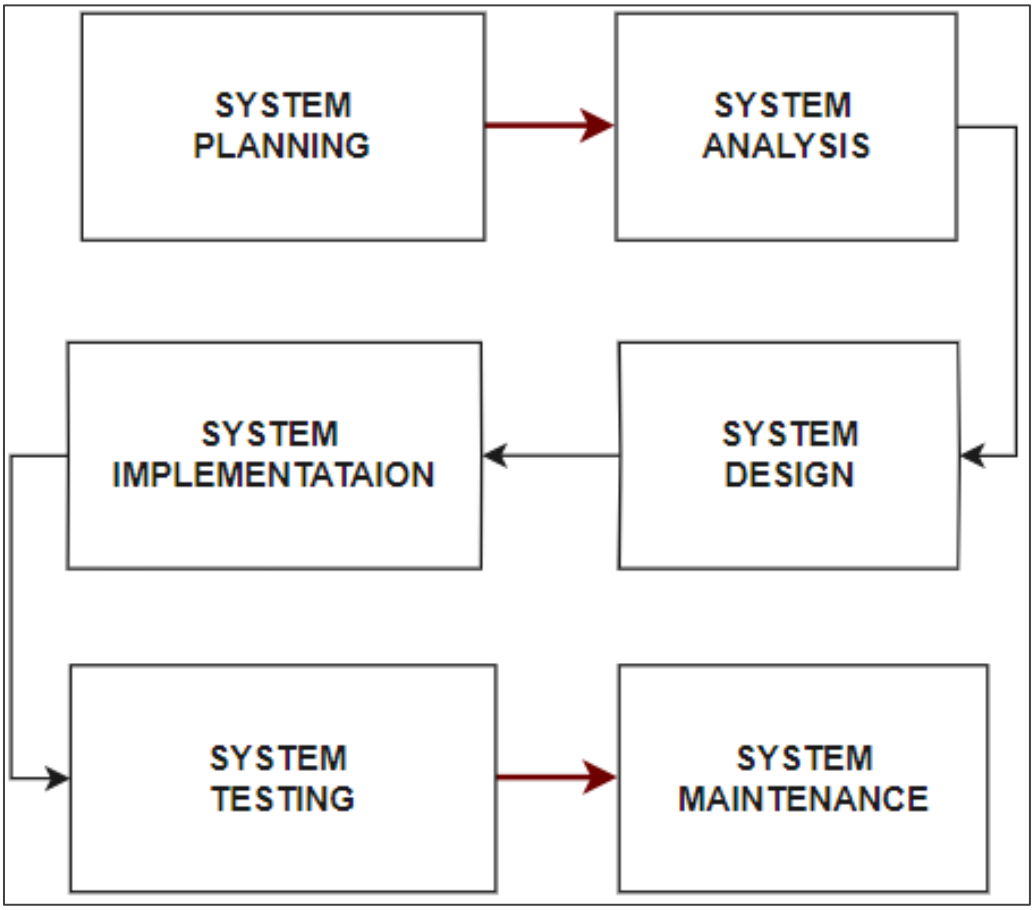


Figure 7: Project development lifecycle

(iv) Testing

This system was tested using eXtreme programming. As a result, small early releases of the system were tested for specific useful features, while others were added as needed. Figure 8 depicts the various testing phases of the system's simple design.

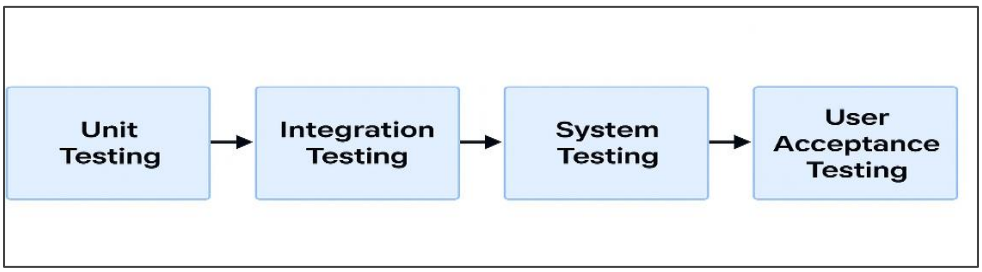


Figure 8: Testing phases

3.11 System testing

3.11.1 Unit testing

Unit testing was conducted to verify the functionality and reliability of individual components within both the integrated information system and the mobile application. This testing process was carried out during the development phase to ensure that each module, function, and feature operated as expected before integration. By isolating and testing specific units of the software, potential errors were identified and resolved early, enhancing the overall system stability and performance.

3.11.2 Integration testing

During the interfacing of two or more units, integration testing was performed. The goal was to expose any faults that may occur between the integrated units. After the modules have been individually tested, integration testing was beginning.

3.11.3 System testing

Continuous System testing was conducted to evaluate the fully integrated system's functionality, performance, and reliability. This phase ensured that all system components worked together as expected and met the defined requirements. It involved executing a series of test cases to identify potential defects in the interaction between different modules, including

the web application, mobile application, cloud services, payment gateway, and SMS notification system.

The testing process included functional testing to verify that core features, such as booking, payments, and notifications, operated correctly. Additionally, non-functional testing assessed system performance, scalability, and security, ensuring that the system could handle concurrent user requests and protect sensitive data. Any detected flaws were documented and resolved to enhance system stability and usability before deployment.

3.11.4 System validation

System validation was performed to ensure that the developed system met all specified requirements and functioned as intended in real-world scenarios. This process involved verifying that both the mobile and web applications operated correctly and efficiently, aligning with user expectations and business objectives.

Validation testing was conducted through user acceptance testing (UAT), where end-users, including company employees and customers, interacted with the system to assess its usability, functionality, and overall performance. The accuracy of payment processing via payment APIs and the effectiveness of SMS notifications through the Beem Africa API were specifically validated. Additionally, system performance was evaluated under different conditions to confirm responsiveness, reliability, and security. Feedback from users was documented and used for final refinements before full deployment.

3.11.5 Ethical consideration

Approval for this project was obtained from the relevant authorities at Solidarity Car Rental following university regulations, ensuring adherence to ethical research practices. Participation was voluntary, with informed consent sought from all participants, upholding the principle of autonomy. The measures were implemented to safeguard the confidentiality and privacy of participants. Data were securely stored and anonymized to prevent identification.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents results from the focus group discussions, interviews, system development and validation. Finally, the chapter provides discussions of the project findings.

4.2 Results from responders

4.2.1 Demographic information

The gender distribution of respondents in this study reveals a nearly equal split, with 49% female and 51% male participants (Fig. 9). This balanced representation ensures that the system's effectiveness and user preferences are analyzed from diverse perspectives. The slight male majority (51%) compared to female participants (49%) does not significantly affect the overall results, ensuring that the findings remain impartial and representative of both genders. This gender balance enhances the reliability of the study's conclusions, supporting the development of a car rental system that is inclusive and accessible to all users, regardless of gender.

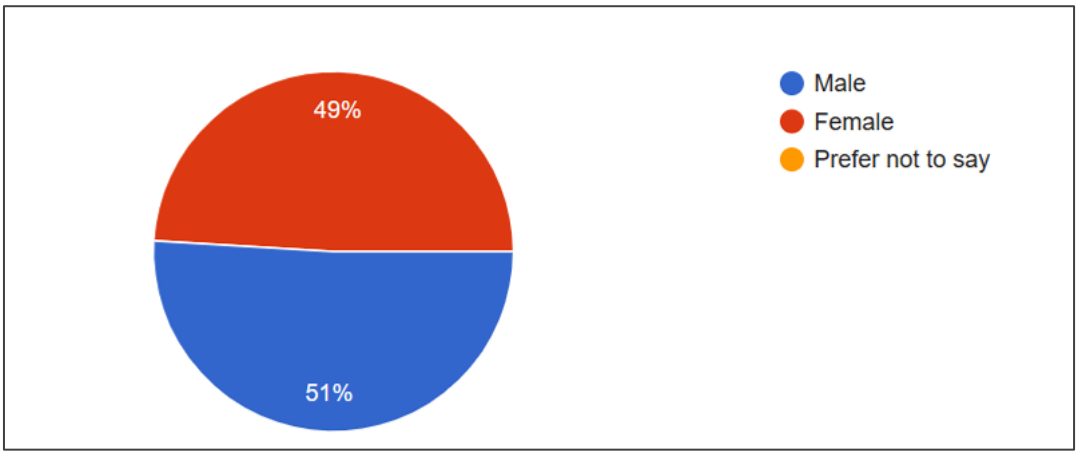


Figure 9: Representation of demographic information

4.2.2 Respondents preferences for car rental reservation methods

The majority of respondents (94.2%) expressed a clear preference for making car rental reservations online, either through the website or mobile app. This emphasizes the increasing

demand for digital platforms, highlighting the convenience and accessibility they provide to customers. A smaller group of respondents (4.8%) still preferred in-person reservations, suggesting that a segment of customers may appreciate face-to-face interactions for reasons such as personalized service or trust. The least preferred option was phone reservations, with only 1% of respondents selecting this method, indicating that traditional reservation channels are becoming less popular as online platforms continue to dominate. These findings highlight the importance of providing an efficient and user-friendly online booking system to cater to the evolving preferences of the target audiences as shown in Fig.10.

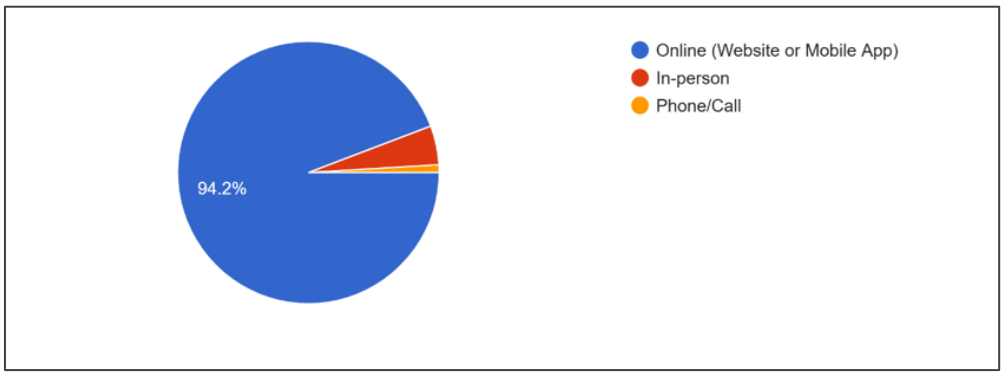


Figure 10: Respondents' preferred car rental reservation methods

4.2.3 Customer preferences for payment methods

The results from the survey indicate a clear preference for mobile payment options among customers of Solidarity Car Rental, with 92.3% of respondents opting for mobile payment systems such as M-Pesa, Tigo-Pesa, and Airtel Money (Fig. 11). This reflects the growing trend of mobile money usage in Tanzania and highlights the importance of providing a seamless, mobile-friendly payment method in the car rental process. The system developed for Solidarity Car Rental incorporates these mobile payment options, enabling users to easily pay for their bookings via their preferred platforms. In contrast, only 2.9% of respondents expressed a preference for using credit or debit cards, suggesting that while card payments remain a valid option, mobile payments are more convenient for the majority of customers. Also, 3.8% of respondents preferred to pay in person when picking up the car, which is a more traditional approach to payment and could suggest a lack of trust or familiarity with online payment systems. Finally, 1% of respondents indicated that they would like more payment options, which presents an opportunity for Solidarity Car Rental to explore additional payment methods in the future, such as integrating new digital payment systems. These results validate the

system's mobile payment integration and offer insight into potential areas for further improvement in payment options.

