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Universiti Tun Hussein Onn Malaysia Bike Rental System

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Abstract: Bike rental service is a business operation that rents bicycles for certain amount of time. With the modernization of services throughout modern civilization, the bike rental service is upgraded from manual filing to computerized system. Due to this, Universiti Tun Hussein Onn Malaysia (UTHM) Bike Rental System had been proposed mainly for students and staff to know the availability of the bike rental. The project's objective is to design the third-party lease which is 'The Right Bike Store' a bike rental system that caters to the bike rental services provided in the UTHM by developing mobile application for users and web application for the staff and administrators. This system limits to UTHM staff and students only. The methodology chosen to develop UTHM Bike Rental System is Waterfall model. By using the methodology of the Waterfall model, the tasks distribution is divided into planning, analysis, design, implementation and testing stages. The software used to develop this system which are the Visual Studio Code for the web application by using Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), JavaScript and Hypertext Preprocessor (PHP). The mobile application is developed by using Android Studio and the language of Java and Extensible Markup Language (XML). This system consists of eight modules and uses five main keys to store data in Firebase real-time database. The mobile application of this system caters only to the users which are the students and staff of UTHM while the web application caters only to the employees which consists of administrators and staff.

Keywords: Universiti Tun Hussein Onn Malaysia (UTHM), Rental system, Web, Mobile

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1. Introduction

Bike rental service is one of the common services in the Universiti Tun Hussein Onn Malaysia (UTHM). It is a service that benefits the students who need transportation to class to the students that cycle during their free time in the evening. Bike rental system access is limited in the suburbs where most universities are located [1]. Therefore, with the bike rental service in the university which is owned by a third-party lease from the store called 'The Right Bike Store' is managed by the students that are interviewed by the store owner can help student's transportation issues.

This project requires the users, either students or staff of UTHM to install the mobile application called 'Rent-A-Bike'. The users need to register their account before being able to rent a bike. The users will be able to choose either weekly or hourly rental along with other details such as pickup date, pickup time, drop-off date and drop-off time. The total payment amount will be calculated automatically according to its rates and duration. The users can view their rental orders, update their profile information, and view the amount of available rental bikes. For the employees, they will need to login to the web application. The employees consist of staff and administrators. The staff will be responsible for adding, updating, or deleting bike details and updating or deleting rental information. Besides that, staff can view customers, employees, and sales information. The administrators can do everything that staff can do. The administrators have additional permission which can add, update, or delete sales information and employee's information.

The current bike rental service is through manual filing. There are a few problems encountered with the current bike rental service process. The staff have issues with knowing the status of the bikes which are either available or rented. With the usage of the current method, there is bound to be human error in handling all the forms that are stored manually in a file. Other than that, the students have issues with the availability of bikes. There are three main objectives that needs to be achieved in this project to design a bike rental system for The Right Bike Store, to develop a mobile and web application for bike rental service and to test the mobile and web application.

This paper consists of introduction, related work, methodology, results and discussion, implementation and testing, and conclusion. The related work consists of introduction, domain background and the comparison between three similar existing systems with the proposed system. Then, the methodology explains the methodology approach and tasks in each phase of the chosen System Development Life Cycle (SDLC) model. The results and discussion consist of the system structure, functional requirements along with non-functional requirements. The implementation and testing consist of the testing for errors of the designed system. Finally, the conclusion explains the project's achievements, limitations, and future enhancements.

2. Related Work

Bike rental is business operations that rents out bicycles for a certain amount of time. Due to the modernization of services, there are several bike rental systems that have been created for the facilitate the bike rental users. However, the bike rental systems are uncommon in Asian countries such as Malaysia, Indonesia and Singapore. This is due to unfit physical and cultural context in Asian cities such as their densely populated areas and difference in transit interaction [2]. With a bike rental system on campus, students are able to save time on commuting or walking to their destination in the campus [3].

In order to develop the UTHM Bike Rental System, a literature review was conducted to compare and contrast the existing system with the proposed system. Various studies have been conducted regarding the existing bike rental system to ensure the proposed system development perfectly caters to the bike rental service in the UTHM. From the studies, the disadvantages had been determined to avoid implementing the disadvantages in the proposed system. The advantages of the existing system have been identified and examined to ensure the features added in the proposed system are suitable with the current UTHM bike rental service. To ensure the proposed system is unique compared to other existing systems, comparison between existing systems had been made.

Table 1: Comparison of existing systems with proposed system

Feature	nextbike [4]	Link Bike [5]	Royal Brothers [6]	Proposed System (UTHM Bike Rental System)
Register and Login	Yes	Yes	Yes	Yes
Account Verification	E-mail	None	Phone Number	Student's e-mail
Bike Variation	Yes	No	Yes	Yes
Bike Availability	Yes	Yes	Yes	Yes
Set Duration	Yes	Yes	Yes	Yes
Payment Method	Online payment	Online payment	Online payment	Cash
Rental Type	Pay as you ride, monthly and annually	Daily	Daily and monthly	Hourly and weekly
Available in Malaysia	No	Penang	No	Parit Raja, Batu Pahat
System Type	Hybrid Application	Mobile Application	Hybrid Application	Mobile and Web Application

The UTHM Bike Rental System was proposed to facilitate the bike rental service in UTHM. After thorough comparison, there are several features that can be implemented in the proposed system. There are three existing systems compared with the proposed system which are the nextbike, LinkBike and Royal Brothers. Based on Table 1, all the existing system requires users to register, login, view bike availability, set rental duration and rental type available. The uniqueness of the UTHM Bike Rental System is that it is designed specifically for UTHM bike rental service as it requires users to login using UTHM email and matric number. There are only a few available bike rental applications in Malaysia. Thus, the proposed system is located for Parit Raja. The proposed system does not use online payment as the rental fees rate is less than RM10. The comparison acts as a guideline for the proposed system to ensure the system provides efficiency and reliability.

