

UTHM Bicycle Rental Management System

Nazlia Afniza Jamaluddin¹, Firkhan Ali Hamid Ali^{1*}

¹ Faculty of Computer Science and Information Technology,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author: firkhan@uthm.edu.my

DOI: <https://doi.org/10.30880/aitcs.2026.07.01.029>

Article Info

Received: 14 June 2025

Accepted: 18 June 2026

Available online: 30 June 2026

Keywords

Bicycle rental management, Real-time availability, Web-based application, Online reservations

Abstract

The UTHM Bicycle Rental Management System is a web-based platform developed to address the inefficiencies in the current manual bicycle rental process at Universiti Tun Hussein Onn Malaysia (UTHM). This system aims to streamline rental operations and improve user satisfaction by providing features such as real-time bicycle availability and online reservations. Leveraging PHP for backend development, along with HTML, CSS, and JavaScript for the frontend, and MySQL for database management, the system offers a secure, scalable, and user-friendly interface. It utilizes the Agile methodology for iterative development, ensuring that user feedback is incorporated throughout the process. Key outcomes include reducing delays, minimizing manual workload, and enhancing operational efficiency. The system supports sustainable campus transportation and demonstrates the potential of digital solutions in transforming resource management. Future enhancements could expand its usability to broader contexts while integrating advanced analytics for better decision-making.

1. Introduction

Bicycle rental services have become an integral part of campus life, offering students, lecturers, and staff a convenient and sustainable means of transportation. At Universiti Tun Hussein Onn Malaysia (UTHM), the current manual bicycle rental system faces several challenges, particularly during peak hours. These challenges include delays, difficulties in managing availability, and a lack of real-time updates, which often lead to user dissatisfaction. The inefficiency of this manual process, coupled with issues such as conflicts over bicycle selection, unavailable bicycles, and inadequate maintenance reporting, highlights the urgent need for a digital solution.

The proposed UTHM Bicycle Rental Management System is a web-based platform designed to address these challenges by automating and optimizing the rental process. This system integrates features such as real-time availability tracking, online reservations, and a streamlined maintenance reporting mechanism. By transitioning from a paper-based system to a fully digital framework, the platform improves operational efficiency, reduces administrative workload, and enhances the overall user experience.

Currently, students and staff rely on this service not only for transportation but also for recreational purposes. However, the limitations of the manual system, including delays and errors in record-keeping, make it less reliable during periods of high demand. Moreover, the absence of automated maintenance tracking has resulted in unsafe or unavailable bicycles being rented out, further frustrating users and staff.

To overcome these challenges, the UTHM Bicycle Rental Management System aims to provide a seamless, user-friendly digital experience. Its features enable users to check bicycle availability, make online reservations, and report maintenance issues directly through the platform. By automating key processes, the system reduces errors, prevents conflicts over bicycle selection, and supports sustainable transportation initiatives within the campus community. This project not only addresses the inefficiencies of the current manual system but also sets

a foundation for future enhancements, demonstrating the potential of digital solutions to improve campus services.

2. Related Work

In this section, the related work of the proposed UTHM Bicycle Rental Management System will be discussed. This section will illustrate research on literature review, definition, and theory related to the proposed system. The topics that will be discussed are bicycle rental systems, real-time tracking technology, and web-based applications.

2.1 Bicycle Rental Systems

All Bicycle rental systems have become an essential part of urban and campus transportation due to their role in promoting sustainable mobility. These systems provide users with an efficient and affordable alternative to private vehicles, reducing traffic congestion and environmental pollution. Traditionally, bicycle rental systems operated through manual processes, requiring users to visit physical rental stations to fill out paperwork and secure a bicycle. However, advancements in technology have transformed these systems into digital platforms that provide seamless and automated processes [1].

Digital bicycle rental systems integrate features such as real-time availability tracking, reservation management, and maintenance reporting to address common inefficiencies. The lack of real-time data in traditional systems often results in users arriving at stations only to find no bicycles available. Real-time data, as highlighted in [1], plays a critical role in optimizing operations by providing users and administrators with instant access to accurate information, reducing delays and improving user satisfaction.

Campus-based bicycle rental systems, in particular, require tailored designs to meet the needs of students and staff. As noted in [2], customization in designing bicycle rental systems for academic environments, including simplified booking processes and user-friendly interfaces, is crucial for widespread adoption. The UTHM Bicycle Rental Management System incorporates lessons from these studies by offering a platform that prioritizes efficiency, user experience, and the specific transportation needs of a campus community.

2.2 Real-Time Bicycle Tracking

Real-time tracking technology is a cornerstone of modern resource-sharing systems. By enabling the instant monitoring of resource status and availability, it addresses the inefficiencies inherent in manual systems. In the context of bicycle rentals, real-time tracking ensures that users can view the current availability of bicycles at any location, minimizing the chances of conflicts or wasted trips [1], [3].

The integration of real-time tracking systems not only boosts operational efficiency but also enhances user trust in the service by providing transparency [1]. Moreover, the integration of dynamic server-side scripting and database systems improves the reliability and accuracy of real-time updates [3]. These technologies form the backbone of the UTHM Bicycle Rental Management System, allowing users and administrators to access up-to-date information on bicycle availability, reservations, and maintenance needs.

Real-time tracking also facilitates proactive maintenance by alerting administrators to issues such as overdue returns or malfunctioning bicycles. This ensures that the fleet remains in optimal condition, contributing to user safety and satisfaction. By incorporating this technology, the proposed system addresses a major gap in existing manual and semi-automated systems [3].

2.3 Web-Based Applications

Web-based applications have revolutionized how users interact with services by eliminating the need for local installations. These applications can be accessed via any internet-connected device, offering unparalleled convenience and accessibility. Web-based platforms use client-side and server-side technologies, such as HTML, CSS, JavaScript, and PHP, to deliver dynamic and responsive user experiences [4].

One of the key advantages of web-based systems is their ability to support multiple users simultaneously. This is particularly beneficial for services like bicycle rentals, where users, staff, and administrators need to interact with the platform in real-time. As noted in [4], web-based platforms simplify collaboration, reduce operational costs, and enhance scalability, making them ideal for systems that serve large and diverse user bases.

The UTHM Bicycle Rental Management System leverages these benefits by providing a centralized platform that supports real-time reservations, availability tracking, and maintenance reporting. Additionally, the system is designed to be mobile-friendly, ensuring that users can access it conveniently from their smartphones, tablets,

or laptops. Such accessibility fosters user engagement and satisfaction, particularly in environments like university campuses where mobility and convenience are priorities [5].

2.4 Comparison Existing Systems with the Proposed System

The comparison of features between the proposed UTHM Bicycle Rental Management System and three existing systems which are Your DIY Project Rental, Dressaville, and TK Rentals are conducted to analyze similarities and differences. This comparative analysis highlights how the proposed system overcomes the limitations of the existing systems, ensuring a comprehensive, user-friendly, and efficient rental experience. Table 1 shows the feature comparison between the proposed UTHM Bicycle Rental Management System and three existing systems in terms of functionality and support.