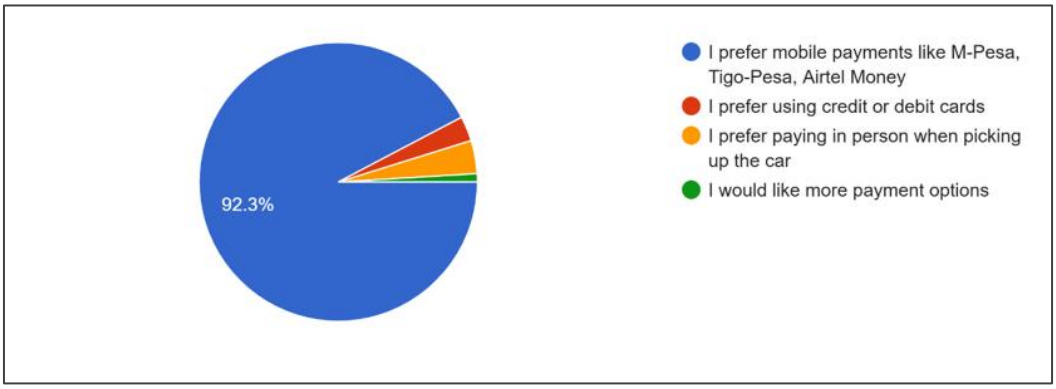


Figure 11: Representation of customer preferences for payment methods

4.2.4 Customer preferences for mobile application features

The results in Fig. 12 indicate a clear preference for specific features in the mobile application. A significant majority of respondents (86.5%) highlighted the importance of payment tracking and invoices, suggesting that users highly value the ability to monitor their payment status and access detailed transaction records. Real-time updates on reservation status were also favored by 4.8% of respondents, which reflects an interest in staying informed about the progress of their bookings. A smaller portion of respondents (6.8%) expressed a desire for an easy search for car availability, while 1.9% preferred a feature to track their booking history. There was also interest in booking cancellation or modification options, although the exact percentage for this feature is not provided. These insights emphasize the need for features that enhance transparency, control, and convenience for customers in the mobile application.

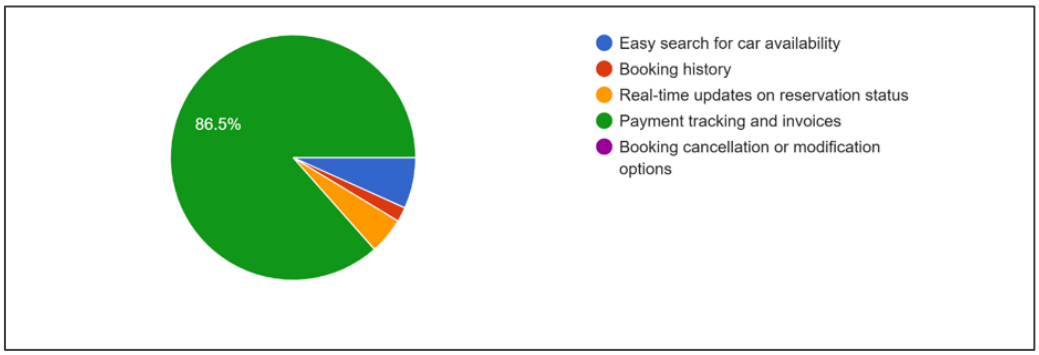


Figure 12: Preferred mobile application features

4.2.5 Willingness to adopt cloud solutions for car rentals

According to the results of the interviews, 81.40% of respondents strongly agreed and feel that a cloud-based integrated information system for car rental services should be implemented to optimize car rental management, followed by 17.60% who agreed. However, 0.70% were unconcerned about the proposal, while 0.30% disagreed, as seen in Fig. 13.

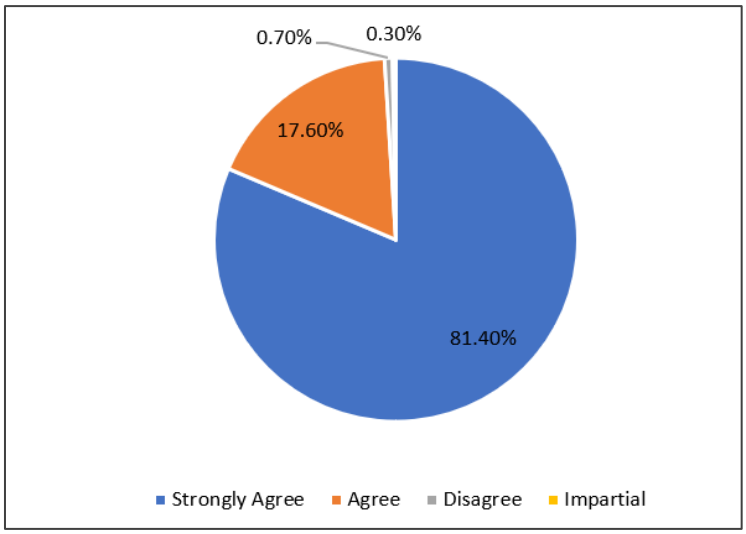


Figure 13: Willingness to adopt cloud-based system

4.3 Results from the requirement analysis

4.3.1 Identified functional and non-functional requirements

Data gathered from interviews and focus group discussions were analyzed to identify both functional and non-functional requirements for the system. These requirements served as the foundation for the system's design and development process. Table 1 outlines the functional requirements, while Table 2 presents the identified non-functional requirements. Functional requirements describe the specific operations or tasks the system must perform. In contrast, non-functional requirements define system attributes and constraints such as usability, performance, security, accessibility, availability, accuracy, and simplicity.

Table 1: Functional requirement of the system

S/N	Requirements	Description
1.	Enable secure user account creation and login.	Users should be able to create an account and log in to the system securely.
2.	Able to search, select, and manage their car reservations.	The system should allow users to search and select rental cars, make reservations, and manage their bookings.
3.	Provide real-time details on car availability.	The system should provide real-time information about car availability and manage the inventory of rental vehicles.
4.	Make online payments for car rentals securely	Users should be able to make secure online payments for their car rentals through various payment methods.
5.	Generate reports on car rental activities for analysis.	The system should generate reports on car rental activities, financial transactions, and other relevant data for analysis and decision-making.
6.	Feature a user-friendly mobile app	The system should have a user-friendly mobile app to facilitate easy access and usage on smartphones and tablets.

Table 2: Non-functional requirement of the system

S/N	Requirements	Descriptions
1.	Performance	The system should be fast and responsive, with minimal latency, to ensure a smooth user experience even during peak usage.
2.	Security	The system should implement strong security measures to protect user data and rental data.
3.	Reliability	The system should be highly reliable, with minimal downtime to ensure uninterrupted service.
4.	Scalability	The system should be able to handle increasing user demands and accommodate future growth without significant performance degradation.
5.	Usability	The system should be intuitive and easy to use, with a clear and user-friendly interface, to minimize user training requirements.
6.	Accessibility	The system should adhere to accessibility standards, allowing users with disabilities to access and use the system effectively.

4.4 System development results

The cloud-based integrated information system for car rental services was successfully developed. Communication between the web platform and the mobile application was effectively achieved through API integration. Key modules such as car management, reservation management, invoicing, payment processing, and reporting were efficiently combined into a single unified system. This integration promotes a smooth and synchronized workflow for both customers and staff. Clients can easily browse available vehicles, make bookings, and process secure payments through their mobile devices. They also have access to detailed proforma invoices, which enhances transaction transparency. On the administrative side, authorized personnel including the CEO, Operations Manager, System Administrator, and

Rental and Reservation Officer are granted role-based system access to manage operations effectively.

4.4.1 Results of the developed system

The cloud-based car rental information system was developed to support internal staff operations, including roles such as the CEO or Operations Manager and the Rental and Reservation Officer. The CEO had access to reports detailing both rented and available vehicles, as well as the payment overview, including completed transactions and outstanding balances. This functionality supported better decision-making at the management level. Meanwhile, the Rental and Reservation Officer was responsible for managing reservations, registering clients, adding vehicle listings and pricing, receiving system alerts, issuing invoices to clients, and verifying and approving payments based on received payment confirmations

(i) Login page

The login page (Fig. 14) serves as the primary access control mechanism for both mobile and web applications, ensuring secure authentication of users before they interact with the system. It provides separate login interfaces for different user roles, including customers, employees, and administrators, enabling role-based access control. Upon accessing the system, users are required to enter their credentials, which include a username and password. For enhanced security, the authentication process is integrated with Azure's built-in reverse proxy, which manages and validates login requests. Failed login attempts trigger error messages, while successful authentication grants access to the appropriate dashboard based on user roles. Additionally, the system incorporates a "Forgot Password" feature, allowing users to reset their credentials via email verification. The login page is designed with a user-friendly interface, ensuring ease of navigation across different devices, including desktops and mobile phones. The seamless integration with cloud services further enhances security, availability, and scalability.

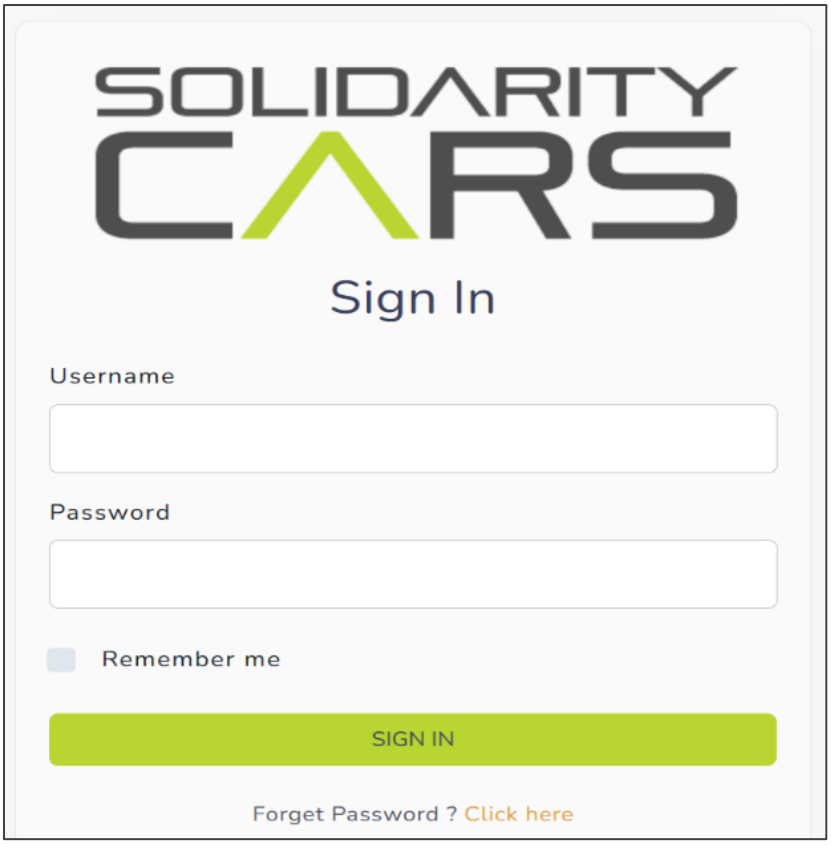


Figure 14: Login page

(ii) Dashboard of the developed system

Upon successful login, the administrator gains access to the system's dashboard, which provides an overview of key operations, including registered users, customers, car details, reservations, and payment statuses. The dashboard is designed to be intuitive and user-friendly, allowing administrators to efficiently manage system resources and monitor business activities in real-time.

The administrator can view comprehensive reports on booking statuses, distinguishing between paid and unpaid reservations, as well as identifying available and booked cars. Additionally, the system enables user account management, allowing the administrator to assign roles and permissions based on organizational hierarchy. This ensures that employees have the necessary access to perform their tasks while maintaining data security as shown in Fig. 15.