3. Methodology

Methodology is a method used to analyze data and processes. The methodology for the UTHM Bike Rental System uses the Waterfall model. The Waterfall model is one of the System Development Life Cycle (SDLC). Software Development Life Cycle (SDLC) is the process of creating and implementing over the course of several phases which are the planning, analysis, design, implementation, and testing [7]

3.1 Waterfall Model

Waterfall model is a methodology suited for project management. It consists of five phases which are planning analysis, design, implementation, and testing phases. Figure 1 shows the Waterfall Model of the UTHM Bike Rental System.

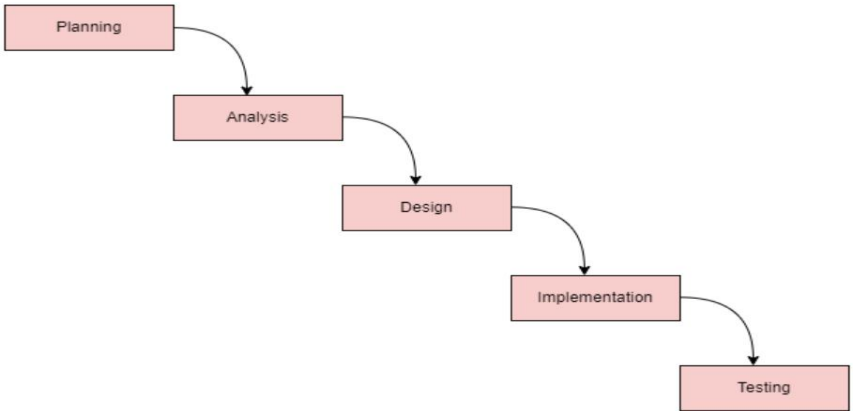

Figure 1: Waterfall Model [8]

Figure 1 shows the workflow of Waterfall model used for the UTHM Bike Rental System. Based on the Waterfall model, it put an emphasis on documentation such as requirements and design before developing the system to avoid making a big change to the design when the system has been developed. The Waterfall model offers an organized structure by stating the most crucial requirements in earlier phase which are determining user's requirements [9].

3.2 Planning Phase

Planning phase is when a project development begins. The details of the current process of bike rental system were studied. Then, the proposal is prepared along with the Gantt chart and project's schedule. The scope of the project and the expected outcome also had been identified.

3.3 Analysis Phase

Analysis phase is to thoroughly examine and assess the feasible options that fulfils the project's requirements and constraints. Thus, a study on three similar system which are the nextbike system, LinkBike system and the Royal Brothers system had been done with the proposed system. Then, an interview had been done with the staff of the bike rental store via WhatsApp. The software and hardware requirements, functional and non-functional requirements which are to discuss the critical software system quality issues are identified [10].

3.4 Design Phase

In the design phase, the user interface of the system is designed by creating a wireframe. The digital wireframes had been created using the MockFlow Wireframe Pro software for both web-based and mobile-based application. This is to ensure the flow of the system is well ordered. Next, the system flowcharts for students, staff and administrator had been illustrated. Finally, the creation of the context diagram, data flow diagrams and entity relationship diagram had been created.

3.5 Implementation

Implementation is when the coding implementation of the system starts. The web application is developed using Visual Studio Code by using the Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), JavaScript, and Hypertext Preprocessor (PHP) language. The mobile application is developed using Android Studio with the language of Extensible Markup Language (XML) and Java. Both the applications are connected to Firebase Realtime Database. The platform to run the web application is through localhost by using XAMPP and mobile application can be run using the Android emulator and by installing the mobile application into an Android phone.

3.6 Testing Phase

The Waterfall model testing phase takes place after the implementation phase where the system testing begins. The system testing phase is to ensure its functionality and interfaces are examined. System testing is also tested by users to ensure the system meets the requirements stated and its

purpose is fulfilled. Unit testing and integration testing are the two tests used to determine if the system operates effectively and correctly.

4. Analysis and Design

Analysis and design phase is to understand more regarding the process of the UTHM Bike Rental System. This section consists of flowcharts, Context Diagram, Data Flow Diagram level 0, Entity Relationship Diagram.

4.1 Flowchart

Flowchart diagrams are created to depict the process of the UTHM Bike Rental System for every user. With the help of flowchart, the necessary steps and processes can be organized and thus improve the system efficiency. The users of UTHM Bike Rental System are the users, administrators and staff.

4.1.1 User Flowchart

Figure 2 shows the flowchart for users. The users use the mobile application where the users are required to register or login into their account before renting a bike or viewing any contents in the mobile application.

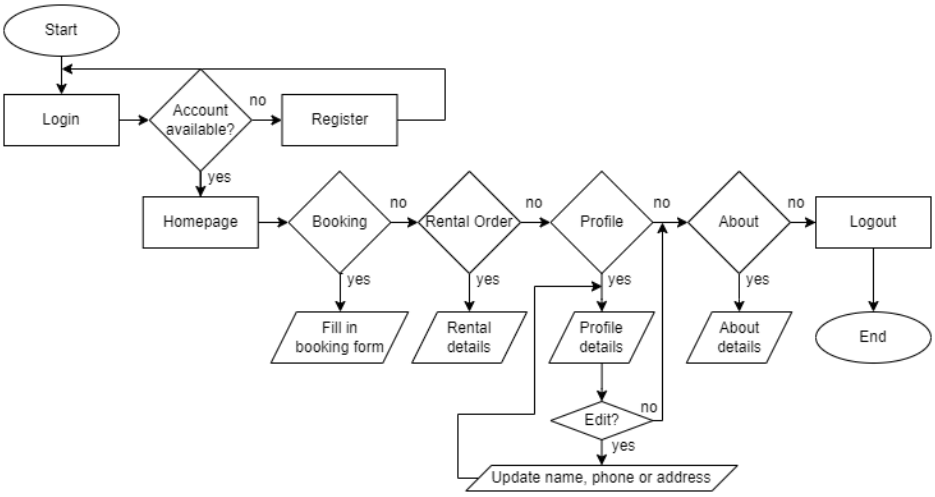

Figure 2: User Flowchart

4.1.2 Admin and Staff Flowchart

Figure 3 shows the flowchart for employees which are the administrator and staff. The employees use a web application to manage the bike rental service. The staff needs to be added by the administrator before being able to login into the web application. After login, the employees are able to manage bike and order besides viewing customer information whereas the administrator have additional permission to manage sales and employees.

