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Designing a Mobile-Based Electric Bicycle Rental System Using a UML Approach

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ABSTRACT

Innovation in transportation, such as online transportation booking applications and electric vehicles are phenomena caused by the development of information technology. But, the likes of traffic safety and complex transportation system integration are some obstacles that still need to be addressed. This research aims to design a Mobile-Based Electric Bicycle Rental System using Unified Modeling Language (UML) in order to increase efficiency and convenience. A Qualitative Research Method is used to analyze the Business Process. The System Analysis stage involves identification, determining requirements, and systematic study to ensure design compliance or suitability. The System Designing stage covers creating structured UML Model, Database Design, determining Table Structure, and developing a User Interface. This study's result presents a comprehensive design of the Electric Bicycle Rental System, reflected by well-structured UML Diagrams, efficient Database Design and an intuitive User Interface. This System is expected to be an innovative solution to conquer efficiency and convenience hurdles in renting an Electric Bicycle.

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I. INTRODUCTION

Information technology growth has been the main catalyst of transformation in various aspects of human life, especially in the transportation field [1]. Technology in the transportation field has advanced rapidly in recent decades, including innovations in mobile transportation booking applications, online ticket booking, digital mapping, and the emergence of electric-powered vehicles [2].

The improved availability and accessibility of information technology has changed the way people interact with transportation systems. The appearance of mobile applications that enables on-demand transportation booking has changed the traditional paradigm in the use of public transportation to become more advanced and modern. The

ability to track and map journeys in real time has also improved travel efficiency and safety [3].

The growth of technology not only brought progress in mobility, but also presented more sustainable and eco-friendly transportation solutions. For example, electric vehicles are becoming popular as an alternative to reduce the negative environmental impact caused by conventional vehicles. Electric vehicles are powered by clean and renewable energy sources, such as electricity or rechargeable batteries. This significantly reduces greenhouse gas emissions and air pollution generated by the ignition of fossil fuels in conventional vehicles. Therefore, electric vehicles are an effective solution to support environmental sustainability and minimize the carbon emissions of the transportation sector.

However, despite these significant advancements in transportation technologies, there are still various hurdles that need to be addressed. Issues such as traffic safety and complex transportation system integration remain as the focus of policymakers and industry experts.

In this particular context, researchers design a Mobile-based Electric Bicycle Rental System with UML (Unified Modeling Language). This is based on previous studies and research showing that UML is a proven industry standard in visualizing, designing, and documenting Software systems. The use of UML also makes it easier on the developers in the system designing phase due to its object-oriented nature.

A previous study which was conducted by Zatin Niqotaini reinstated the use of Unified Modeling Language (UML) on the productivity of stock management at XYZ Store. The study explained that applying UML as a design tool could computerize the method of stock management. In this context, UML helped in designing a stock management system through various diagrams which covered the crucial aspects, such as Use Case Diagram, Activity Diagram, Sequence Diagram, and Class Diagram. Thus, the study gives additional proof that UML does not only serves a role in the development of Mobile-based applications such as Electric Bicycle Rental or Information System for Cultural Clothing Rental, but also plays an important role in increasing efficiency and productivity of stock management at the XYZ store [4].

Another study by Zatin Niqotaini also used UML to design the Fathforce Starter Kit Pro at PT. Inovasi Media. They implemented UML modeling as part of the software design process with the use of PHP Language Programming and Laravel Framework. The result of that study shows that the application design was made with Unified Modeling Language (UML) and user interface. This web application is open-sourced, which makes it possible for everybody to access and modify it to their needs [1].

On the basis of the problems stated previously, and the evident potential in the current transportation field, the writers have decided to design a Mobile-based Electric Bicycle Rental System that uses UML as its basis in aim to increase efficiency and convenience in the rental process while also facilitating a better accessibility for the users.