Table 1 Comparison Existing Systems with the Proposed System

Features	Your DIY Project Rental	Dressaville	TK Rentals	UTHM Bicycle Rental Management System
Registration/Login	No	Yes	No	Yes
Inventory Management	Yes	Yes	No	Yes
Product Catalog	Yes	Yes	Yes	Yes
Online Reservation	No	Yes	No	Yes
Online Payment	No	No	No	Yes
Rental History	No	No	No	Yes
Reporting	No	No	No	Yes
Reservation Notifications	No	Yes	No	Yes
Report Generation	No	No	No	Yes

3. Methodology/Framework

The development of the UTHM Bicycle Rental Management System employs the Agile methodology, a flexible and iterative approach tailored to dynamic software development projects. Agile focuses on delivering incremental progress through iterative cycles, known as sprints, each lasting 2-4 weeks. This approach is especially suitable for this project as it ensures the system evolves based on real-time feedback, addressing user needs and adapting to any changes throughout the development process.

Agile methodology emphasizes collaboration, adaptability and transparency. Stakeholders, including potential users, administrators, and developers, are actively involved at every stage of the project. This involvement ensures the system aligns with user expectations and meets functional and non-functional requirements effectively. Continuous feedback loops are integral to this methodology, promoting iterative improvements and reducing the risk of major setbacks at later stages.

Table 2 illustrates the overall system development workflow based on the Agile methodology, outlining each major phase from requirements gathering to deployment. It summarizes the main activities, objectives, and deliverables involved in building the UTHM Bicycle Rental Management System in a structured and iterative manner.

Table 2 System Development Workflow

Phase	Description	Deliverables
-------	-------------	--------------

Requirements Phase	Stakeholder discussions to identify user needs and document functionalities	Requirement specification document, functional and non-functional requirements tables
Design Phase	Creation of system architecture, Entity Relationship Diagrams (ERDs), and user interface mockups	System architecture diagrams, ERD, UI design
Development Phase	Incremental coding of modules like user registration, bicycle tracking, and reservation features	Fully functional modules, integration of front-end and back-end systems
Testing Phase	Iterative testing for functionality, performance, and user acceptance validation	Test cases, test reports, and a list of resolved bugs or improvements
Deployment Phase	Deployment to a live environment, configuration of servers, and user training	Live system, deployment documentation, user manuals, and training materials

3.1 System Requirements

The system requirements analysis outlines both functional and non-functional needs, ensuring that the UTHM Bicycle Rental Management System aligns with the goals of its users and meets the operational demands of the campus environment. The requirements are categorized into functional requirements, which describe the core functionalities the system must perform, and non-functional requirements, which specify the quality attributes and constraints of the system.

Table 3 *Functional Requirements*

Module	Description
User Registration	- Allow users to create a new account by providing necessary details - Displays error messages for invalid or incomplete inputs
User Login	- Permits users to log in using their email address and password - Notifies users if login credentials are incorrect
Bicycle Reservation	- Enables users to book bicycles based on current availability - Prevents duplicate reservations by updating availability in real-time
System Notifications	Send email alerts to users for reservation confirmations
Reports and Analytics	Generate data insights on rental trends and popular bicycles

Table 3 illustrates the functional requirements of the UTHM Bicycle Rental Management System, outlining the key system features necessary to support user registration, login, reservation, notifications, and analytics. These functions ensure that the system meets its primary objectives of enabling efficient bicycle booking and user interaction.

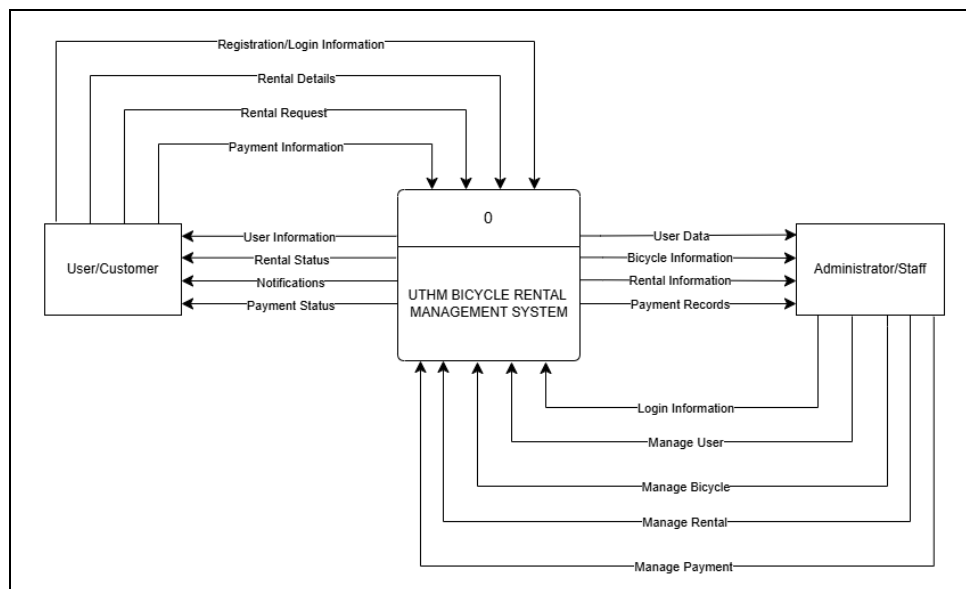
Table 4 *Non-Functional Requirement*

Requirements	Description
Usability	The system interface is intuitive and easy to use for both users and staff, with clear navigation
Performance	- The system should handle multiple concurrent users without significant lag - The system ensures real-time updates for bicycle availability
Reliability	The system must remain consistently available to users, ensuring reliable service
Security	- The system encrypts and securely stores user data - The system enforces role-based access controls, ensuring only staff can manage bicycle records
Scalability	The system should handle an increase in users, bicycles, or rental activity without performance degradation
Compatibility	The system is accessible on multiple devices, including desktop and mobile browsers

Table 4 presents the non-functional requirements, which define the system's expected quality attributes such as usability, performance, reliability, security, scalability, and compatibility. These requirements help ensure that the system not only functions properly but also deliver a smooth, secure, and responsive experience across different devices and user conditions.

3.2 System Analysis

This section provides a comprehensive analysis of the system's operations and data flow to ensure a clear understanding of the interactions and processes involved in the UTHM Bicycle Rental Management System. Various diagrams are used to model and visualize the system's structure, workflows, and relationships between components, enhancing the overall clarity and alignment with system objectives.

**Fig.1** *Context Diagram*

The context diagram offers a high-level representation of the system, illustrating its interactions with external entities such as users, administrators, and the database. This diagram provides a simplified overview of how data flows between the system and its stakeholders. Fig.1 illustrates the interactions between the UTHM Bicycle Rental Management System, users/customers, and administrators/staff. It depicts the flow of data and the main processes involved in the system's operations.