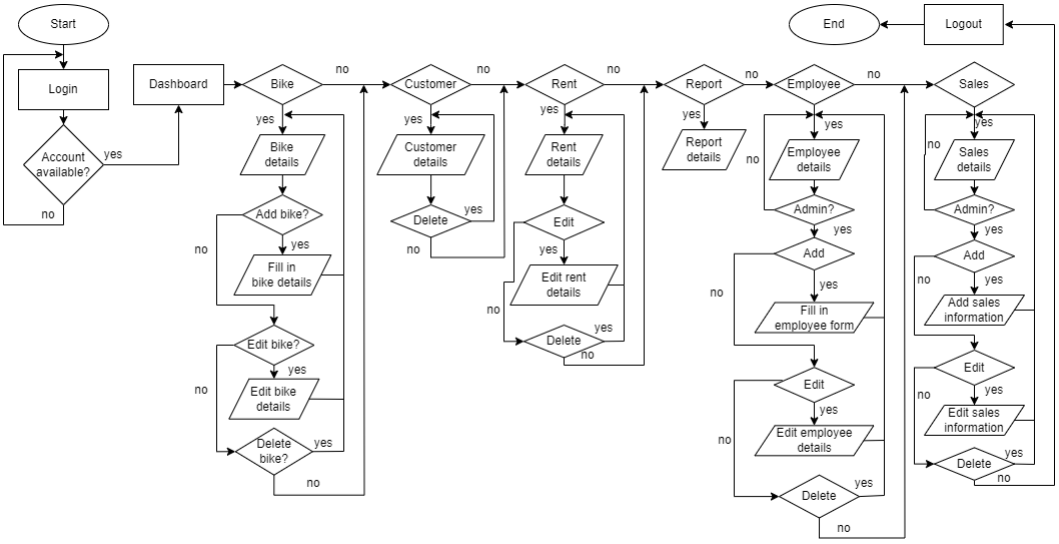

Figure 3: Admin and Staff Flowchart

4.2 Context Diagram

Figure 4 shows the context diagram of the UTHM Bike Rental System. There are three entities which are the user, staff, and administrator. The context diagram shows the interactions between the entities and the system where some of the data input by administrator and staff will be displayed to the users and vice versa.

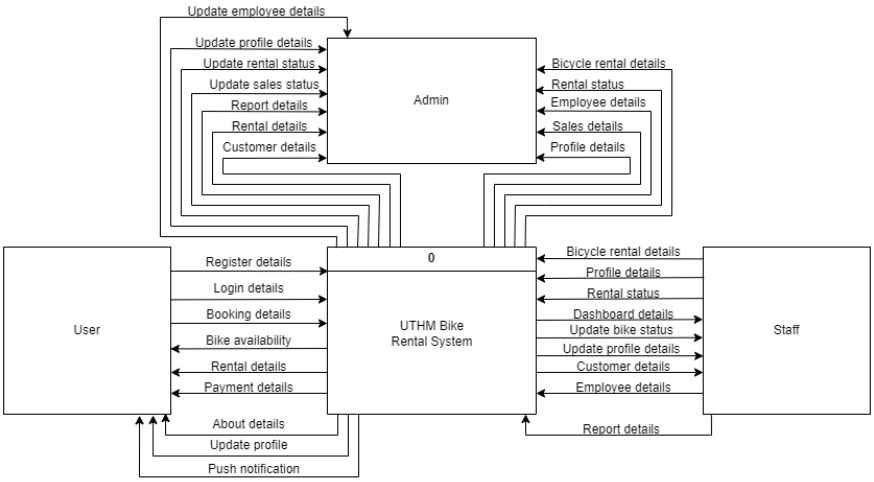

Figure 4: Context Diagram

4.3 Data Flow Diagram

Data Flow Diagram (DFD) is a visual tool for expressing data transformation in a system by illustrating logic models. DFD includes the system design process analysis and requirement stage by depicting the target system's network of operations and activities [11]. Figure 5 shows the Data Flow Diagram Level 1 of the UTHM Bike Rental System. The Data Flow Diagram level 0 shows the data flow between three entities, eight modules or processes and five repositories used in the system.