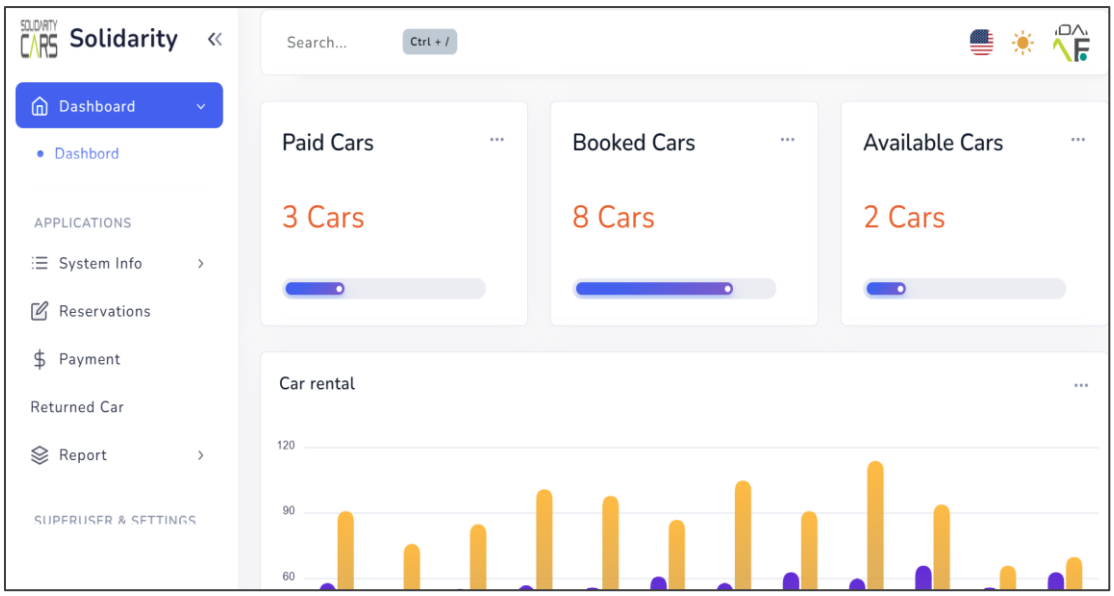


Figure 15: Dashboard of the system

(iii) Results of car management

The purpose The Rental and Reservation Officer can manage the company's fleet by adding and updating car details within the system. The process begins with registering the car's make, ensuring that all vehicles are categorized appropriately based on their manufacturers. This structured approach helps maintain an organized inventory, allowing for easy tracking and retrieval of car details when needed.

Once a car make is added, additional specifications such as the model, year of manufacture, fuel type, seating capacity, and rental pricing can be entered. The system provides an interface where officers can update car availability, mark vehicles as booked or available, and deactivate listings for maintenance or other operational reasons. as shown in Fig. 16.

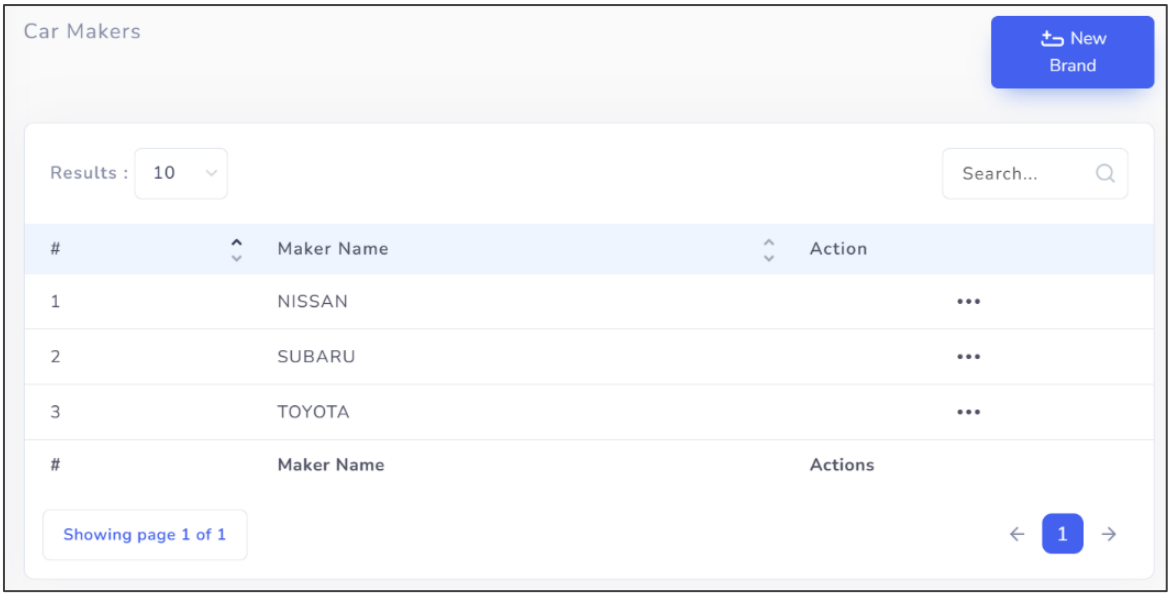


Figure 16: Results of car management

Once the car brands are added to the system, the next step for the Rental and Reservation Officer is to enter the car models associated with each brand. This process ensures that each car model is accurately categorized under its respective manufacturer. The system allows for easy addition of car models by selecting the appropriate make, streamlining the registration of new vehicles into the system. In case of any errors or discrepancies, while adding car models or other car details, the system provides functionalities to edit or delete the entries. This feature ensures that the system remains accurate and up-to-date, allowing the officer to correct any mistakes made during the input process.

The illustration in Fig. 17 is the list of car models that have been successfully added to the system, showing how the car makes and models are organized. The seamless process for adding, editing, or deleting car details helps maintain a well-managed fleet that is essential for efficient booking and reservation management.

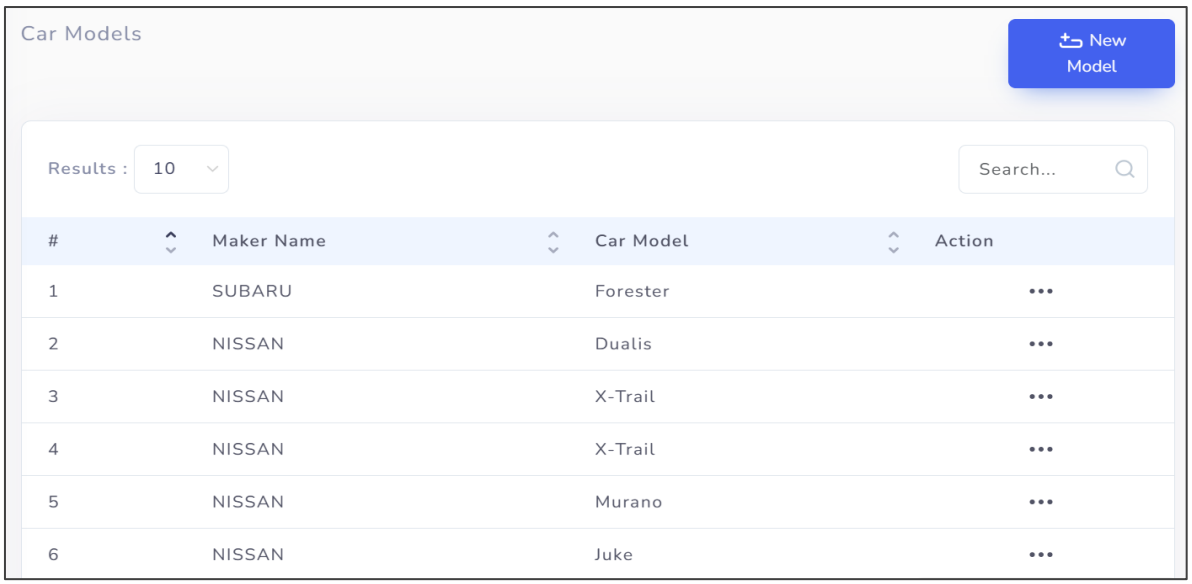


Figure 17: Car models

To complete the car registration process, the responsible officer must select the appropriate car model before entering additional details. These details include the vehicle's plate number, total passenger capacity, and relevant images. The system requires the upload of a main image along with multiple additional images to provide a comprehensive visual representation of the car. These images allow customers to analyze different aspects of the vehicle before making a booking, ensuring transparency and enhancing the user experience. By offering a detailed preview, the system helps customers make informed rental decisions based on both the car's specifications and its visual condition.

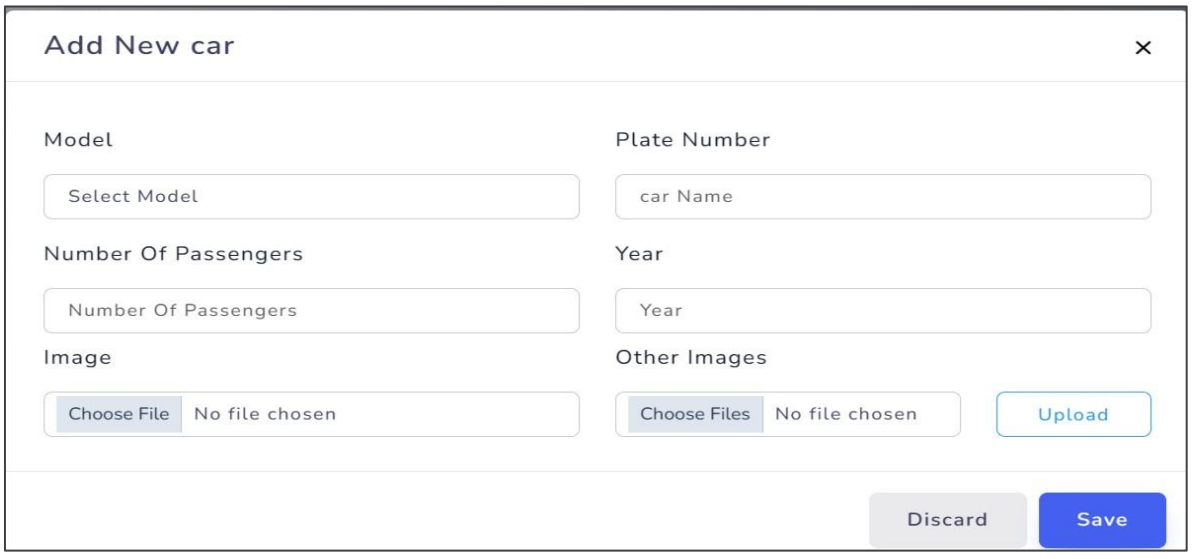


Figure 18: Adding new car

Once all car details have been added as in Fig. 18, users can view the available cars along with their status. When a car is booked, it is automatically removed from the list of available vehicles, allowing for efficient reservation management based on client requests. This eliminates the risk of overbooking or double bookings, as employees are unable to reserve a car that has already been booked. Figure 19 displays the list of available cars within the system.

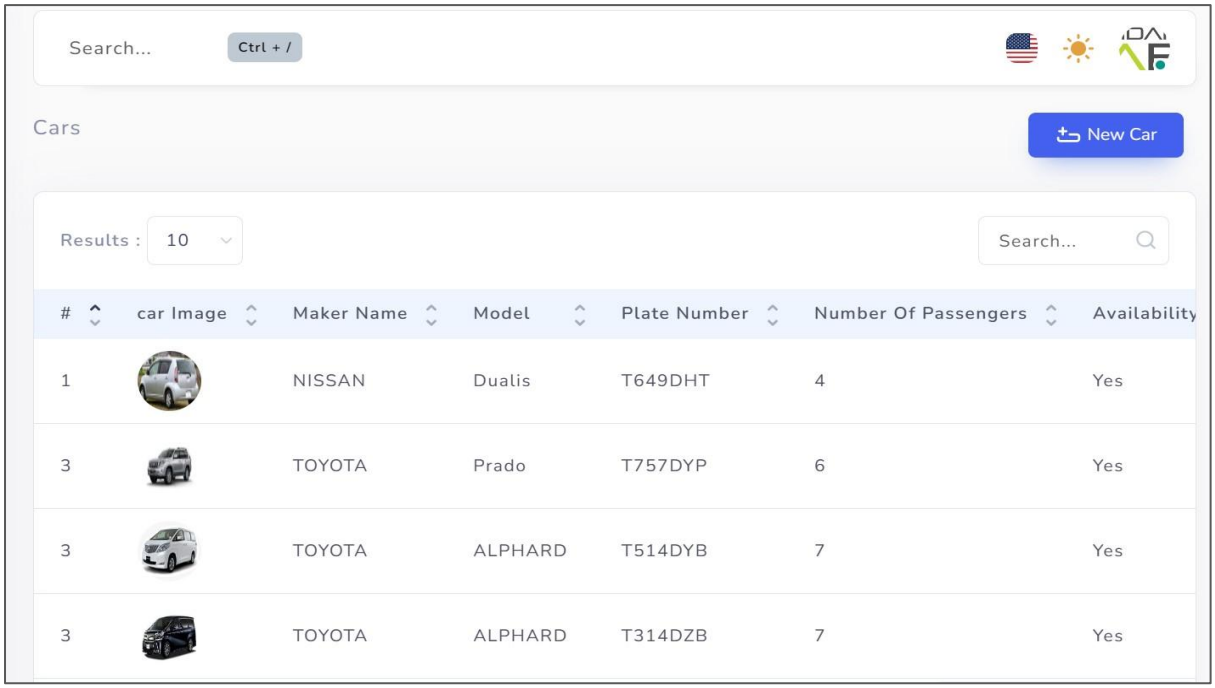


Figure 19: Lists of cars

(iv) Results of reservation management

Users can make bookings or reservations directly through the system. Additionally, the rental and reservations officer can create new bookings within the system. Before processing a new booking, customer details must first be entered into the system, as illustrated in Fig. 20.