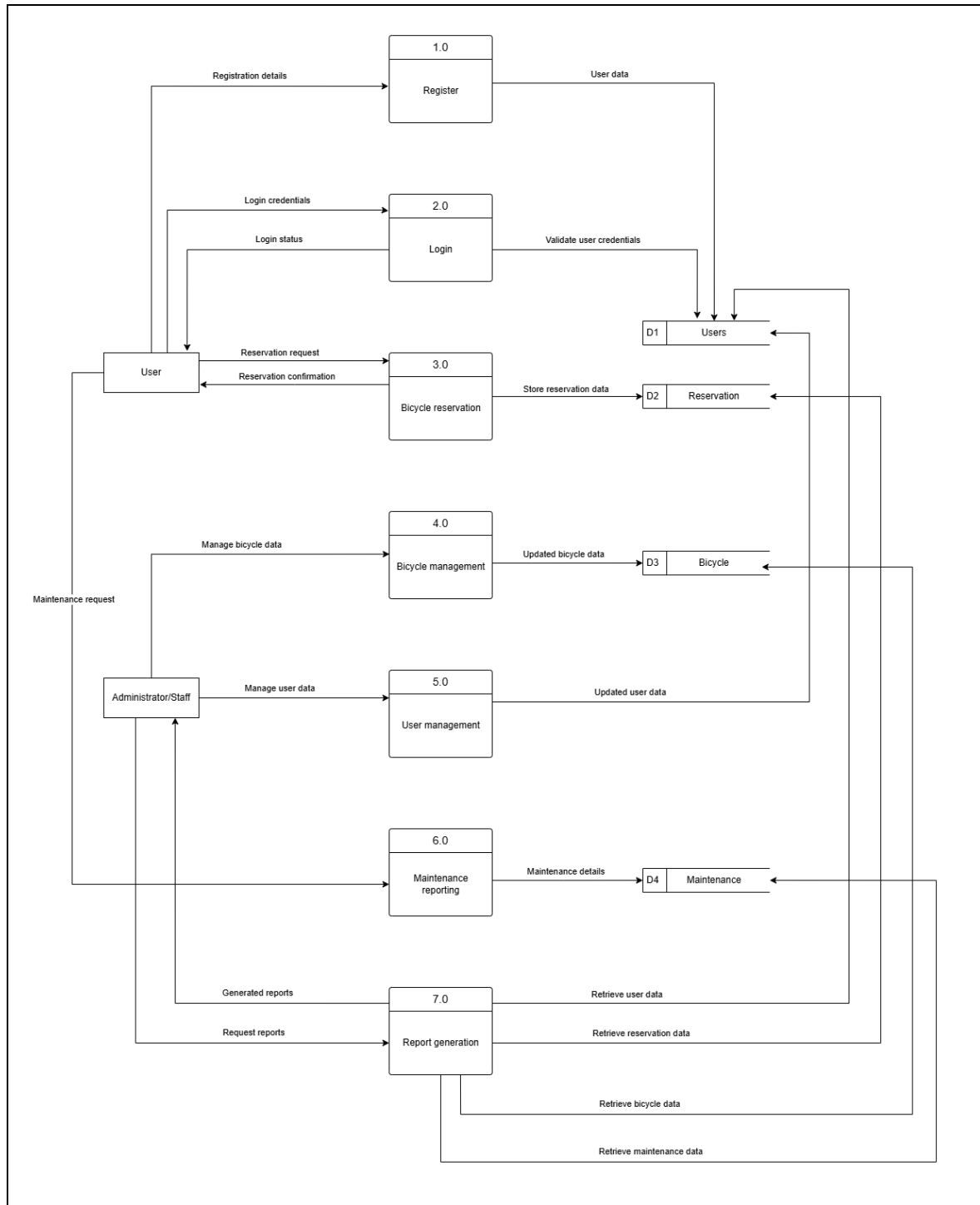


Fig.2 Data Flow Diagram (DFD Level 0)

Fig.2 shows the Data Flow Diagram Level 0 of UTHM Bicycle Rental Management System. The Data Flow Diagram (DFD Level 0) provides a high-level representation of the UTHM Bicycle Rental Management System, illustrating the primary processes, data flows, and external entities interacting with the system. This diagram expands upon the context diagram by breaking down the core functionalities of the system and detailing the flow of data between the system and its users or administrators. The Level 0 DFD focuses on capturing the key processes and the inputs and outputs associated with these processes without diving into the intricate details of how the processes are implemented.

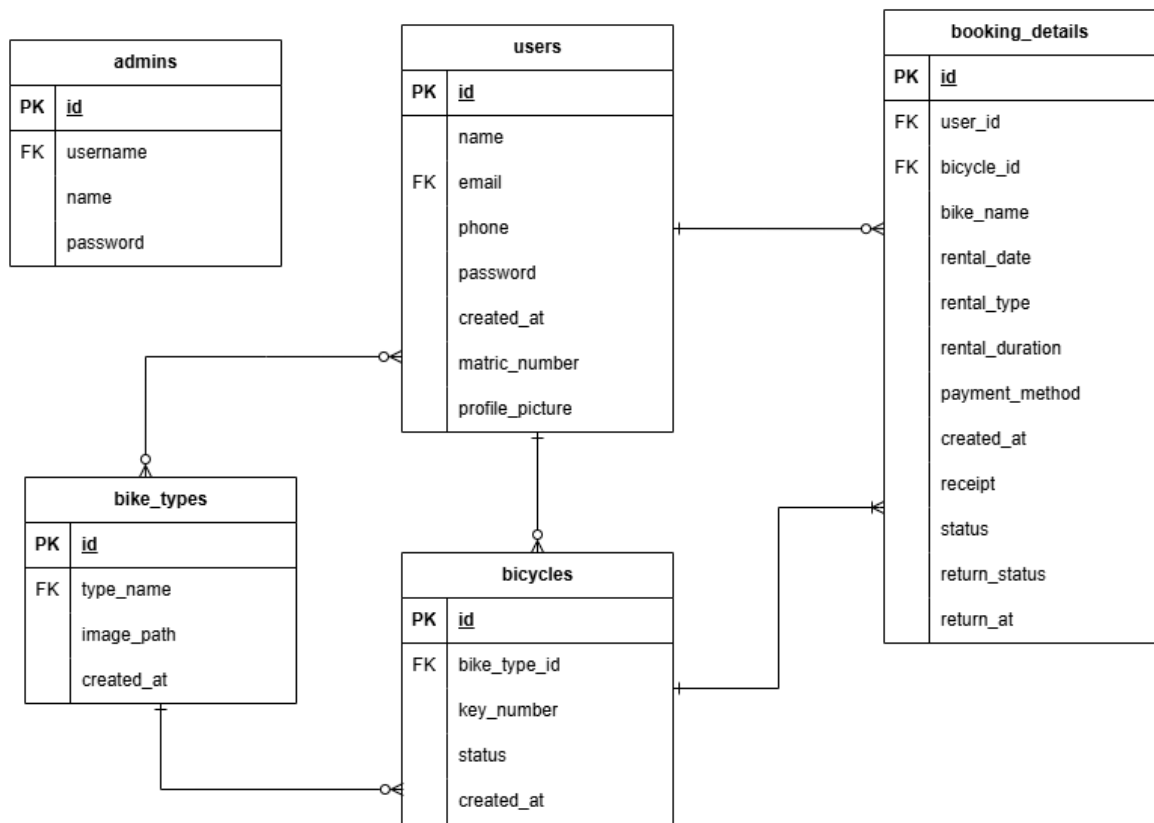


Fig.3 Entity Relationship Diagram (ERD)

The Entity Relationship Diagram (ERD) in Fig.3 is a visual representation of the data structure of the UTHM Bicycle Rental Management System. It models the relationships between key entities within the system, illustrating how data is stored, organized, and linked in the database. The ERD ensures that the system's database is designed efficiently, enabling seamless data retrieval and management.