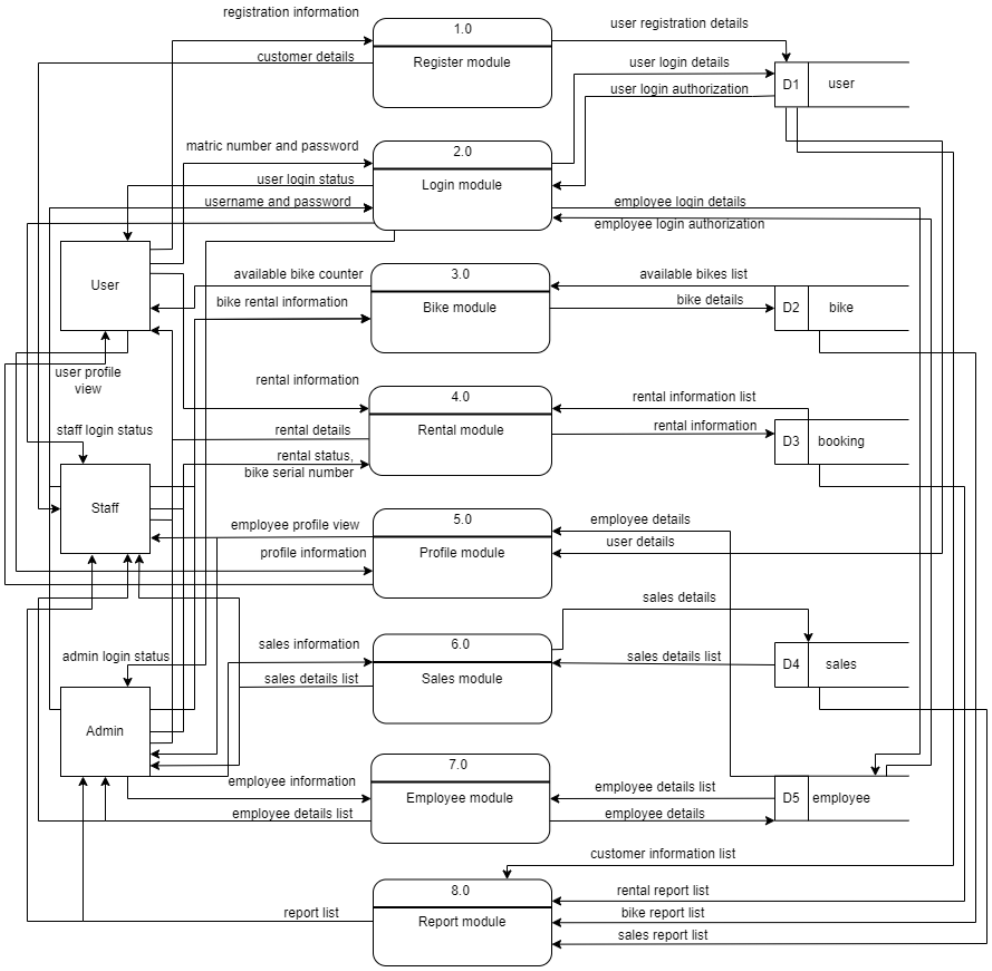

Figure 5: Data Flow Diagram Level 1

4.4 Entity Relationship Diagram

The Entity Relationship Diagram (ERD) is to aid in comprehending the basis of the data and information that are going to be stored in the database. Figure 6 shows the Entity Relationship Diagram for the bike rental system.

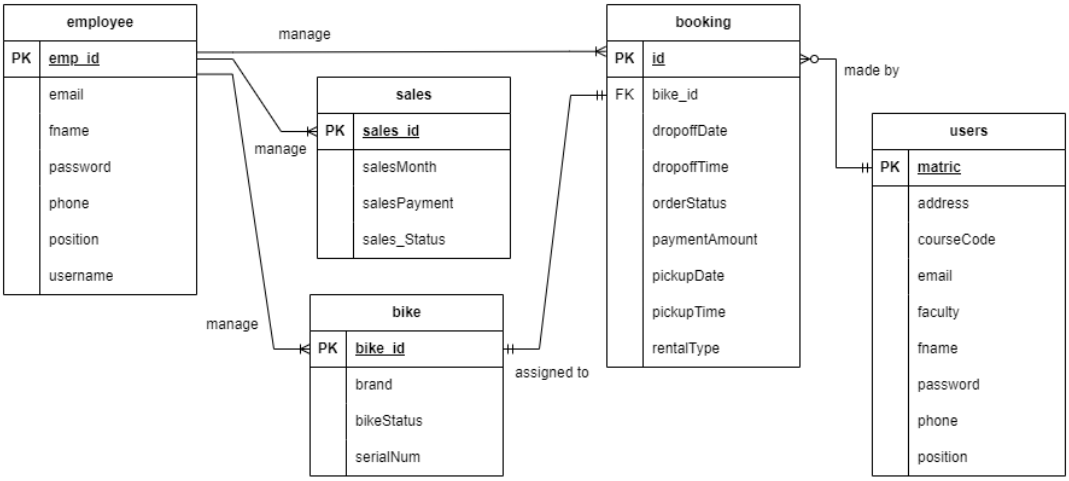

Figure 6: Entity Relationship Diagram

5. Results and Discussion

Results and discussion section shows the system outcomes such as its mobile and web interfaces along with testing results.

5.1 Mobile Application Interfaces

This section will show the mobile application interfaces of the UTHM Bike Rental System.

5.1.1 Registration Interface

Figure 7 shows the register interface where user needs to fill in their information such as full name, matric number, phone number, email, password, faculty, position either staff or student and their course code. The users can click the 'Register' button or be redirected to login page by clicking 'Already have an account? Login Now'.

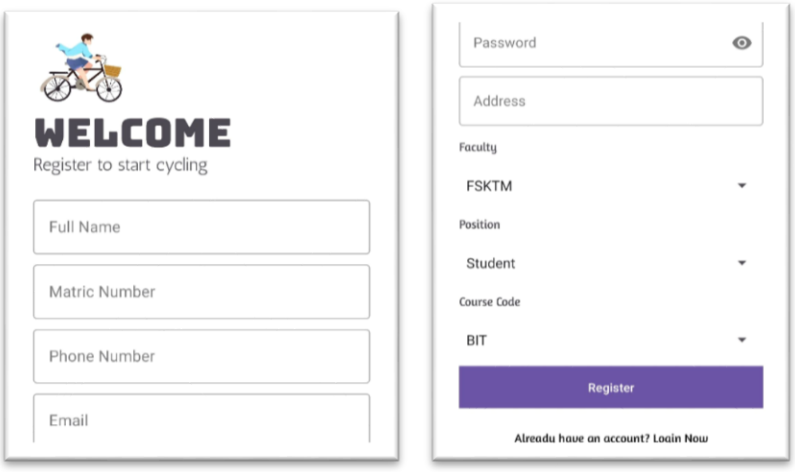

Figure 7: Registration page

5.1.2 Login Interface

Figure 8 shows the login interface for users. Users can login using a matric number and password. After the authentication is successful, the users will be redirected to the homepage of the mobile application. If users do not have an account, they can click on the 'New User? Register Now' and be redirected to the registration page.

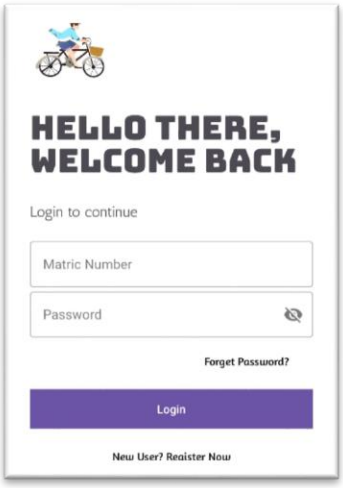

Figure 8: Login page

5.1.3 Homepage Interface

Figure 9 shows the homepage where it will display the current available bikes for rent. The users can also click the icon at the top left corner of the page and a navigation menu will be displayed. The navigation menu consists of home, book now, rental order, notification, profile, about and logout buttons.