II. METHODOLOGY

Qualitative research methodology is used to analyze the business processes that occur in this electric bicycle rental application, which was then followed by the creation of a system design using UML. Below is a diagram that visualize the stages and overall process of the conducted study:

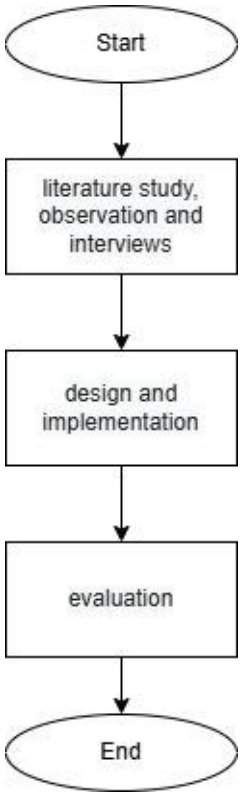

Fig. 1. Stages of the conducted study.

As shown in Fig. 1, the whole process of the conducted study has 3 main stages, which can be explained as follows:

Literature Review, Observation and Interview. This study collects data and information from various sources, including scientific literature and digital platforms [6]. Field observations were done by identifying problems that could be solved by creating this system, while interviews were used as a tool. This aspect is fundamental in data collection. In order to obtain in-depth information, direct interaction with relevant parties was carried out."

Planning and Implementation. During the design phase, the application's systems and functionality are designed using Unified Modeling Language (UML). Next, the coding execution process, which is the implementation phase, is done through application development and visual programming accompanied by writing program code [7].

Evaluation. The evaluation phase aims to test the functionality of the completed application through its implementation [8].

III. RESULT AND DISCUSSION

Next, the design is visualized using Unified Modeling Language (UML). UML functions as a tool that provides structured graphical representation of a system design or software [9]. The UML Diagrams used for this study are the Use Case Diagram, Activity Diagram, Sequence Diagrams, and Class Diagram. The following figures are the aforementioned Diagrams:

Use Case Diagram

The first step in visualizing the system's design is to create a Use Case Diagram. This Diagram is used to visualize the interaction between actors and the system in order to achieve a specific goal.

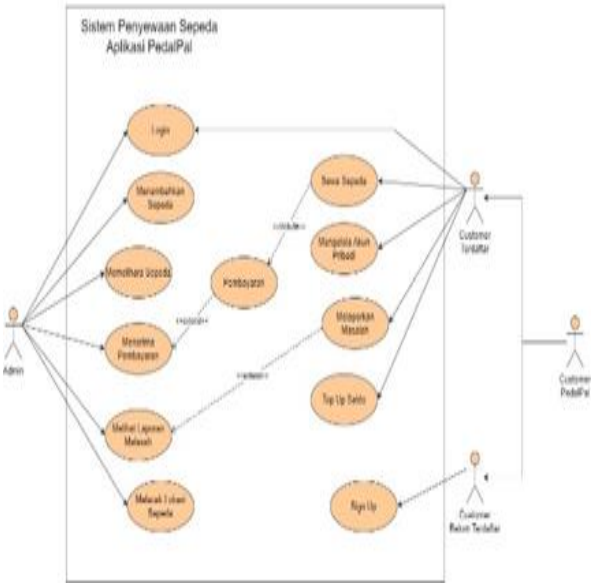

Fig. 2. PedalPal Use Case Diagram

Activity Diagrams

This particular section presents the Activity Diagrams which are related to the Business Process, and will be implemented in the application system.