The flowchart illustrates the step-by-step workflows for critical processes in the UTHM Bicycle Rental Management System, including user registration and login, bicycle reservation, maintenance reporting, and report generation. It provides a clear and concise visualization, ensuring that all processes are well-documented and aligned with user and system requirements.

3.3 System Design

The system design for the UTHM Bicycle Rental Management System is a critical phase in translating requirements into tangible solutions. This phase focuses on creating visual representations of the system's architecture, database, and user interfaces to ensure the seamless integration of components and an intuitive user experience.

The system architecture of the UTHM Bicycle Rental Management System defines the interaction between its key components, following a client-server model to ensure efficient operation and scalability. The client-side developed using HTML, CSS, and JavaScript, manages the front-end user interface, facilitating seamless user interactions such as registration, login, and bicycle reservations. The server-side, implemented with PHP, handles the back-end processes, including processing user requests, executing business logic, and communicating with the database. At the core of the architecture is the database layer, powered by MySQL, which securely stores and retrieves critical data such as user information, bicycle details, reservations, and payment records. This architectural design ensures a modular, scalable, and robust system that effectively supports the needs of both users and administrators.

The relational schema illustrates the logical organization and relationships within the system's database. It defines how data is structured, stored, and accessed, ensuring seamless interaction between the system components and efficient data management.

Table 5 Key Tables and Descriptions

Table	Description
users	Stores user account information such as user ID, name, email, phone number, password, matric number, profile picture, and account creation date.
admins	Holds admin login credentials, including admin ID, name, username, and hashed password. Used for system administration access.
bike_types	Contains metadata for bicycle categories, including the type name, an image path, and creation timestamp.
bicycles	Stores individual bicycle records with unique key numbers, rental status, and links to a specific bike type via foreign key (bike_type_id).
booking_details	Records all reservation transactions, including user ID, bicycle ID, rental type, rental date, duration, payment method, status, and return info.

Table 5 presents the key tables and their descriptions, detailing the purpose and structure of each core entity in the system's database. These tables form the foundation of the data layer, supporting essential operations such as user authentication, bicycle tracking, reservation processing, and administrative management. The well-defined schema ensures efficient data organization and seamless integration between frontend and backend components.

4. Implementation and Testing

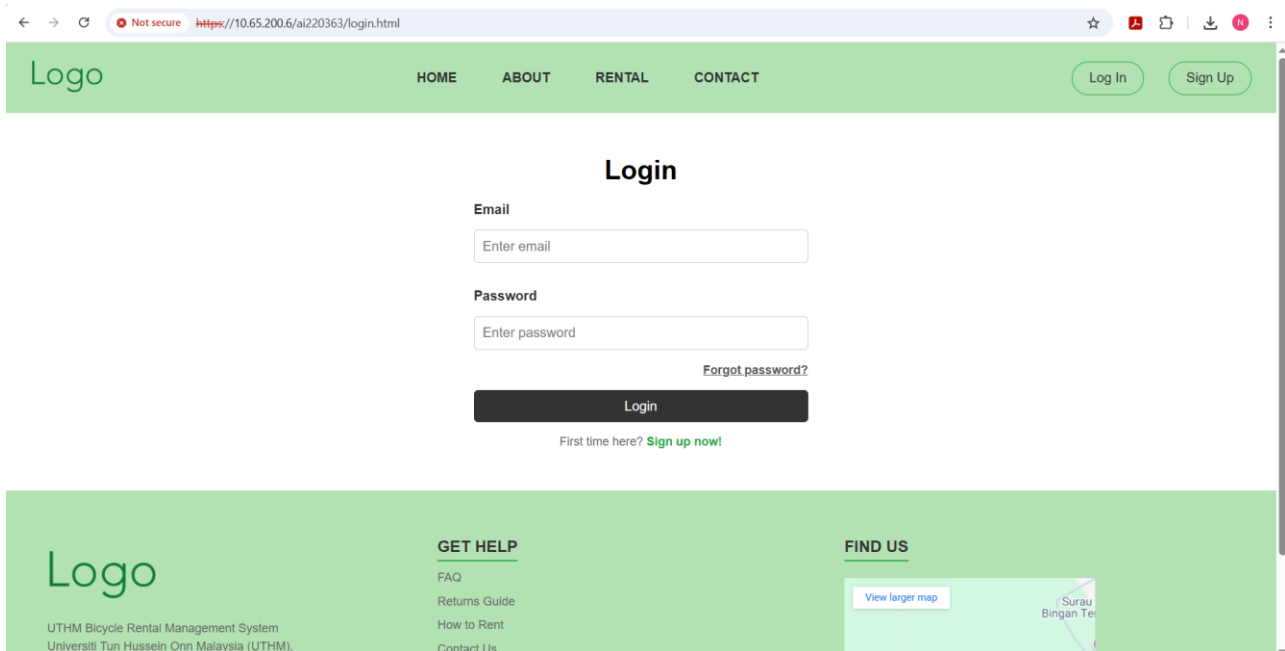
This section presents the outcomes of the system development process by showcasing the main features of the UTHM Bicycle Rental Management System through visual examples. Each figure included here reflects key parts of the system, such as the user registration page, login interface, bicycle booking form, admin dashboard, and reservation management tools. These visuals help illustrate how the system looks and functions from both the user and administrator perspectives. They serve to highlight how the system addresses user needs and improves overall operational flow within the bicycle rental process.

4.1 Implementation

The screenshot shows a web browser window with the URL <https://10.65.200.6/ai220363/signup.html>. The page has a green header bar containing a logo on the left, navigation links (HOME, ABOUT, RENTAL, CONTACT) in the center, and 'Log In' and 'Sign Up' buttons on the right. The main content area is titled 'Sign up' and contains four input fields: 'Name' (placeholder: Enter name), 'Email' (placeholder: Enter email), 'Phone number' (placeholder: Enter phone number), and 'Password' (placeholder: Enter password). Below these fields is a dark 'Register' button and a link 'Already have an account? Login here'.