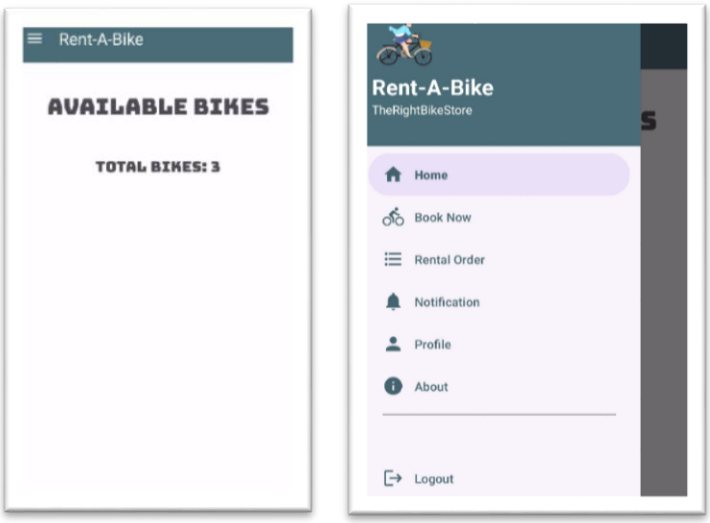

Figure 9: Homepage and navigation drawer

5.1.4 Booking Interface

Figure 10 shows the booking interface for users. The users will be required to fill in the booking form. The data required are the rental type, pickup date, pickup time, drop-off date, drop-off time and the total payment. The total payment will be automatically calculated according to the rental fees rate and duration. When users click on the 'Book Now' button, they will be redirected to the rental order interface.

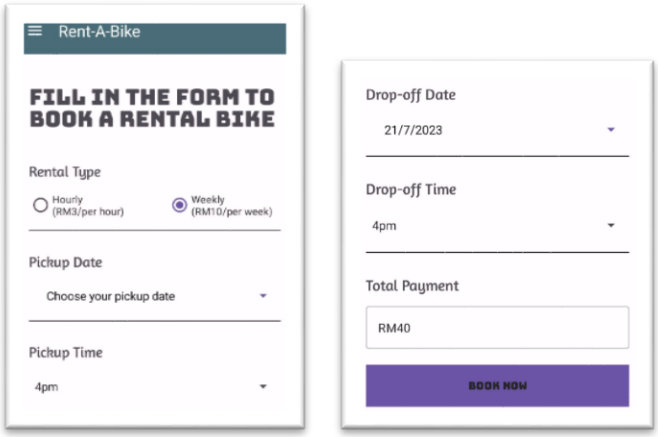

Figure 10: Booking page

5.1.5 Rental Order Interface

Figure 11 shows the rental orders in a list view. When the order is clicked, users will be redirected to another interface that will display more detailed information for rental orders. Additional information is added which are the bike serial number and rental order status.

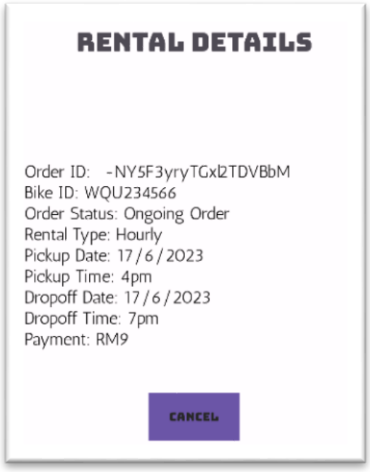

Figure 11: Rental order interface

5.1.6 Profile Interface

Figure 12 shows the profile interface for users that will display their information. The users can edit their profile by clicking on the 'Update Profile' button. The users can then save their information by clicking on the 'Save Changes' button.

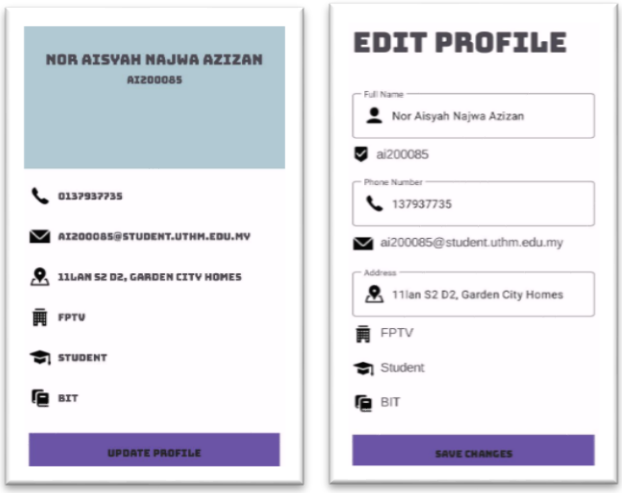

Figure 12: Profile interface

5.2 Web Application Interfaces

This section will show the interfaces of the UTHM Bike Rental System.

5.2.1 Login Interface

Figure 13 shows the login interface for employees. The employees are required to enter their assigned username and password. The user then needs to click the 'Login' button to be redirected to dashboard page.