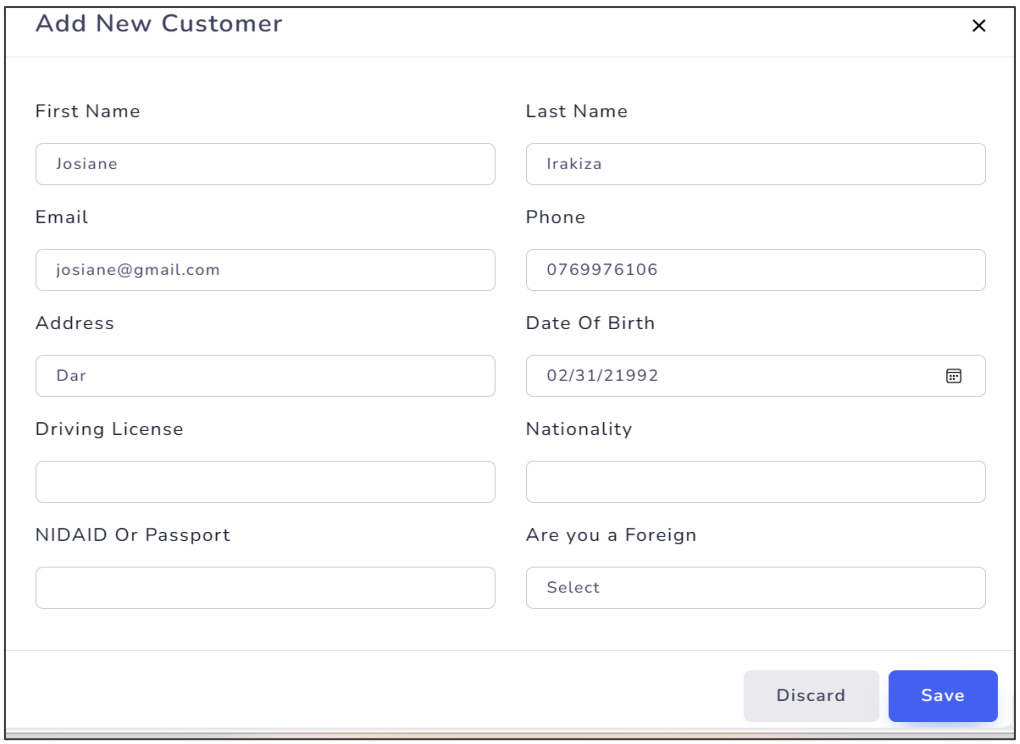


Figure 20: Adding a new customer

After the customer's details are entered into the system, the user can initiate a reservation by choosing the customer's name and filling in the trip information. This involves specifying the pick-up and return locations, dates for both pick-up and drop-off, details of the selected car, and the travel zones for the journey, as shown in Fig. 21.

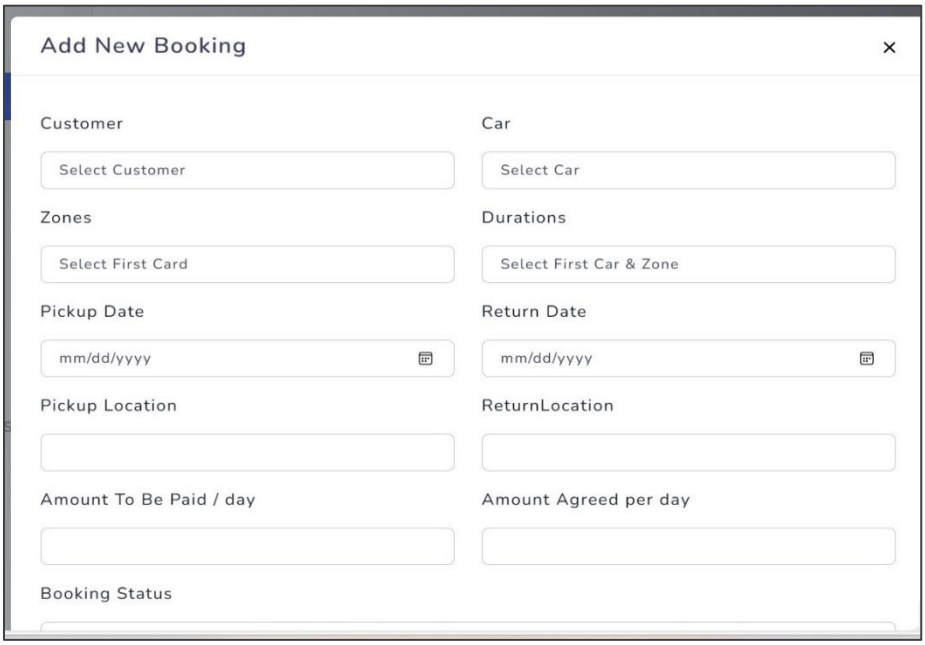


Figure 21: Adding new bookings

The designated staff member is able to manage reservations, including making adjustments or removing entries when necessary. As illustrated in Fig. 22, the reservation and rental officer has access to a comprehensive list of all bookings. This streamlined reservation management process helps maintain accurate car schedules and effectively avoids the problem of overbooking.

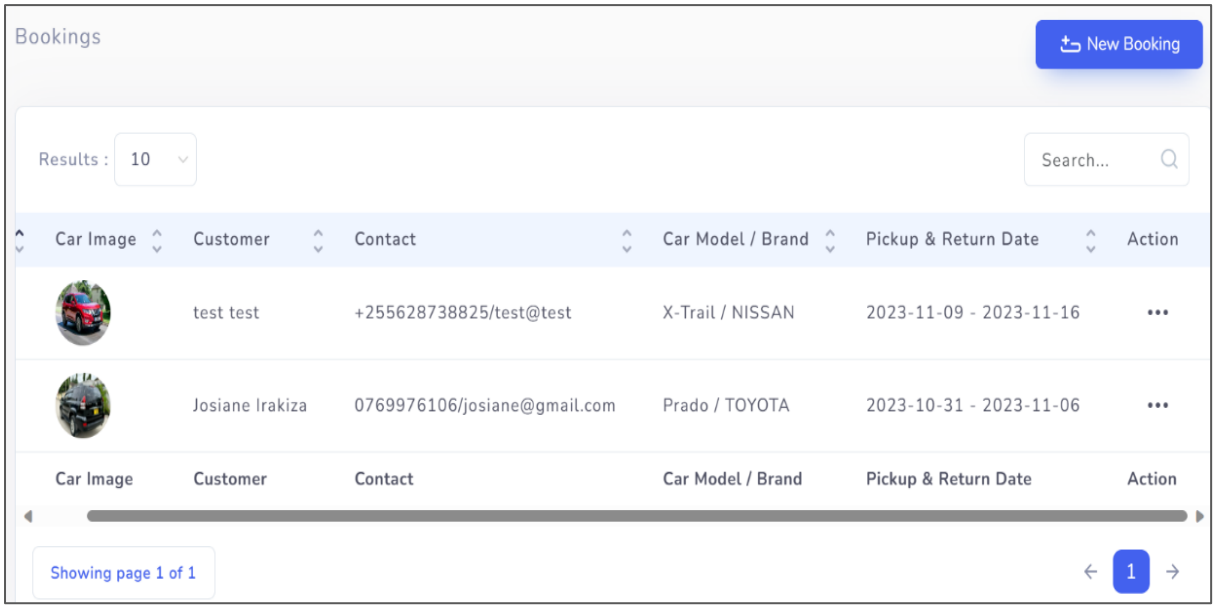
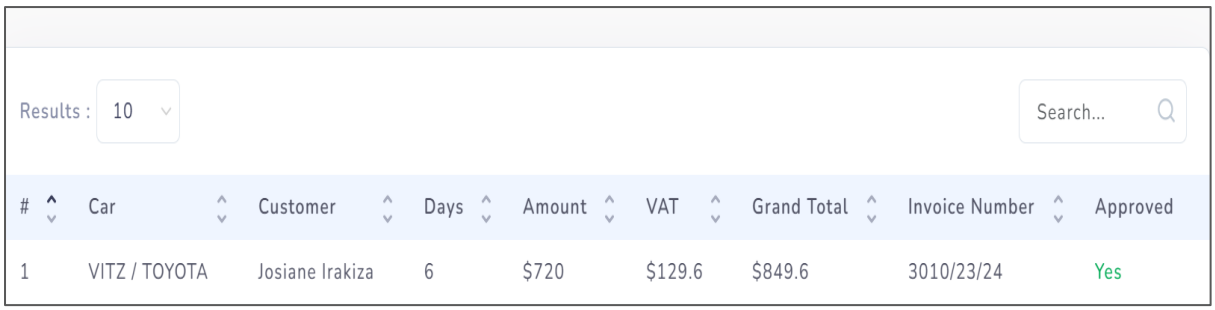


Figure 22: Customer reservations

(v) Results of payment and invoicing

The developed system has significantly enhanced the payment and invoicing process, providing a secure and transparent environment for handling transactions. Upon payment by a client, the system automatically notifies the relevant staff for verification. These employees confirm the validity of the payment details, a vital step in maintaining financial accuracy. The system clearly differentiates between paid and unpaid reservations, allowing staff to efficiently manage and track payment statuses. This distinction also supports the management in monitoring outstanding transactions and taking timely follow-up actions. Figure 23 illustrates the list of reservations along with the corresponding payment details.



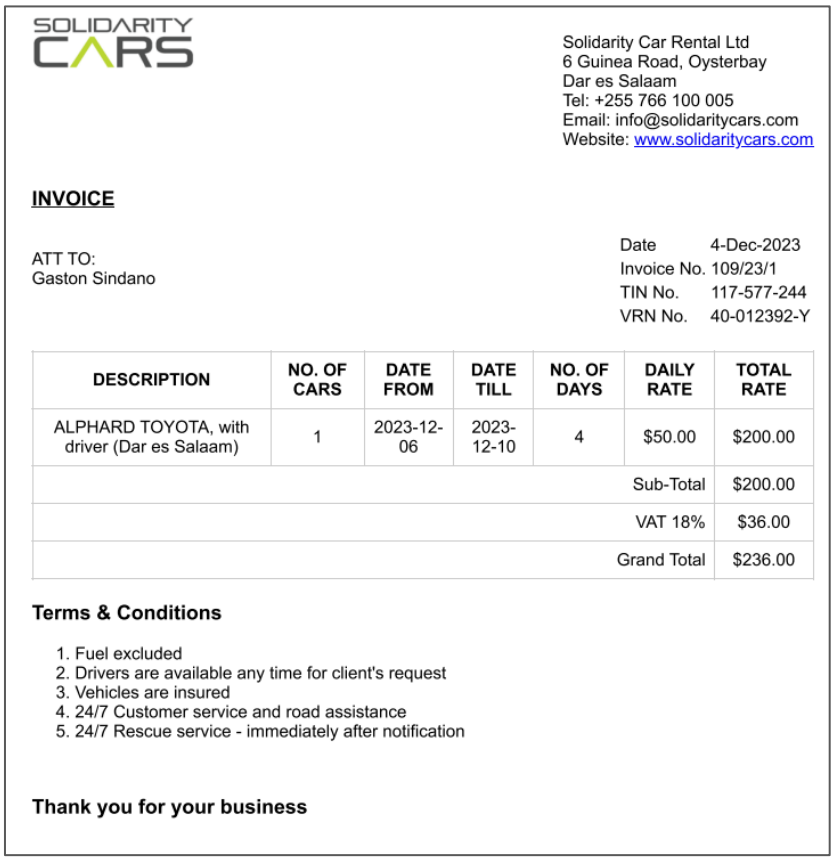
Results : 10

Search...