Fig.4 User Sign-Up Interface

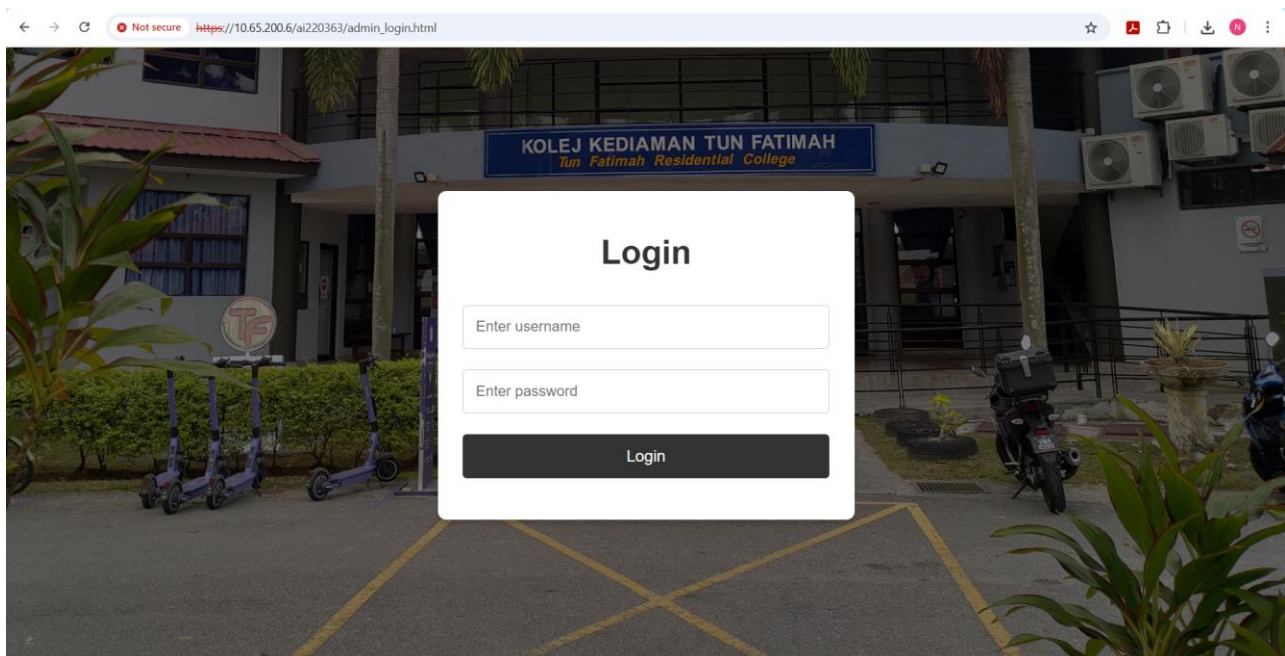
Fig.4 shows the User Sign-Up Interface. This page allows new users to create an account by entering their name, email, matric number (for students), phone number, and password. Validation is implemented to ensure correct input formats, especially for institutional email and numeric phone numbers. This page plays a key role in access control, ensuring that only verified users can proceed with the system.



The screenshot shows a web browser window with the URL <https://10.65.200.6/ai220363/login.html>. The page has a green header with a 'Logo' on the left and navigation links 'HOME', 'ABOUT', 'RENTAL', and 'CONTACT' in the center. On the right of the header are 'Log In' and 'Sign Up' buttons. The main content area is titled 'Login' and contains two input fields: 'Email' with the placeholder 'Enter email' and 'Password' with the placeholder 'Enter password'. Below the password field is a link for 'Forgot password?'. A dark 'Login' button is positioned below the inputs. At the bottom of the login section, it says 'First time here? [Sign up now!](#)'. The footer is green and contains a 'Logo' on the left, a 'GET HELP' section with links to 'FAQ', 'Returns Guide', 'How to Rent', and 'Contact Us', and a 'FIND US' section with a 'View larger map' button and a map snippet showing 'Surau Bingan Te'.

Fig.5 Login Interface

Fig.5 shows the Login Interface. It enables users to securely log in using their email and password. Invalid login attempts trigger error messages to guide the user. This login process is essential to protect the system and limit access to authorized individuals only.



The screenshot shows a web browser window with the URL https://10.65.200.6/ai220363/admin_login.html. The background is a photograph of the entrance to 'KOLEJ KEDIAMAN TUN FATIMAH' (Tun Fatimah Residential College), showing a building with a sign, palm trees, and parked motorcycles. Overlaid on this background is a white login form titled 'Login'. The form contains two input fields: 'Enter username' and 'Enter password'. Below these fields is a dark 'Login' button.

Fig.6 Admin Login Page

Fig.6 shows the Admin Login Page. This interface is exclusive to admins and separates administrative access from regular user access. After login, admins are redirected to their dashboard for system management, which improves overall system security.

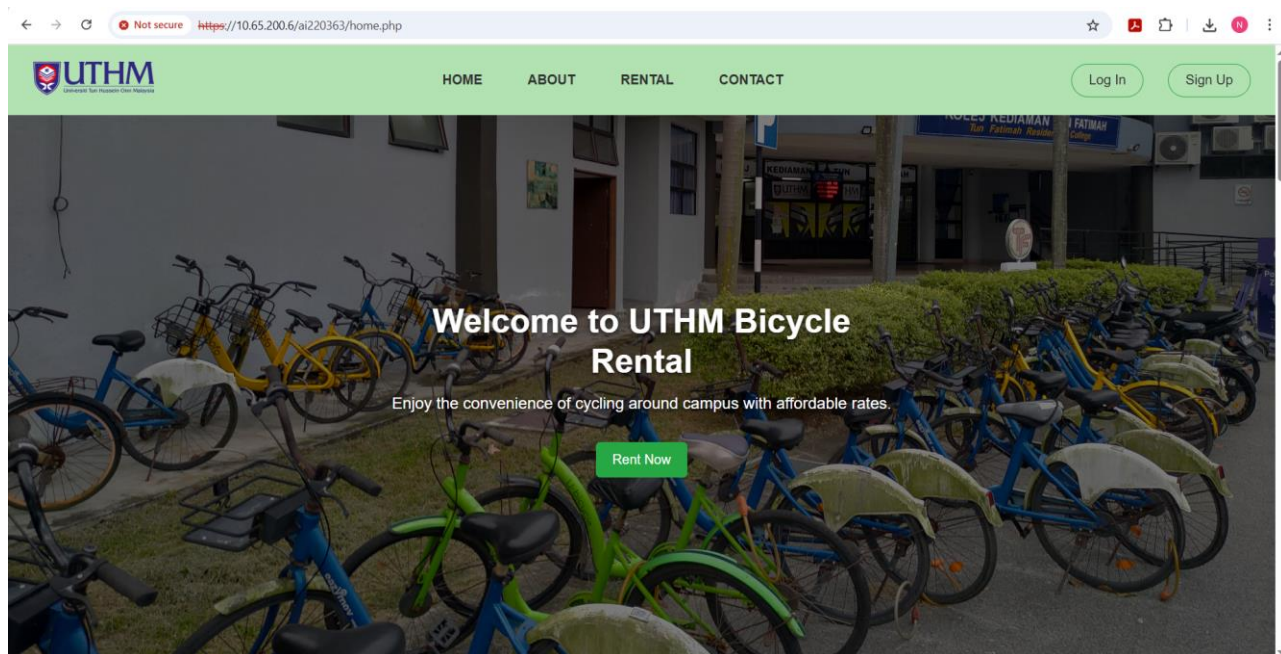


Fig.7 Homepage

Fig.7 shows the homepage banner section of the UTHM Bicycle Rental Management System. This section welcomes users with a full-width image of campus bicycles and a highlighted “Rent Now” button to encourage immediate interaction. It serves as the system’s landing page and creates a first impression by combining attractive visuals with a short introductory message. The banner emphasizes accessibility, affordability, and the convenience of on-campus cycling, effectively guiding users into the rental process.