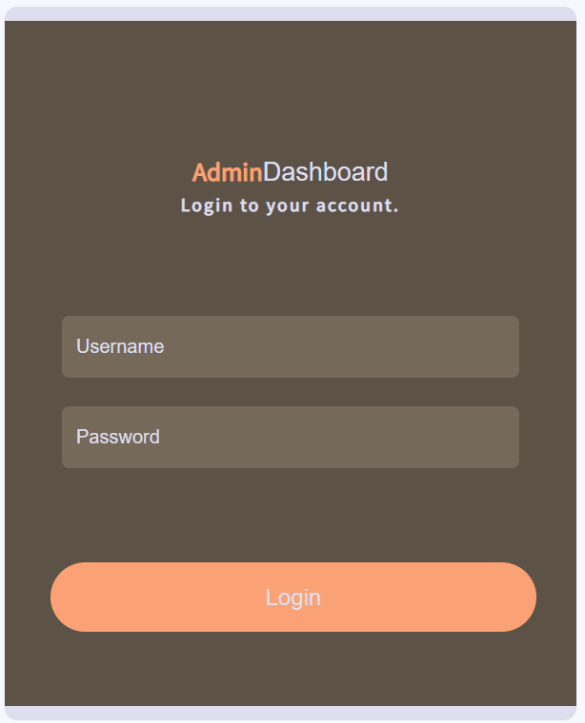

Figure 13: Login page for employees

5.2.2 Dashboard Interface

Figure 14 shows dashboard page. The dashboard page contains information regarding bike status, total customer, total order and total sales counter. The navigation menu consists of dashboard, bike status, customer, rent information, report, employee, sales, profile button and dark mode toggle button.

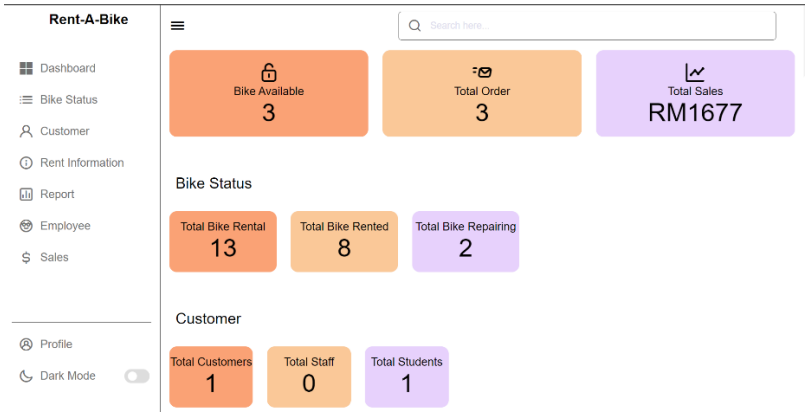

Figure 14: Dashboard page

5.2.3 Report Interface

Figure 15 shows the report interface. The report interface contains information from the bike status, rent information, customer, and sales. There are buttons at top of page to toggle between reports.

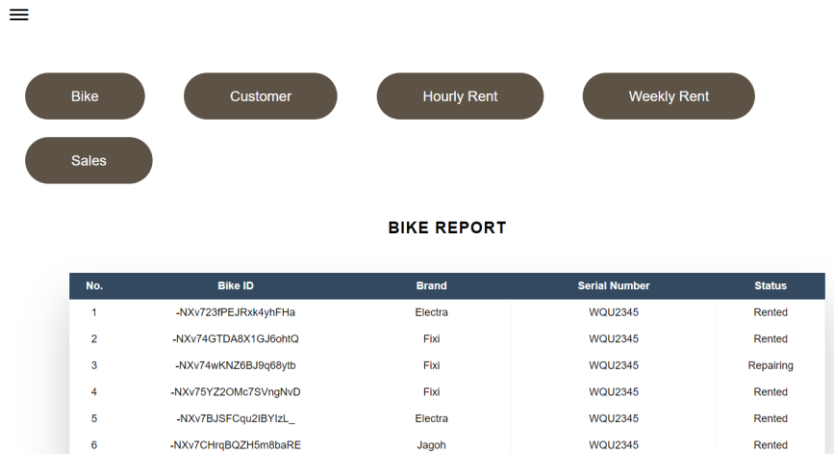

Figure 15: Report interface

5.2.4 Bike Interface

Figure 16 shows bike status interface. The bike details such as bike id, brand, serial number, and status will be displayed. The employees can add bike by clicking the at the 'Add Bike' button or clicking the edit or delete button to edit and delete accordingly. Figure 17 shows the interface for adding bike and editing current bike.

Figure 16: Bike status interface

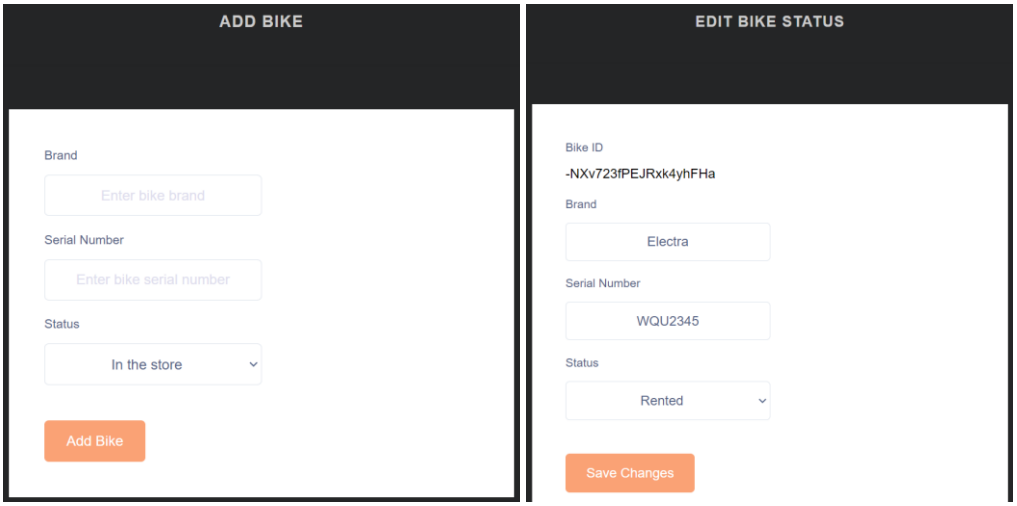

Figure 17: Add and edit bike interfaces

5.2.5 Customer Interface

Figure 18 shows the customer's information. The employees can delete the customer's information by clicking the delete button with trash icon.