Sign Up Activity Diagram

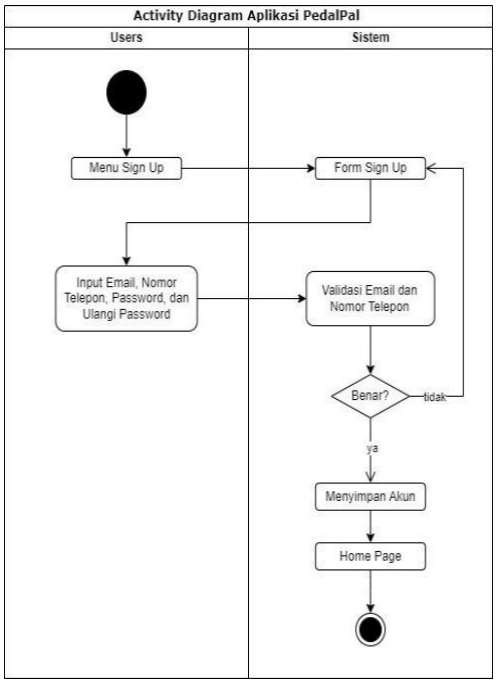

Fig. 3. Sign Up Activity Diagram

Login Activity Diagram

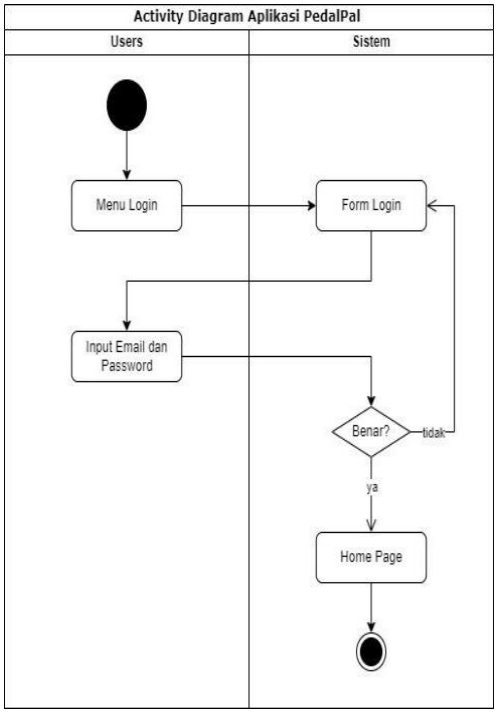

Fig. 4. Login Activity Diagram

Scan Activity Diagram

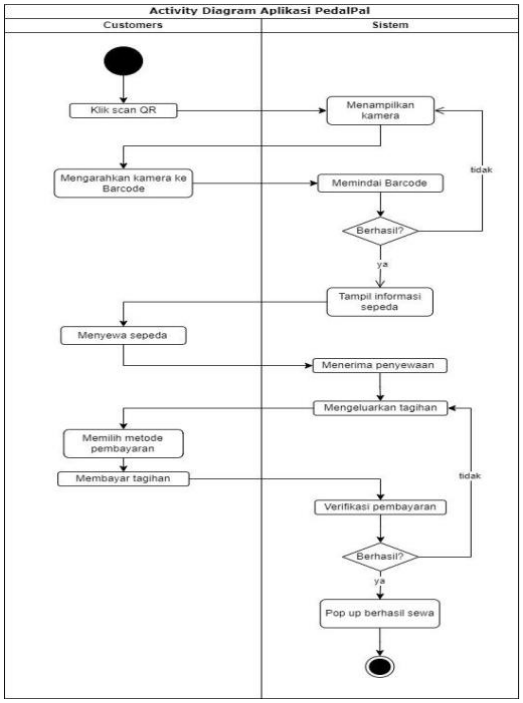

Fig. 5. Scan Activity Diagram

Profile Activity Diagram

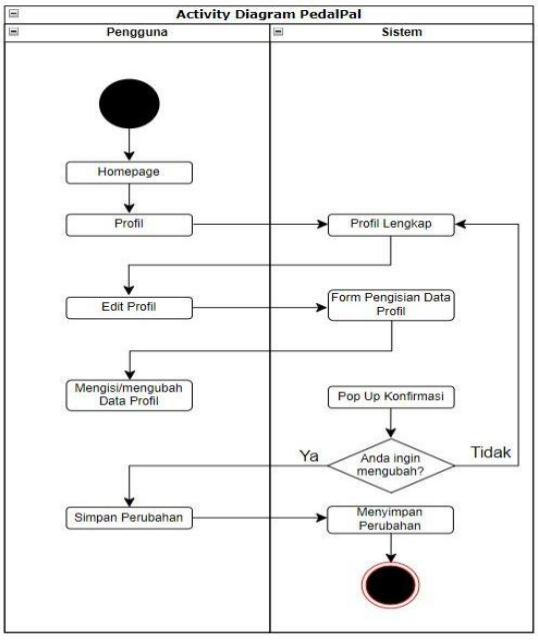

Fig. 6. Profile Activity Diagram

Settings Activity Diagram