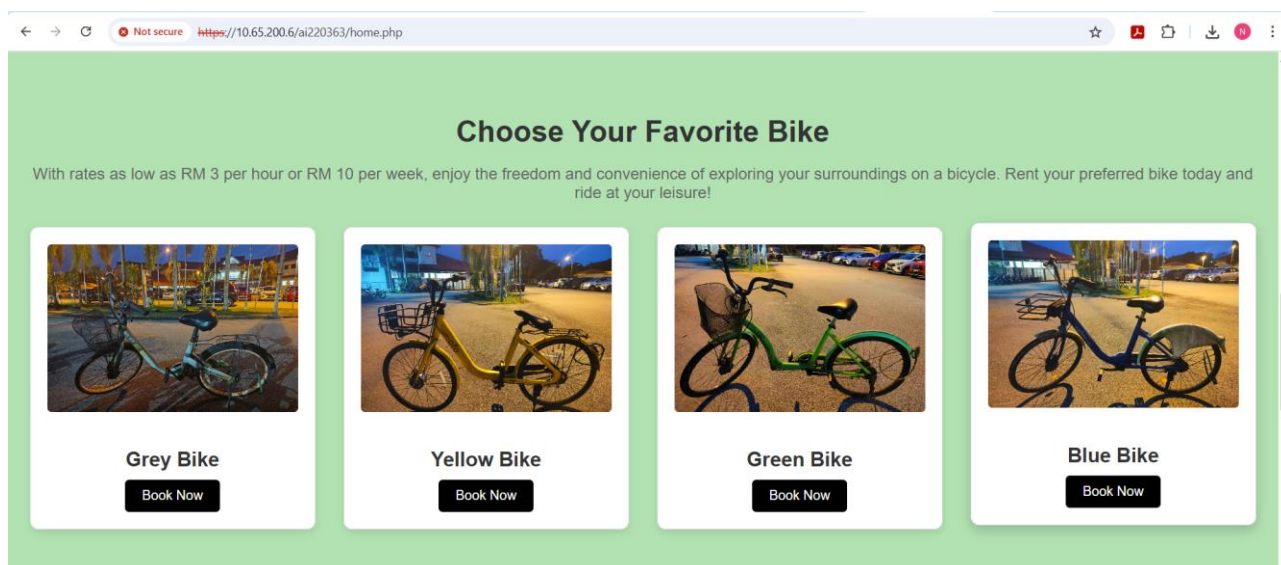


Fig. 8 Bicycle Selection Interface

Fig.8 displays the bicycle selection interface on the homepage. This section allows users to browse available bike types such as Grey Bike, Yellow Bike, Green Bike, and Blue Bike with each presented with a photo, name, and a “Book Now” button. It provides a quick and clear way for users to explore options and proceed with booking based on preference. The layout is responsive and user-friendly, offering immediate visibility into bicycle availability and pricing, and supporting better user decision-making.

Fig.9 Bicycle Booking Page

Fig.9 displays the Bicycle Booking Page. This interface lets users select a bicycle type, rental date, duration (hourly or weekly), and payment method (cash or QR). The system checks bicycle availability and prevents double booking. Once submitted, the booking is marked as "Pending" until handled by an admin.

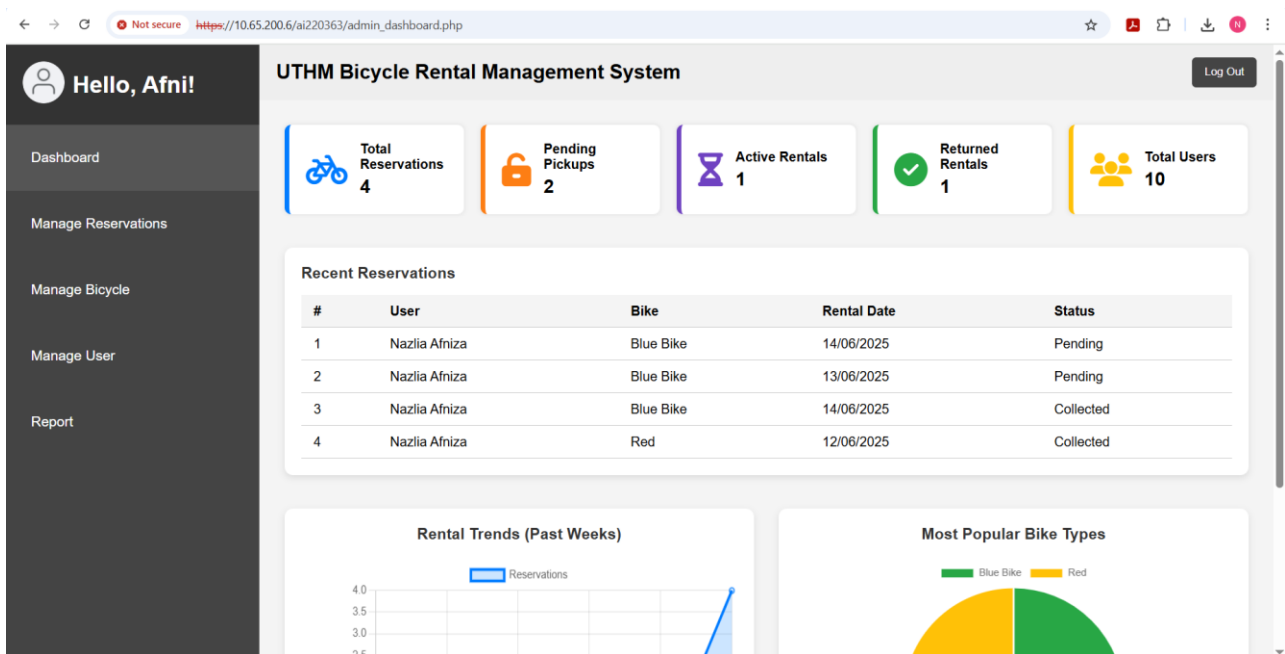


Fig.10 Admin Dashboard Page

Fig.10 shows the Admin Dashboard. It presents real-time data, including total reservations, pending pickups, active rentals, returned rentals, and user counts. The card-based layout enables quick data review, and the dashboard includes recent bookings and usage charts to help admins track activity trends.