#	Car	Customer	Days	Amount	VAT	Grand Total	Invoice Number	Approved
1	VITZ / TOYOTA	Josiane Irakiza	6	$720	$129.6	$849.6	3010/23/24	Yes

Figure 23: Results of payment verification

Once a payment is confirmed, the system promptly produces a comprehensive invoice. These invoices detail the payment breakdown, including daily rates, total charges, and VAT as per company policy. This automation enhances efficiency by minimizing manual errors and saving time. Clients benefit from added convenience, as the invoices can be printed, downloaded, or sent electronically. This streamlined connection between payment processing and invoicing not only ensures financial precision but also improves the client experience by emphasizing the system's effectiveness and ease of use. Figure 24 presents an example of an invoice generated by the system 24.



SOLIDARITY CARS

Solidarity Car Rental Ltd
6 Guinea Road, Oysterbay
Dar es Salaam
Tel: +255 766 100 005
Email: info@solidaritycars.com
Website: www.solidaritycars.com

INVOICE

ATT TO:
Gaston Sindano

Date 4-Dec-2023
Invoice No. 109/23/1
TIN No. 117-577-244
VRN No. 40-012392-Y

DESCRIPTION	NO. OF CARS	DATE FROM	DATE TILL	NO. OF DAYS	DAILY RATE	TOTAL RATE
ALPHARD TOYOTA, with driver (Dar es Salaam)	1	2023-12-06	2023-12-10	4	$50.00	$200.00
					Sub-Total	$200.00
					VAT 18%	$36.00
					Grand Total	$236.00

Terms & Conditions

1. Fuel excluded
2. Drivers are available any time for client's request
3. Vehicles are insured
4. 24/7 Customer service and road assistance
5. 24/7 Rescue service - immediately after notification

Thank you for your business

Figure 24: Generated customer invoice

(vi) Results of report generation

The system effectively compiles detailed reports that offer valuable insights into the company's activities. These reports cover key performance indicators such as car utilization rates, total bookings, duration of rentals, and specific vehicle types. This reporting capability enables management to evaluate operational efficiency, detect usage patterns, and plan strategically for future development. Figure 25 illustrates a sample of the car utilization report.

#	Car Model & Maker	Registration Number	Booking Count	Total Booking Days	Utilization Percentage
1	Forester - SUBARU	T163DYP	1	4	1.13%
2	Dualis - NISSAN	T708DVV	1	2	0.57%
3	X-Trail - NISSAN	T534DXT	2	14	3.97%
4	Murano - NISSAN	T389DZX	3	14	3.97%
5	VITZ - TOYOTA	T671TVU	1	15	4.25%
6	ALPHARD - TOYOTA	T388DZX	3	13	3.68%
7	ALPHARD - TOYOTA	T314DZB	4	21	5.95%
8	ALPHARD - TOYOTA	T514DYB	2	7	1.98%

Figure 25: Car utilization report

(vii) Results of SMS alerts

The system sends automatic reminders to customers as their rental period approaches its end, encouraging timely vehicle returns. This proactive communication has helped Solidarity Car Rental Limited minimize delays in returns, thereby improving overall fleet efficiency. Additionally, clients benefit from the timely updates, which foster better customer satisfaction through clear and consistent messaging. Figure 26 displays a sample SMS notification sent to a client.

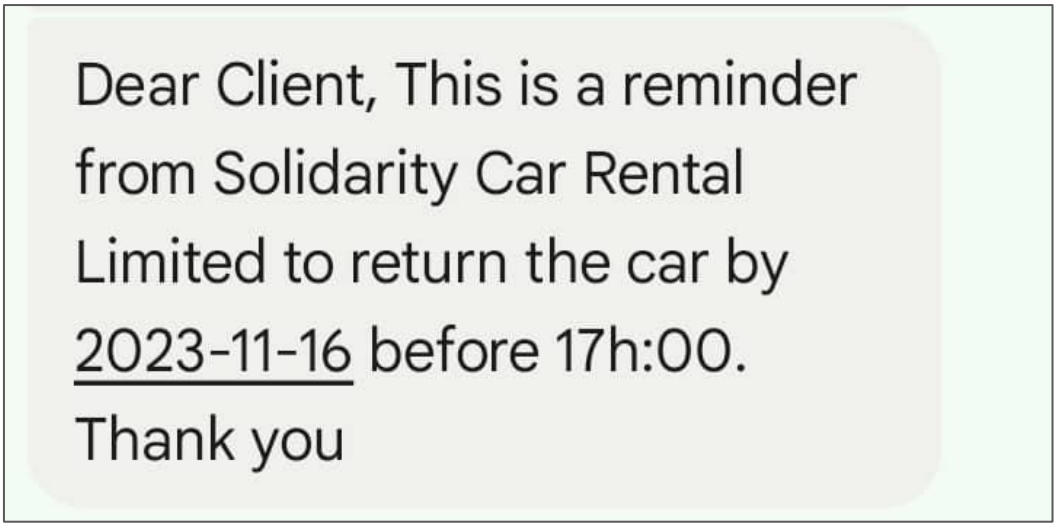


Figure 26: Notifications on car rental reminder

4.4.2 Results of the mobile APP

The mobile application was developed for Solidarity Car Rental Limited's clientele, catering to both individual and corporate users. Through the app, customers can conveniently view available vehicles, select preferred pickup and return dates, and confirm their reservations with ease. The platform facilitates secure payment transactions and enables direct interaction with the company's support team, promoting efficient communication and quick resolution of customer queries. This integration between the mobile app and the core information system plays a vital role in enhancing operational efficiency and streamlining rental services.

(i) Results of customer registration

To The customer registration module is a fundamental element of the mobile app. It allows users to create accounts by entering necessary personal details, thereby ensuring a hassle-free onboarding process. To ensure account safety and data protection, strict security validations are in place to authenticate each user. Figure 27 presents the app's registration interface.

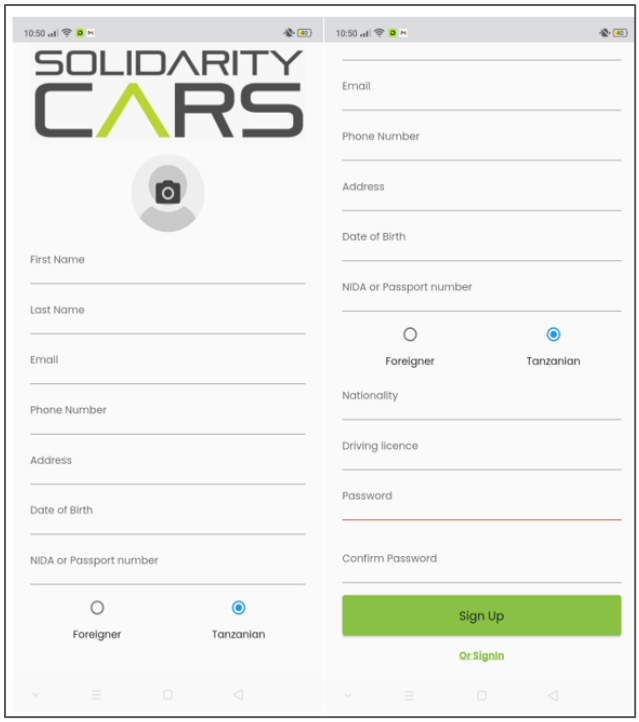


Figure 27: Customer registration screen

(ii) Results of car reservation and selection process

Through the mobile application, customers can conveniently explore a list of available vehicles, each displaying pricing tailored to specific regions across Tanzania. Whether navigating the bustling roads of Dar es Salaam or traveling to other areas, users can filter and select vehicles that best match their travel plans and location preferences. Figure 28 illustrates the available car listings within the app.

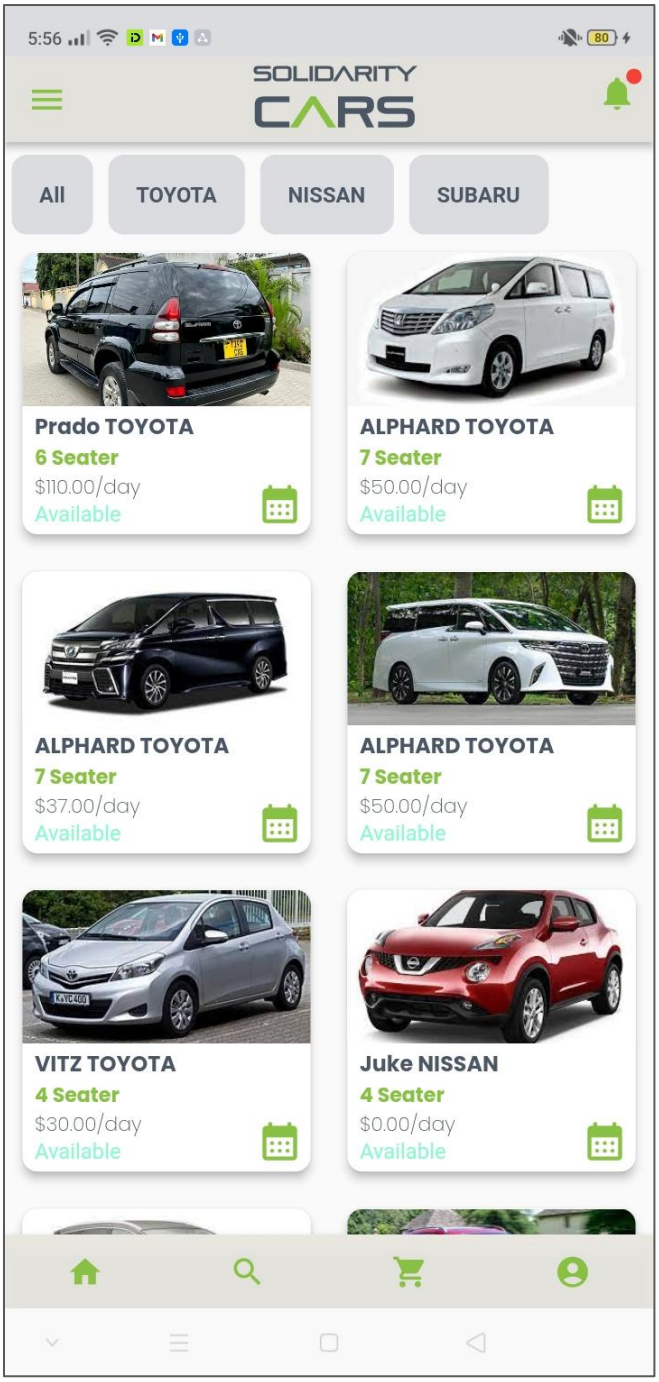


Figure 28: Car reservations and selection process screen

Once a vehicle is selected, customers proceed to enter their rental period, preferred duration, and target location or region, as demonstrated in Fig. 28. This detailed input process allows for a tailored and user-friendly reservation experience.