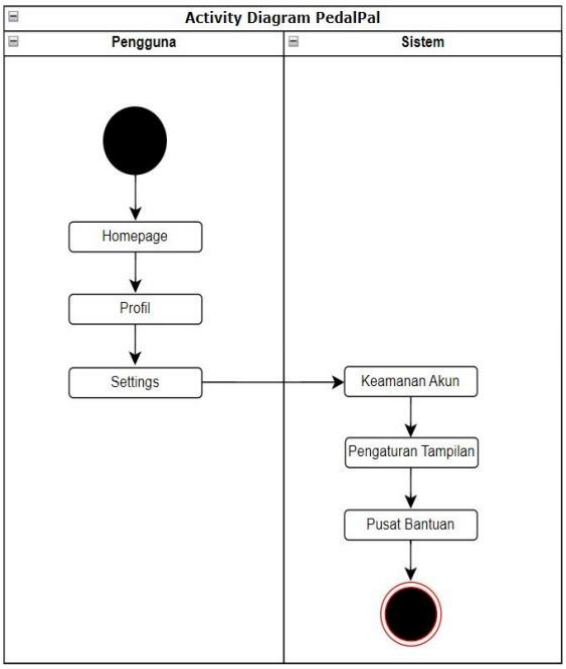

Fig. 7. Settings Activity Diagram

Rent Location Activity Diagram

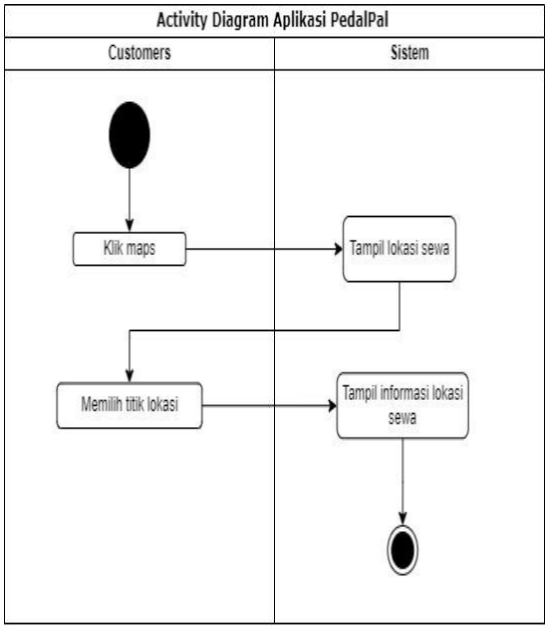

Fig. 8. Rent Location Activity Diagram

History Activity Diagram

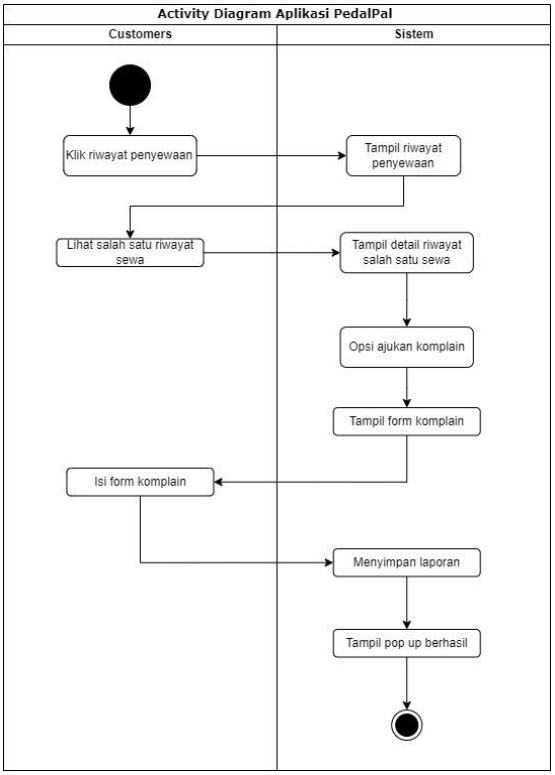

Fig. 9. History Activity Diagram

Logout Activity Diagram

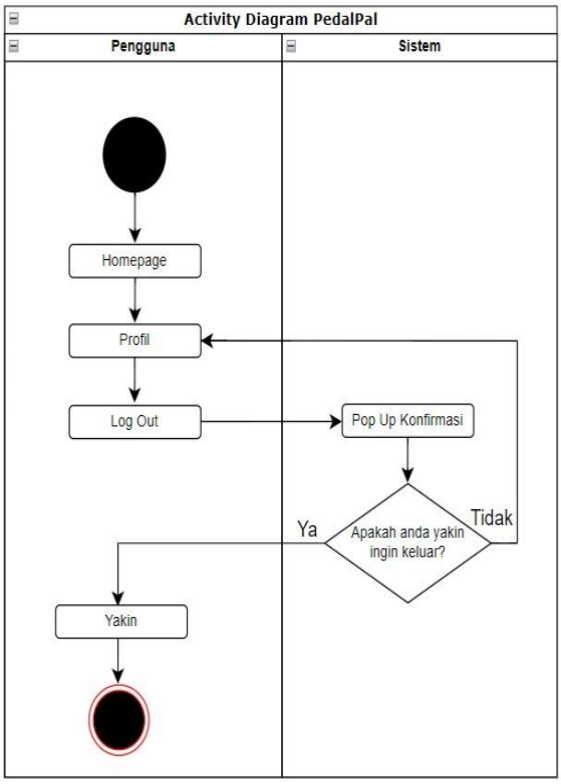

Fig. 10. Logout Activity Diagram