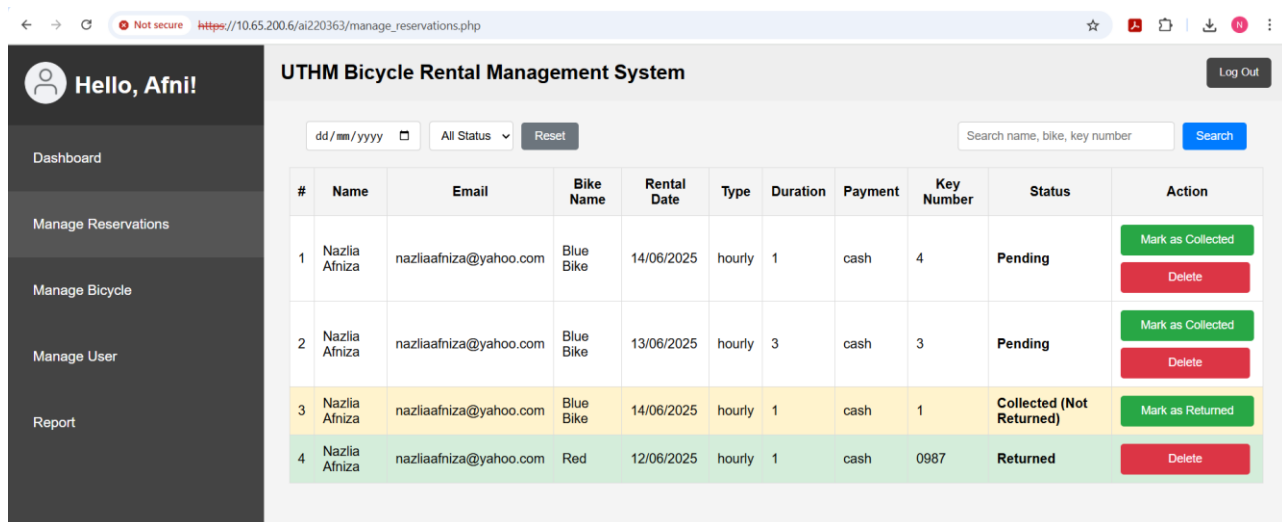


Fig.11 Manage Reservations Page

Fig.11 displays the Manage Reservations Page. Admins can view and manage all bookings here. Filters by status, date, or keyword are available, and actions such as "Mark as Collected," "Mark as Returned," or "Delete" are included. Color-coded rows help quickly identify the current status of each booking.

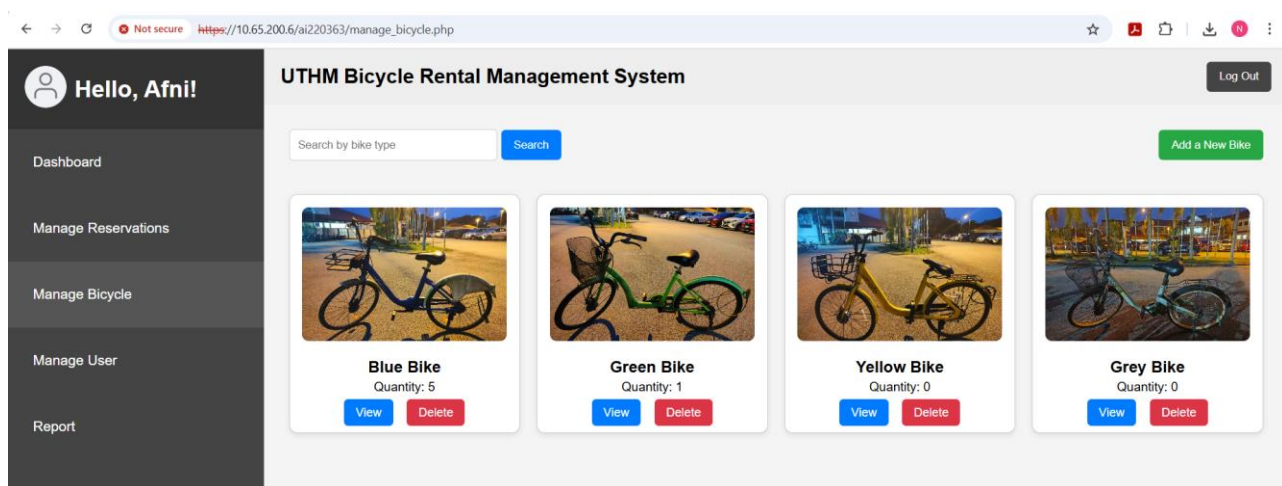


Fig.12 Manage Bicycles Page

Fig.12 shows the Manage Bicycles Page. This module allows the admin to add, edit, or delete bike types and key numbers. Clicking on a bike type reveals all related bicycles and their statuses. This helps admins maintain better inventory control and avoid duplicate assignments.

4.2 Testing

To verify the functionality and performance of the system, a comprehensive test plan was executed. Table 6 summarizes the functional testing results across all key modules. Each module was tested using various scenarios to ensure reliability and correctness. All planned test cases passed successfully, demonstrating that the system functions as intended in a typical usage environment.

Table 6 Test plan for functional testing

Module	Test Plan	Expected Result	Result
Registration & Login	Submit incomplete registration form	Error message displayed	Pass
	Submit valid registration form	Account created, redirected to login page	Pass
	Login with incorrect email/password	Error message displayed	Pass
	Login with valid credentials	Redirected to user dashboard	Pass
User Profile Management	Update name, phone number, or matric number	Changes saved successfully	Pass
Bicycle Booking	Submit booking with valid input	Booking submitted, status set to "Pending"	Pass
	Submit booking with missing/invalid data	Validation error displayed	Pass
	View booking history	Bookings listed correctly	Pass
Reservation Management	View all reservations	Records displayed with filters (search/date/status)	Pass
	Mark booking as "Collected" or "Returned"	Status updated and reflected in system	Pass
Bicycle Management	Add new bike type	Bike type appears in manage page	Pass
	Add new key number under bike type	Key number shown under correct bike type	Pass
	Edit/delete key number	Updates saved or key deleted	Pass
User Management	Add/edit/delete an admin	Admin list updated successfully	Pass
Dashboard & Statistics	View total reservations, users, rentals, etc.	Real-time stats displayed correctly	Pass
	View charts (trend, popular bikes)	Charts load with correct data	Pass

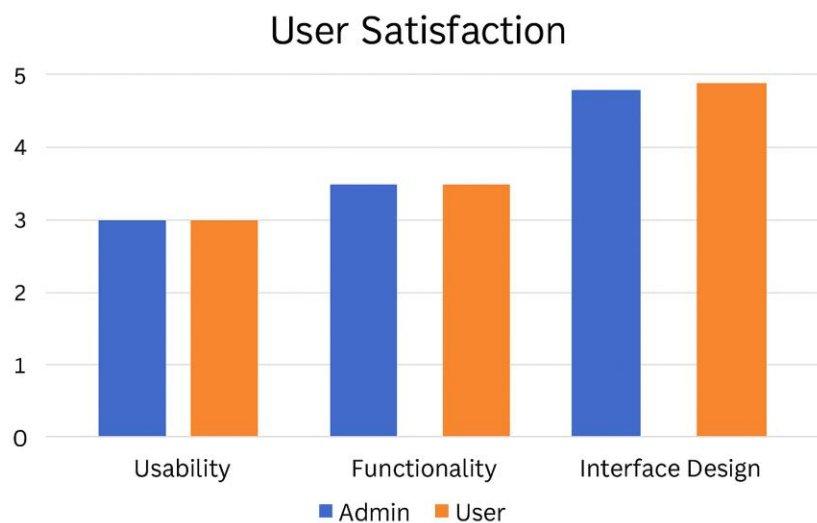
**Fig.13** UAT Results

Fig.13 shows the user satisfaction results from User Acceptance Testing (UAT) conducted with selected participants representing both administrator and user roles. The evaluation focused on three core aspects of the system: usability, functionality, and interface design. These categories were chosen to reflect the overall user experience from the perspectives of interaction, performance, and visual presentation. Feedback was collected

after users explored and interacted with the system's key features, including registration, bicycle booking, reservation management, and profile updates.