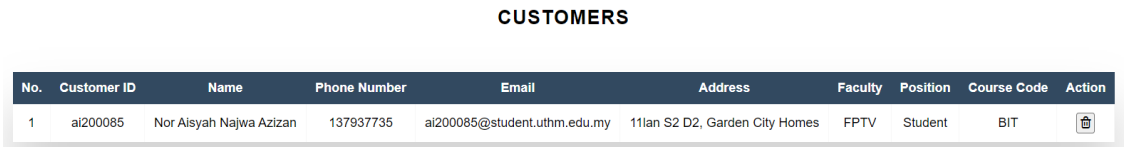

Figure 18: Customer details interface

5.2.6 Rent Information Interface

Figure 19 shows rental order information. The rental orders are displayed according to its rental types which are weekly and hourly. The employees can toggle between rental types displays by clicking on the 'Hourly' or 'Weekly' button. The employees can also edit or delete the rental information by clicking the icon button accordingly. Figure 20 shows the edit rental interface.

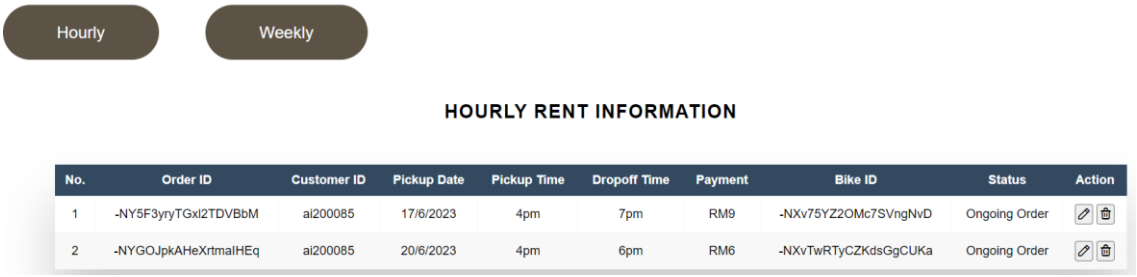

Figure 19: Rental information interface

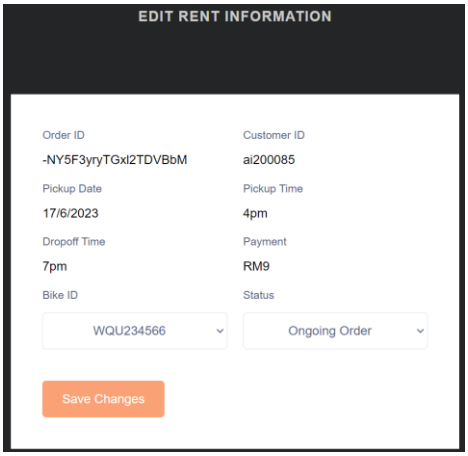

Figure 20: Edit rental interface

5.2.7 Sales Interface

Figure 21 shows the sales interface for staff. Figure 22 shows the sales interface for administrators. Only the administrators can add, edit, and delete sales. Figure 23 shows the add and edit sales information interfaces.

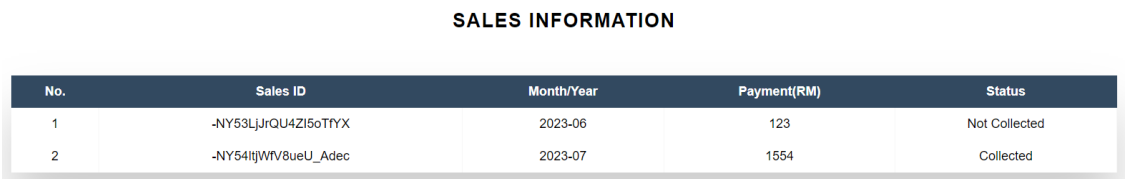

Figure 21: Staff sales interface

Figure 22: Admin sales interface

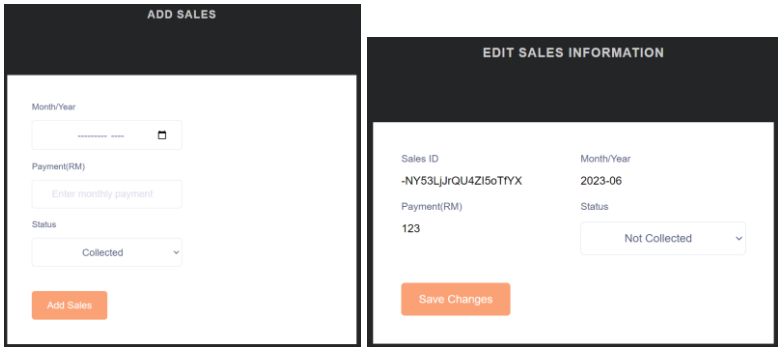

Figure 23: Add and edit sales interfaces

5.2.8 Profile Interface

Figure 24 shows the profile interface for employees where their full name, phone number, email and position are displayed. The employees can edit their profile or logout from their account by clicking the button accordingly.

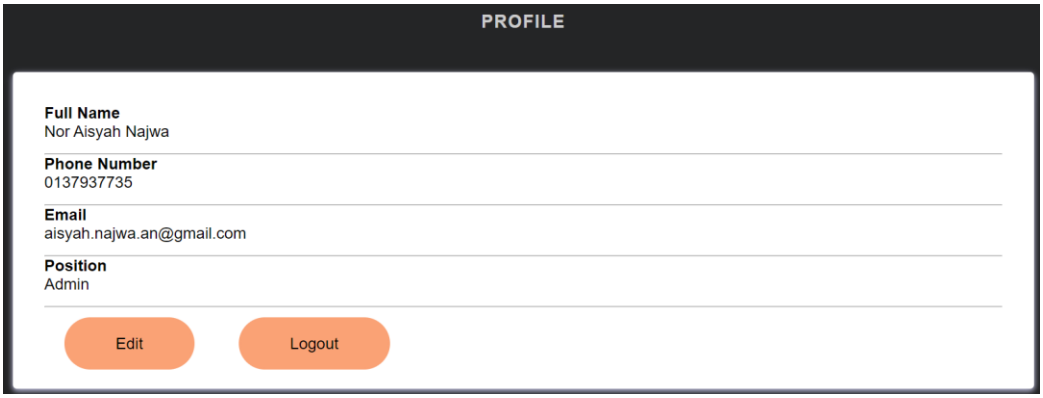

Figure 8: Employee profile interface

5.3 Testing

The testing conducted to test the proposed system is functional testing and user acceptance testing. The tests are carried out to ensure systems are efficient, reliable, and error-free for every feature available. Test results and expected results are supposed to match. This is to ensure the requirements align with the outcomes of the project.