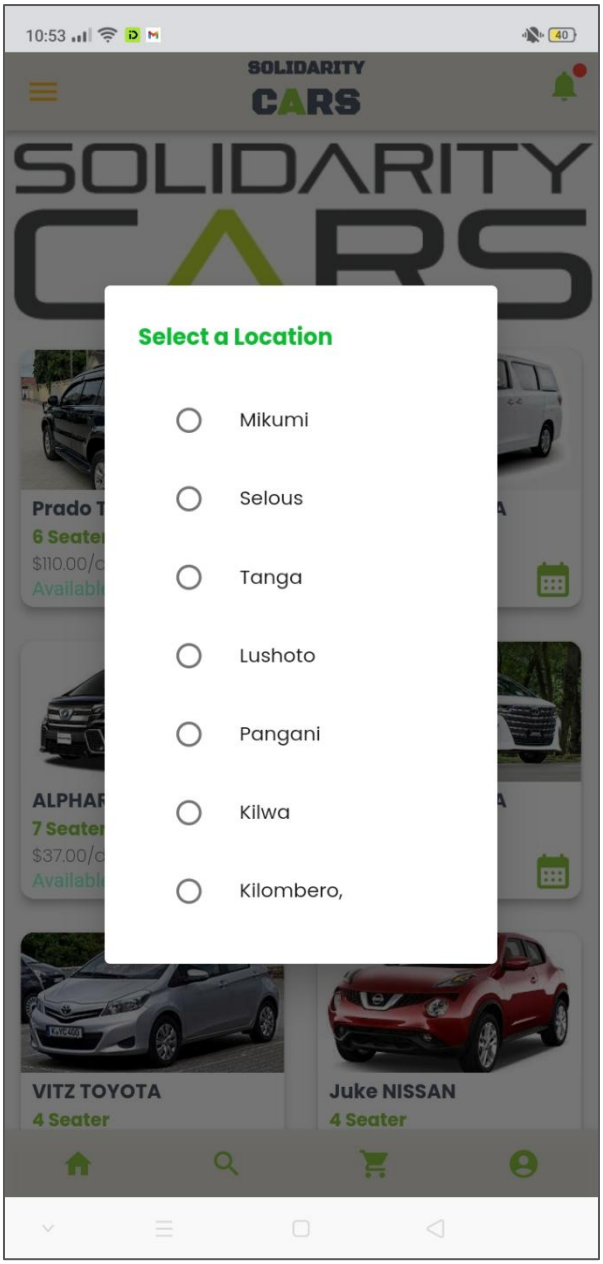


Figure 29: Results of location selection

To complete their booking, users simply confirm their selection, making it easy to secure the chosen vehicle instantly. This efficient process provides customers with fast, accurate, and stress-free reservations, aligning smoothly with Solidarity Car Rental's service delivery. Figure 30 illustrates the reservation confirmation interface.

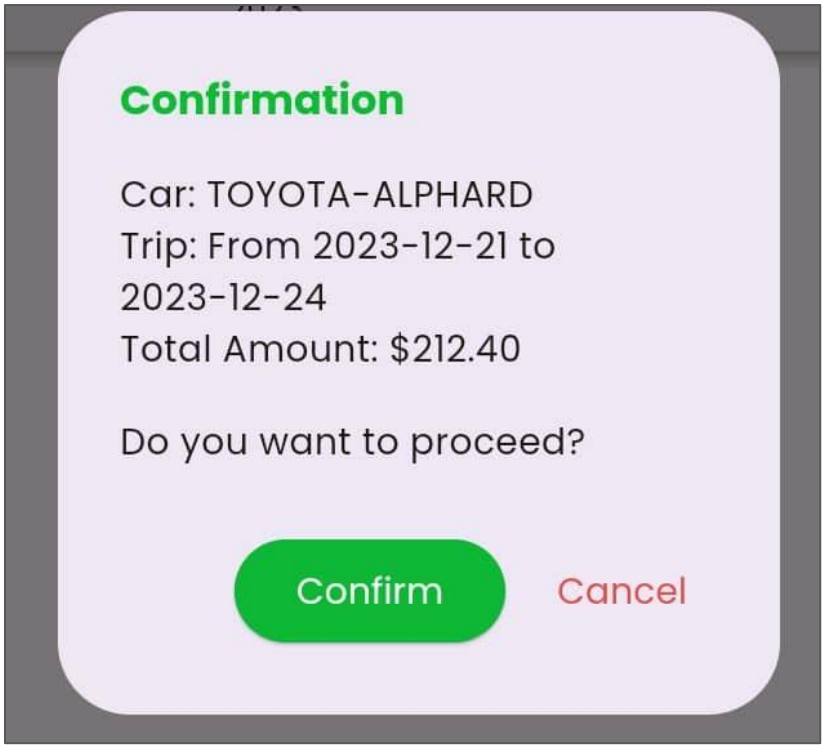
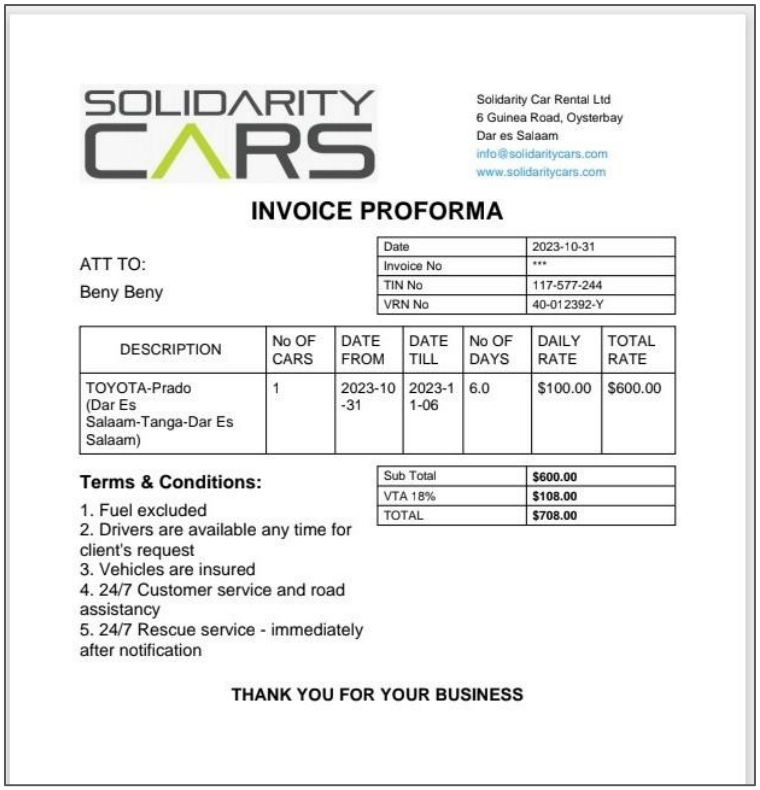


Figure 30: Car reservations confirmations

Once the reservation is confirmed, the system automatically generates a proforma invoice for the customer. This invoice outlines the total rental cost along with any applicable terms and conditions based on the company's policies. Figure 31 displays the proforma invoice produced by the system.



SOLIDARITY CARS

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Dar es Salaam
info@solidaritycars.com
www.solidaritycars.com

INVOICE PROFORMA

ATT TO:
Beny Beny

Date	2023-10-31
Invoice No	***
TIN No	117-577-244
VRN No	40-012392-Y

DESCRIPTION	No OF CARS	DATE FROM	DATE TILL	No OF DAYS	DAILY RATE	TOTAL RATE
TOYOTA-Prado (Dar Es Salaam-Tanga-Dar Es Salaam)	1	2023-10-31	2023-11-06	6.0	$100.00	$600.00

Terms & Conditions:

1. Fuel excluded
2. Drivers are available any time for client's request
3. Vehicles are insured
4. 24/7 Customer service and road assistancy
5. 24/7 Rescue service - immediately after notification

Sub Total	**$600.00**
VTA 18%	**$108.00**
TOTAL	**$708.00**

THANK YOU FOR YOUR BUSINESS

Figure 31: Results of preform invoice

(iii) Payment

The payment functionality within the mobile app ensures a seamless and secure transaction process for customers. After confirming a reservation, users can choose their preferred mobile payment method such as M-Pesa, Tigo Pesa, or Airtel Money. They securely input their payment details within the app, maintaining the privacy of their financial information. Once the transaction is complete, the system automatically issues a comprehensive invoice, detailing daily charges and the full payment breakdown. Customers receive immediate confirmation and access to their finalized booking. Figure 32 depicts the payment process.

Table 3: System testing results for payment integration

Test Parameter	Expected Outcome	Results
Payment Method Selection	Users can choose M-Pesa, Tigo-Pesa, or HaloPesa.	Successfully implemented.
Payment Instruction Display	Clear steps for completing payments are provided.	Fully functional.
Payment Proof Upload	Users can upload transaction proof.	Successfully implemented.
Staff Verification Process	Staff can validate payments via the web application.	Works as expected.
Automated Invoice Generation	The system sends invoices after successful verification.	Implemented successfully.

These results in Table 3 confirm that the payment process, though not directly integrated with mobile payment APIs, effectively supports secure and verifiable transactions while ensuring smooth booking management.

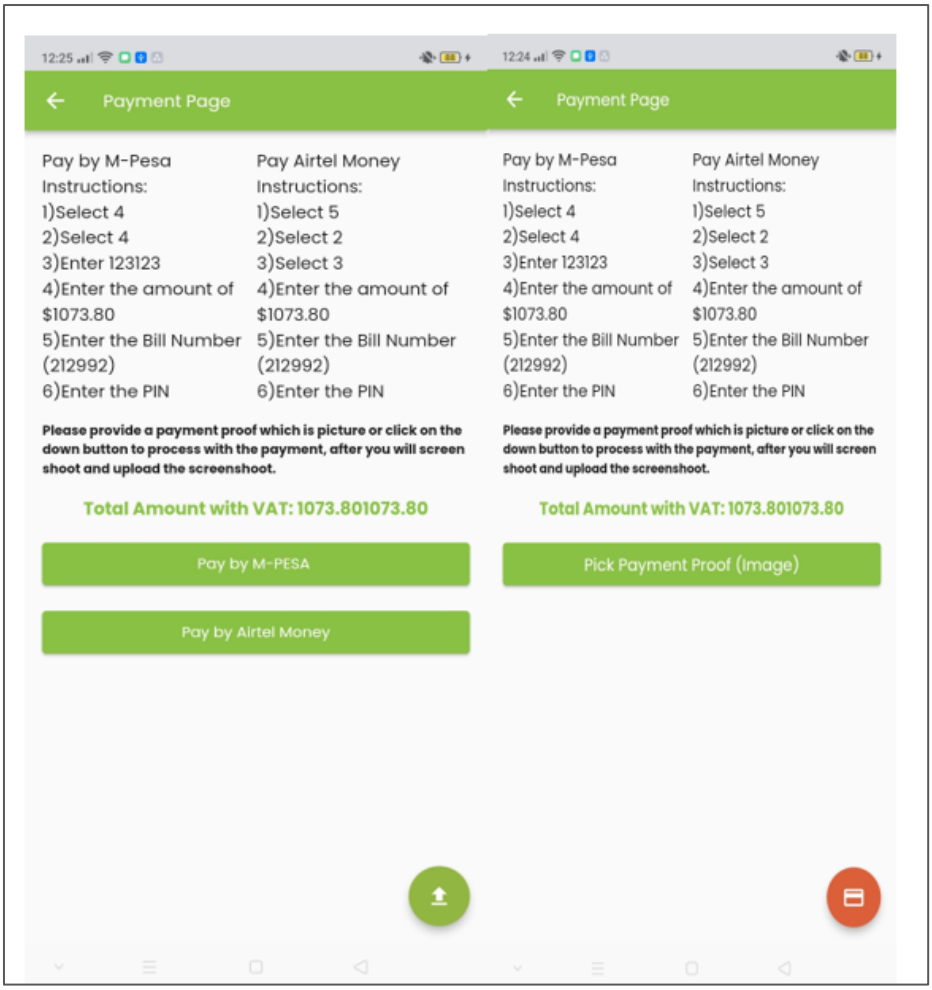

Figure 32: Results of mobile payments

4.5 Unit testing

The Each system module was tested individually to verify functionality and ensure expected performance. The testing covered essential features, including user authentication, reservation management, real-time car availability, secure online payments, report generation, and mobile app usability. Table 4 presents the unit testing results:

Table 4: Unit testing

Unit Testing Parameter	Expected Outcome	Results
User Authentication	Secure account creation and login	Pass
Car Reservation Management	Search, select, and manage bookings	Pass
Real-Time Car Availability	Display up-to-date car availability	Pass
Secure Online Payment	Enable mobile payments via M-Pesa, Tigo-Pesa, Airtel Money	Pass
Report Generation	Generate rental activity reports for analysis	Pass
Mobile App Usability	User-friendly interface for seamless interaction	Pass
Performance	Fast system response with minimal delays	Pass
Security	Ensure data protection and secure transactions	Pass
Reliability	System operates without failures or disruptions	Pass
Scalability	Supports increasing users and transactions efficiently	Pass
Usability	Easy-to-navigate design for better user experience	Pass
Accessibility	System accessible across multiple devices/platforms	Pass

These results confirm that the system meets the required standards, ensuring a smooth and secure car rental experience for both customers and company staff.