The purpose of the UAT was to assess whether the system meets the needs and expectations of its intended users in a real-use scenario. The chart provides a visual summary of their responses, helping to validate the system's effectiveness and reliability before full deployment. This form of testing plays a crucial role in ensuring that the developed features are user-friendly, intuitive, and aligned with actual user workflows. The insights gained also offer guidance for potential refinements and future enhancements.

5. Conclusion

The development of the UTHM Bicycle Rental Management System successfully addresses the inefficiencies and limitations found in the manual rental process previously used on campus. By implementing a fully web-based solution with real-time reservation, inventory tracking, and administrative control, the system offers a more organized, efficient, and user-friendly experience for both students and staff. Features such as user registration, booking management, and admin dashboards were designed with usability and clarity in mind, while the use of agile methodology ensured continuous improvement based on feedback.

Through system testing and user acceptance evaluation, the platform demonstrated its capability to meet user expectations and support campus sustainability goals. The integration of real-time updates, intuitive interfaces, and clear role separation enhances operational reliability and reduces administrative workload. Looking forward, the system can be extended with new features such as QR-based check-ins or automated maintenance alerts. These enhancements would further improve user experience and expand the system's potential beyond its current scope, ensuring it remains a valuable tool for future campus mobility management.

Acknowledgement

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia for its support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

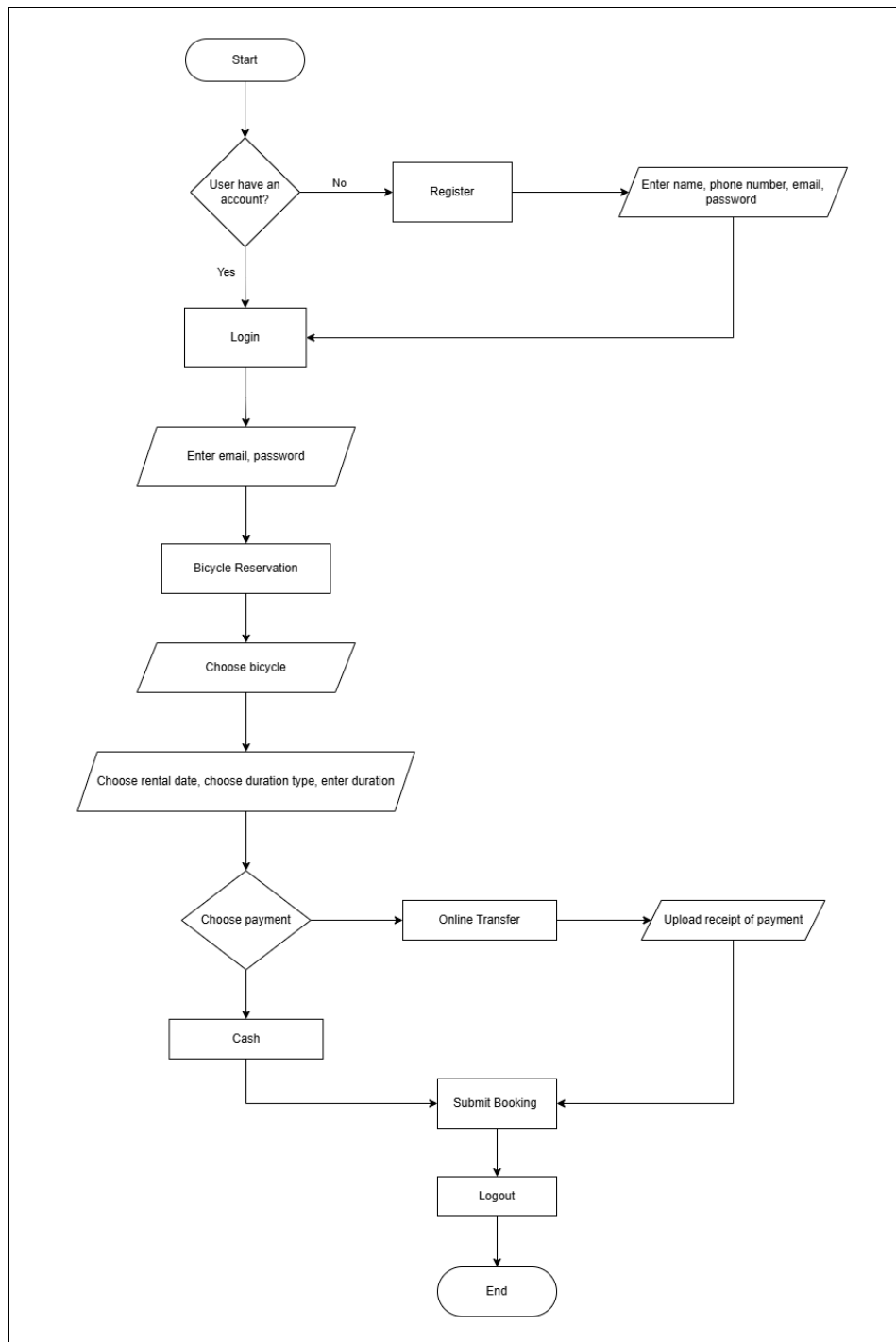
Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Nazlia Afniza Binti Jamaluddin, Firkhan Ali Bin Hamid Ali; **data collection:** Nazlia Afniza Binti Jamaluddin; **analysis and interpretation of results:** Nazlia Afniza Binti Jamaluddin, Firkhan Ali Bin Hamid Ali; **draft manuscript preparation:** Nazlia Afniza Binti Jamaluddin. All authors reviewed the results and approved the final version of the manuscript.*

References

- [1] Y. Zhou, Q. Li, X. Yue, J. Nie, and Q. Guo, "A novel predict-then-optimize method for sustainable bike-sharing management: a data-driven study in China," *Annals of Operations Research*, 2022.
- [2] W. Ping, Y. Chen, and X. Hou, "Design of Campus Bicycle Rental Management System Based on SSM Framework," *Journal of Physics: Conference Series*, vol. 1314, no. 1, 2019.
- [3] V. Vijayalakshmi, K. Senthilkumar, R. R. Mirajkar, S. Adlin Jebakumari, M. K. Goyal, and N. N. Sakhare, "Analyzing the Performance of Machine Learning Algorithms for Real-Time Data Analysis Under Optimization," in *2023 3rd International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON)*, 2023, pp. 123–130.
- [4] V. Pathak, V. Shrivastava, R. Buri, S. Gupta, and S. Sharma, "Current Web Development Technologies: A Comparative Review," in *Emerging Trends in Expert Applications and Security*, Springer, 2023, pp. 13–23.
- [5] E. Preprint, V. Druzhynina, A. Perekrest, P. Sahaida, and V. Druzhynin, "Towards the Creation of a Web-based Platform 'Bike Sharing' in the Local Transport System," 2021.

Appendix A: User's flowchart for UTHM Bicycle Rental Management System



Appendix B: Staff/administrator flowchart for UTHM Bicycle Rental Management System