5.3.1 Functional Testing

The purpose of functional testing is to ensure the proposed system meets the functional requirements that were previously stated. The testing is carried out to ensure the system requirements meet the system outcomes. Functional testing consists of testing each feature, several test plans are displayed to view the system's accuracy.

5.3.2 Test Plan

The test plan is carried out after the completion of the project. It is used to determine if the system meets the project requirements. Table 2 to 8 shows the test plan for all modules of the UTHM Bike Rental System.

Table 2: Test plan for Registration

No	Test Case	Expected Result	Actual Result
1	Register using valid matric number and UTHM email with no empty input	If the registration is successful, user will be redirected to the login page	As expected
2	Enter invalid matric number	Error message “please use your matric number” will be displayed	As expected
3	Enter invalid password pattern	Error message “Password more than 6 characters with number, lowercase, uppercase and special character” will be displayed	As expected
4	Enter invalid email	Error message “Please use your UTHM email” will be displayed	As expected
5	Blank input	Error message “Field cannot be empty” will be displayed	As expected
6	Register using registered matric number	Error message “User registered already” will be displayed	As expected

Table 2 shows the test plan for the user registration. This module is tested with the registration input specifically the matric number, password and email. The registration is only for the users.

Table 3: Test plan for Login

No	Test Case	Expected Result	Actual Result
1	Enter valid matric number and password	User will be redirected to the mobile application homepage	As expected
2	Enter invalid matric number	Error message “User does not exist” will be displayed	As expected
3	Enter invalid password	Error message “Wrong password” will be displayed for both mobile and web application	As expected
4	Blank input	Error message “Field cannot be empty” will be displayed	As expected
5	Employees enter valid username and password	Employees will be redirected to the web application dashboard	As expected
6	Employees enter invalid username	Error message “User does not exist” will be displayed	As expected

Table 3 shows the test plan for login module. The user's matric number and passwordwill be verified before being redirected to the homepage. For employees, they will be redirected to the dashboard. This testing only uses the matric number and password for users and username and password for employees.

Table 4: Test plan for Bike Module

No	Test Case	Expected Result	Actual Result
1	View bike availability	Bike availability counter updates instantly	As expected
2	Add bike details	Bike details added to Firebase	As expected
3	Edit bike details	Brand, serial number and bike status updated to Firebase	As expected
4	Delete bike details	Bike detail deleted from Firebase	As expected

Table 4 shows the test plan for bike module. The users will be able to view bike availability only while the employees are able to manage all bike details. This test mostly focuses on the bike status.

Table 5: Test plan for Rental Module

No	Test Case	Expected Result	Actual Result
1	Users enter rental information	Rental information added to Firebase	As expected
2	View rental information	Rental information displayed at the rental order page in mobile application and rent information page in web application	As expected
3	Edit rental information	Rental status, bike serial number along with its status is updated to Firebase	As expected
4	Delete rental information	Rental information deleted from Firebase	As expected

The test plan for rental module is shown in Table 5. In this module, users can add rent information by filling in the booking form. The users are also able to view the rental details. The employees have the permission to edit and delete the rental details.

Table 6: Test plan for Profile Module

No	Test Case	Expected Result	Actual Result
1	View profile	Profile details displayed	As expected
2	Edit profile	Profile details updated to Firebase	As expected

The test plan for profile module is shown in Table 6. In this module, both users and employees should be able to view and edit their own profiles. The details users can update are their full name, phone number and password while employees are able to update their name, phone number and email.

Table 7: Test plan for Sales Module

No	Test Case	Expected Result	Actual Result
1	View sales details	Sales details displayed	As expected
2	Add sales information	Sales information added to Firebase	As expected

3	Edit sales details	Sales status updated to Firebase	As expected
4	Delete sales details	Sales detail deleted from Firebase	As expected

The test plan for sales module is shown in Table 7. In this module, staff can only view sales details while administrators have the permission to add, edit and delete sales details.

Table 8: Test plan for Employee Module

No	Test Case	Expected Result	Actual Result
1	View employee details	Employee details displayed	As expected
2	Enter valid employee details	Employee details added to Firebase	As expected
3	Enter invalid email	Error message “Wrong email format” will be displayed	As expected
4	Enter invalid password	Error message “Must contain at least 6 characters with number, uppercase, lowercase and special character” will be displayed	As expected
5	Blank input	Error message “Please fill out this field” will be displayed	As expected
6	Edit employee details	Employee username, name, email, phone number or position will be updated to Firebase	As expected
7	Delete employee details	Employee details deleted from Firebase	As expected

The test plan for employee module is shown in Table 8. The staff can view certain employee details only. The administrator has permission to add an employee whether staff or administrator. The administrator also has the permission to edit and delete any employee.

6. Conclusion

The UTHM Bike Rental System is developed using several programming and markup languages to execute the system requirements. The system is expected to be improved in the future. The system can be improved by enhancing the performance and functionality in the system such as integrating the rental system with Internet of Things (IoT) and making the calculations for the systems fully automatic. This project has achieved its objectives and scopes. The first objective implemented is designing a bike rental system for The Right Bike Store. Then, the development of mobile application and web application for the bike rental service has been implemented by using Android Studio and Visual Studio Code as a software to program the applications. Next, the final objective had been achieved as the mobile and web application have undergone User Acceptance Testing. Besides achieving the objectives, the features and functionality are connected to a real-time database by using Firebase. This project also has several limitations such as user must pay rental fees via cash. Furthermore, users cannot choose the bike rentals and the system is made specifically for UTHM students and staff only. Moreover, the mobile application is only compatible with Android operating system.

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