4.6 System testing

System testing was conducted to assess the full operation of the car rental management system, ensuring that all components work together effectively. The tests covered data accuracy, stability, networking, data storage, environmental adaptability, user accessibility, and power efficiency.

Table 5: System testing

System Testing Parameter	Expected Outcome	Results
Full System Operation	All system modules (booking, payment, reports, notifications) function properly	Pass
Data Accuracy and Consistency	Information is stored, retrieved, and displayed correctly across devices	Pass
Data Transmission and Networking	Seamless communication between web, mobile app, and cloud services	Pass
Data Storage and Retrieval	Efficient and secure database operations for storing and accessing data	Pass
User Interface and Accessibility	The interface is intuitive, responsive, and accessible on all platforms	Pass

4.7 User acceptance results

As part of the user acceptance validation process, feedback was collected from 56 individuals comprising 38 staff members of Solidarity Car Rental Limited, 12 corporate clients, and 6 individual clients. This feedback played a key role in evaluating the system's practical relevance and alignment with user expectations. The aim was to determine whether the system met user requirements and was suitable for real-world application. Details of the questionnaire used can be found in Appendix 3. According to the results illustrated in Fig. 31, Microsoft Excel was used for data analysis. The system scored 97% for performance, indicating strong efficiency and responsiveness. In terms of usability, it achieved 83%, reflecting an intuitive user interface. Accessibility was rated at 82%, showing its suitability for a wide range of users. Lastly, the system scored 91% in security, highlighting the effectiveness of its data protection mechanisms. The system demonstrated strong performance across several key areas during the validation process. Accuracy, essential for ensuring precise and error-free operations, received a solid rating of 84%, indicating dependable functionality. Simplicity scored 87%, reflecting a user-centered and easy-to-navigate design. Availability reached 92%, emphasizing the platform's consistent uptime and dependable access. These findings confirm that the system effectively meets user expectations, enhances overall satisfaction, and successfully supports

the operational needs of both clients and company personnel, validating its effective development and deployment.

Table 6: User acceptance results

Tested parameter	Respondents				
	5-Strongly Agree	**4-Agree**	**3-Neutral**	**2-Disagree**	**1-Strongly**
The cloud-based integrated information system operates in accordance with the requirements	94%	6%	0%	0%	0%
The system provides strong security measures to protect user data and rental data.	91%	9%	0%	0%	0%
The system is user friendly and highly reliable	89%	8%	3%	0%	0%
The system is fast and responsive	97%	3%	0%	0%	0%
The system allows users to manage reservations, approve payments and access all needed data	100%	0%	0%	0%	0%
The web application can generate invoices and weekly report or whenever necessary	100%	0%	0%	0%	0%

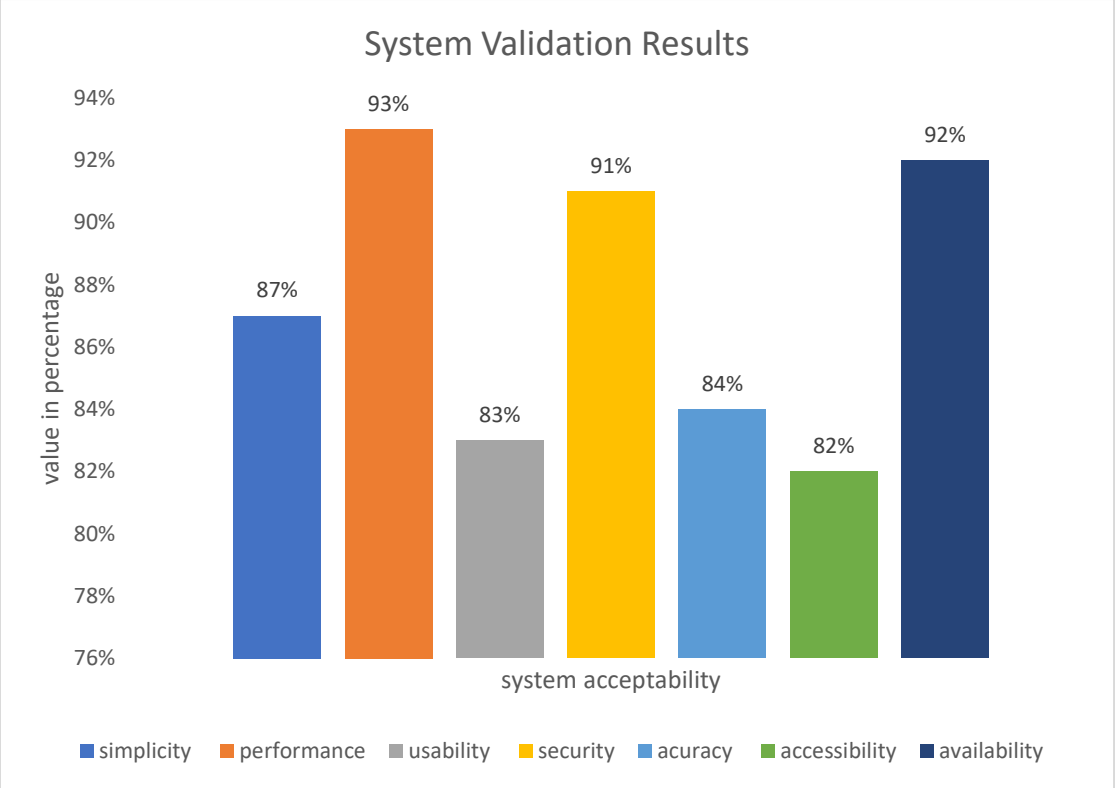

Figure 33: System validation results

4.8 Discussion

The implementation of a cloud-based integrated information system at Solidarity Car Rental represents a significant transformation in the company's operations. This system has reshaped both customer engagement and internal workflow, improving efficiency and delivering a better user experience (Singh, 2023). Through a secure and intuitive mobile application, clients can easily explore available vehicles, place bookings, and complete payments. On the backend, the system automates invoicing, facilitates real-time reporting, and streamlines vehicle management, allowing the organization to make quicker, more informed decisions. Robust security features, such as encryption and secure payment gateways, safeguard sensitive customer data (Stripe, 2023). Built on Azure, the system benefits from strong scalability and smooth integration, which enhance both security and performance (Chapple, 2021). Furthermore, SMS notifications play a key role in customer interaction, automated reminders before rental deadlines encourage timely returns, helping reduce delays and maintain operational flow. Overall, this technology-driven solution addresses existing inefficiencies and strengthens Solidarity Car Rental's position as a leader in Tanzania's evolving car rental market.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The developed cloud-based integrated information system for car rental services constitutes a big step forward in car rental management. The technology has proved its potential to transform the way car rental businesses work via rigorous design and implementation. The system optimizes the entire rental process by smoothly integrating important modules such as web application, payment, SMS Alerts and mobile app capability. This optimization not only streamlines processes but also improves customer service, providing clients with a more seamless and gratifying experience and applying security measures to protect customer and rental data. Furthermore, the system's rapid development style ensures that it properly corresponds with the specific needs of car rental companies. This tailored approach ensures the system's adaptability, allowing it to evolve in alongside with the industry's dynamic needs. As a result, this unique solution is positioned to not only improve the efficiency and income creation of car rental firms, but also their market competitiveness, marking a significant step forward in the evolution of car rental management systems.

5.2 Recommendations

5.2.1 Implication to the policy makers

The implementation of Solidarity Car Rental's cloud-based integrated information system offers key insights for Tanzanian stakeholders. The Ministry of Works and Transport and local authorities should promote digital platforms in car rental services to improve efficiency and service delivery. The Tanzania Communications Regulatory Authority (TCRA) and TZ-CERT are urged to strengthen data security regulations for cloud-based systems. Meanwhile, COSTECH and the Ministry of Information, Communication and Information Technology can support similar innovations through funding and infrastructure. Finally, private car rental firms are encouraged to adopt such systems to modernize operations and enhance customer satisfaction.

5.2.2 Impact on the practitioners

The successful deployment of the cloud-based integrated information system at Solidarity Car Rental offers valuable lessons for practitioners in the car rental industry. Car rental companies, IT departments, customer service teams, and fleet managers stand to benefit significantly from the implementation of this innovative system. To maximize the system's effectiveness, it is crucial to establish a comprehensive personnel training program. This program will empower employees with the skills and knowledge needed for a seamless integration into daily operations. Practitioners in similar enterprises are encouraged to consider the demonstrated benefits of this system as a strategic model for enhancing various aspects of their operations. The system proves instrumental in improving operational efficiency, elevating customer experience, and optimizing overall business performance. To fully harness its potential, practitioners should invest in the necessary infrastructure, ensuring robust IT support, adequate training resources, and ongoing technical assistance. It's important to note that reliable internet connectivity is a prerequisite for utilizing the system effectively. This project serves not only as a technological advancement but as a blueprint for practitioners seeking transformative solutions in the dynamic landscape of the car rental industry.

5.2.3 Limitations of the project

The project encountered limitations that stemmed from both time and budget constraints. Additionally, challenges were faced in integrating the Payment API for mobile banking due to stringent government regulations. Specifically, the government's security measures prohibited providing students access to the Payment API, ensuring the safeguarding of sensitive financial data. Despite these limitations, the project successfully met its requirements, demonstrating resilience and effective management within the given constraints.

5.2.4 Future work

The future work involves integrating IoT sensors into the cloud-based integrated information system for real-time data on rental car conditions, enabling predictive maintenance plans and enhancing overall efficiency. Additionally, implementing a module for managing maintenance charges will offer insights into each vehicle's financial dynamics. Security measures will be a crucial focus in future developments, including features like GPS tracking and geofencing to prevent potential losses during the rental period. This comprehensive approach ensures the

system's resilience and security, contributing to its long-term success in the dynamic car rental services landscape.

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APPENDICES

Appendix 1: Interview guide

Nelson Mandela Africa Institution of Science and Technology

Project Title: Development of Cloud-Based Integrated Information System for Car Rental Services: A Case of Solidarity Car Rental Limited

Section A. Demographics data

1. Can you please share your gender? (Male / Female)
2. . Are you a client or a staff member of Solidarity Car Rental? (Client / Staff)
3. Have you rented a car from Solidarity Car Rental before? (Client only)
4. If yes, how frequently do you rent a car? (Occasionally / Monthly / Weekly / Daily)
5. What is your role at Solidarity Car Rental? (Staff only)
6. How long have you worked at Solidarity Car Rental? (Staff only)

Section B. Preferences for Car Rental Reservation Methods

7. How do you usually prefer to make a car rental reservation? (Online (Website or Mobile
8. App) / In-person / Phone/Call)
9. What factors influence your choice of reservation method?

Section C. Preferences for payments methods

1. How do you feel about the payment options provided by the car rental services? (I prefer mobile payments like M-Pesa, Airtel money, Halotel-Pesa / I prefer using credit or debit cards / I prefer paying in person when picking up the car / I would like more payment options)
2. What challenges, if any, have you faced with the current payment options?
3. Would you consider using an automated digital payment system integrated with the booking process? (Yes / No / Not sure)

Section D. Customer preferences for mobile application features

1. What features would you like to see in a mobile application for managing your car rentals? (Easy search for car availability / Booking history / Real-time updates on reservation status / Payment tracking and invoices / Booking cancellation or modification options)
2. How important is it for you to view car images before making a reservation? (Very important / Somewhat important / Not important)
3. Do you prefer having an option to view car availability across different regions or locations? (Yes / No)
4. Would you find it helpful to receive reminders or updates regarding your booking? (Yes / No)

Section E. Willingness to adopt new system

1. How open are you to the idea of incorporating new technologies into the current car rental system? (Very open / Somewhat open / Not open)
2. Would you be willing to adopt a cloud-based integrated information system for car rental services at Solidarity Car Rental? (Yes / No / Need more information)
3. What concerns, if any, would you have about using a cloud-based system for car rentals? (Data security / Ease of use / Reliability / Other - Please specify)

Thank you for participating in this interview!

Appendix 2: Focus group discussion guide

Nelson Mandela Africa Institution of Science and Technology

Project Title: Developing Cloud-Based Integrated Information System with A Mobile App Interface: A Case of Solidarity Car Rental Limited

Section	Questions
A. Opening	1. Tell us your names
B. Introduction	2. How often do you interact with customers using car rental services, and what are the common challenges you observe?
C. Transition	3. What are some of the operational challenges you face in managing car rentals, and how do you currently address them? 4. In your opinion, how can the current car rental system be improved? 5. What benefits do you think the proposed system would bring to Solidarity Car Rental in terms of operational efficiency?
D. Key	6. How do you envision the proposed system facilitating your daily tasks and responsibilities at Solidarity Car Rental? 7. What measures do you think should be in place to ensure the security of customer and rental data in the proposed system? 8. How do you think the proposed system could enhance customer satisfaction, and what features would contribute to this?
E. Ending	9. In your experience, what role does a mobile app play in customer interactions, and what features should it incorporate? 10. If you were to suggest one improvement for Solidarity Car Rental Limited, what would it be and why?
Thank you all for your participation in this focus group discussion!	

Appendix 3: Focus group discussion guide

The Nelson Mandela African Institution of Science and Technology

Project Title: Development of Cloud-Based Integrated Information System for Car Rental: A Case of Solidarity Car Rental Limited

Consent:

By clicking Yes, you consent that you are willing to answer the questions in this survey.

Yes ☐ No ☐

Instruction: Fill the following form by check √ and honestly rate yourself on how the developed system has meet the requirements by applying the following scales.

5-Strongly Agree 4-Agree 3-Neutral 2- Disagree 1- Strongly Disagree

S/N	Existing Monitoring System	5	4	3	2	1
1.	The cloud-based integrated information system operates in accordance with the requirements					
2.	The system provides strong security measures to protect user data and rental data.					
3.	The system is user friendly and highly reliable					
4.	The system is fast and responsive					
5.	The system allows users to manage reservations, approve payments and access all needed data					
6.	The web application can generate invoices and weekly report or whenever necessary					

Appendix 4: Source Code for the Cloud-Based Integrated Car Rental System

A. Codes for web application

```php
<?php
defined('BASEPATH') OR exit('No direct script access allowed');
 /**
 *@author:    Thacy le 01/10/2023
 * Email:     tuyambazet@nm-aist.ac.tz
*/
class Employee extends MY_Controller {

    function __construct(){
        parent::__construct();
        $this->not_logged_in();
      }

    public function index()
    {

     if(!in_array('viewEmployee', $this->permission)) {
        redirect('Dashbord');
       }

        $data['Employees']=$this->Model->readRequete('SELECT e.*,g.group_name,u.isActive,u.isLocked FROM
             employees e JOIN groups g ON e.idGroup=g.idGroup JOIN user_group u ON e.EmployeeID=u.idUser
             WHERE 1');
        $data['groups']=$this->Model->read('groups');
        $this->load->view('Employee_View',$data);
    }

    function create(){
        if(!in_array('createEmployee', $this->permission)) {
        redirect('Dashbord');
       }

        $idGroup=$this->input->post('idGroup');
        $FirstName=$this->input->post('FirstName');
        $LastName=$this->input->post('LastName');
        $Email=$this->input->post('Email');
        $Phone=$this->input->post('Phone');
        $Username=$this->input->post('Username');
```

```php
        $data=array('idGroup'=>$idGroup,
                    'FirstName'=>$FirstName,
                    'LastName'=>$LastName,
                    'Email'=>$Email,
                    'Phone'=>$Phone,
                    // 'Username'=>$Username,
                   );
      $idUser=$this->Model->createLastId('employees',$data);
      $session=array('idUser'=>$idUser,
                     'idGroup'=>$idGroup,
                     'username'=>$Email,
                     'password'=>$this->password_hash('Solidarity@2023'),
                    );
      $rsp=$this->Model->create('user_group',$session);

        if ($rsp>0) {
            $sms['sms']='<div class="alert alert-background fade show mt-1 message" role="alert">
                            <strong>Waouh!</strong> Employee created successfully.
                        </div>';
        }else{
            $sms['sms']='<div class="alert alert-background fade show mt-1 message" role="alert">
                            <strong class="text-danger">Oups!</strong> An unknown error, contact
                                admin!.
                        </div>';
        }
        $this->session->set_flashdata($sms);
        redirect(base_url('Employee'));
    }

    function update(){
        if(!in_array('updateEmployee', $this->permission)) {
        redirect('Dashbord');
       }
        $EmployeeID=$this->input->post('EmployeeID');
        $idGroup=$this->input->post('idGroup');
        $FirstName=$this->input->post('FirstName');
        $LastName=$this->input->post('LastName');
        $Email=$this->input->post('Email');
```

```
        $rsp=$this->Model->update('employees',['EmployeeID'=>$EmployeeID],$data);
        $this->Model->update('user_group',['idUser'=>$EmployeeID],['username'=>$Email,'idGroup'=>$
            idGroup]);
        if ($rsp) {
            $sms['sms']='<div class="alert alert-background fade show mt-1 message" role="alert">
                            <strong>Waouh!</strong> Employee updated successfully.
                        </div>';
        }else{
            $sms['sms']='<div class="alert alert-background fade show mt-1 message" role="alert">
                            <strong class="text-danger">Waouh!</strong> An unknown error, contact
                                admin!.
                        </div>';
        }
        $this->session->set_flashdata($sms);
        redirect(base_url('Employee'));
    }

    function delete(){
        if(!in_array('deleteEmployee', $this->permission)) {
        redirect('Dashbord');
       }
        $EmployeeID=$this->input->post('EmployeeID');
        $rsp=$this->Model->delete('employees',['EmployeeID'=>$EmployeeID]);
        $rsp=$this->Model->delete('user_group',['idUser'=>$EmployeeID]);

        if ($rsp) {
            $sms['sms']='<div class="alert alert-background fade show mt-1 message" role="alert">
                            <strong>Waouh!</strong> Employee deleted successfully.
                        </div>';
        }else{
            $sms['sms']='<div class="alert alert-background fade show mt-1 message" role="alert">
                            <strong class="text-danger">Waouh!</strong> An unknown error, contact
                                admin!.
                        </div>';
        }
        $this->session->set_flashdata($sms);
        redirect(base_url('Employee'));
    }
```

B. Codes for Mobile app

```
plugins {
    id "com.android.application"
    id "kotlin-android"
    id "dev.flutter.flutter-gradle-plugin"
}

def localProperties = new Properties()
def localPropertiesFile = rootProject.file('local.properties')
if (localPropertiesFile.exists()) {
    localPropertiesFile.withReader('UTF-8') { reader ->
        localProperties.load(reader)
    }
}

def flutterVersionCode = localProperties.getProperty('flutter.versionCode')
if (flutterVersionCode == null) {
    flutterVersionCode = '1'
}

def flutterVersionName = localProperties.getProperty('flutter.versionName')
if (flutterVersionName == null) {
    flutterVersionName = '1.0'
}

android {
    namespace "com.example.car_rent_app"
    compileSdkVersion flutter.compileSdkVersion
    ndkVersion flutter.ndkVersion
```

```
android {
    namespace "com.example.car_rent_app"
    compileSdkVersion flutter.compileSdkVersion
    ndkVersion flutter.ndkVersion

    compileOptions {
        sourceCompatibility JavaVersion.VERSION_1_8
        targetCompatibility JavaVersion.VERSION_1_8
    }

    kotlinOptions {
        jvmTarget = '1.8'
    }

    sourceSets {
        main.java.srcDirs += 'src/main/kotlin'
    }

    defaultConfig {
        // TODO: Specify your own unique Application ID (https://developer.android.com/studio/build/application-id.ht
        applicationId "com.example.car_rent_app"
        // You can update the following values to match your application needs.
        // For more information, see: https://docs.flutter.dev/deployment/android#reviewing-the-gradle-build-configur
        minSdkVersion 21
        targetSdkVersion flutter.targetSdkVersion
        versionCode flutterVersionCode.toInteger()
        versionName flutterVersionName
    }
```

Appendix 4: Poster Presentation

CLOUD-BASED INTEGRATED INFORMATION SYSTEM FOR CAR RENTAL SERVICES: THE CASE OF SOLIDARITY CAR RENTAL LIMITED

Thacianne Tuyambaze[1] Dr. Bonny Mgawe[2] Dr. Elizabeth Mkoba[3]

Nelson Mandela African Institution of Science and Technology

Introduction

Using technology has allowed businesses to improve profitability by streamlining processes, boosting productivity, and cutting costs.

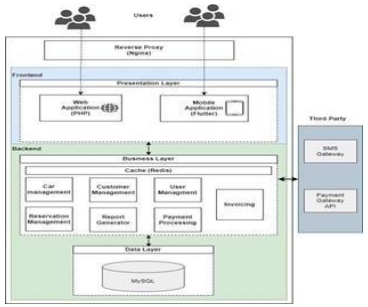
Car rental businesses have been using technology to improve their operations, with the use of mobile applications and management systems becoming more common.

However, managing car rental services is difficult, particularly when dealing with multiple bookings, monitoring car availability, poor system integration, and managing customer feedback.

Problem statement

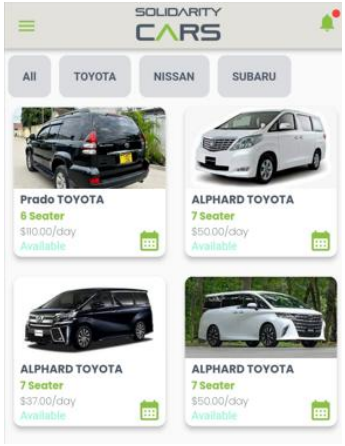
- Lack of integration of important modules which result in inefficient and time-consuming manual processes.
- Paper based handling car rental operations, overbookings, and lack of reminders to return cars
- Lack of adequate security measures to protect sensitive customer and rental data

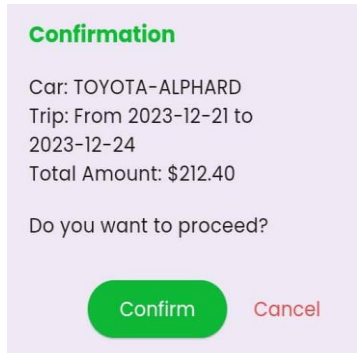
Methods

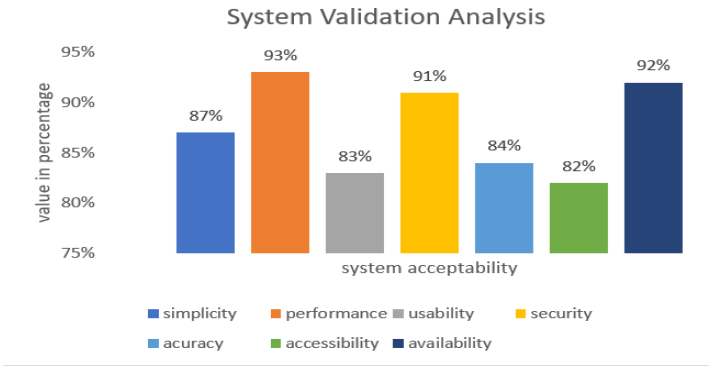


Results

The system streamlines car rental operations by integrating key modules web application, payment, SMS alerts, and mobile app features while enhancing customer experience and data security. Its rapid, tailored development ensures adaptability to industry needs, boosting efficiency, revenue, and competitiveness for car rental companies."







Conclusion

The developed cloud-based integrated information system with for car rental services constitute a big step forward in car rental management. The system optimizes the entire rental process by smoothly integrating important modules and ensure the security of customer and rental data.

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3. Khan. (2020). Car Rental Management System. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 8(6), 5. /Ijraset.2020.6185