Sequence Diagrams

The following section shows the Sequence Diagram of the Mobile-based Electric Bicycle Rental System. In this section, several diagrams are presented which include among others:

Signup Sequence Diagram

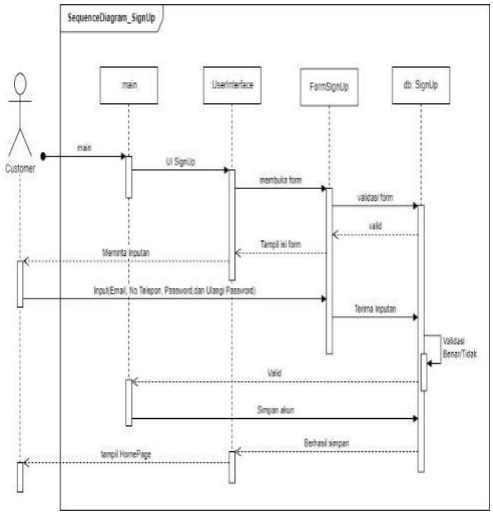

Fig. 11. Signup Sequence Diagram

Login Sequence Diagram

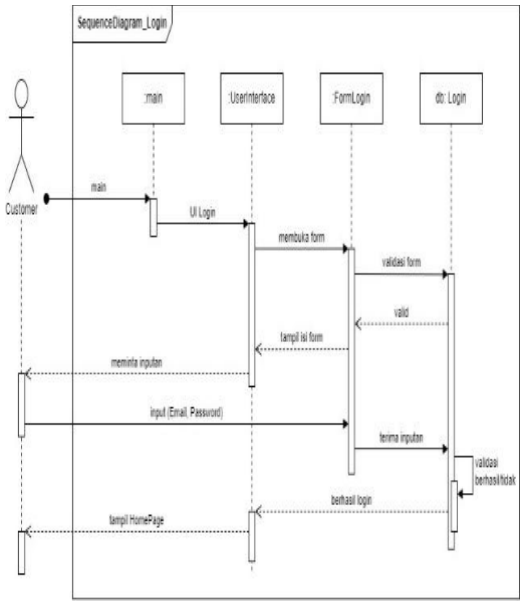

Fig. 12. Login Sequence Diagram

Scan Sequence Diagram

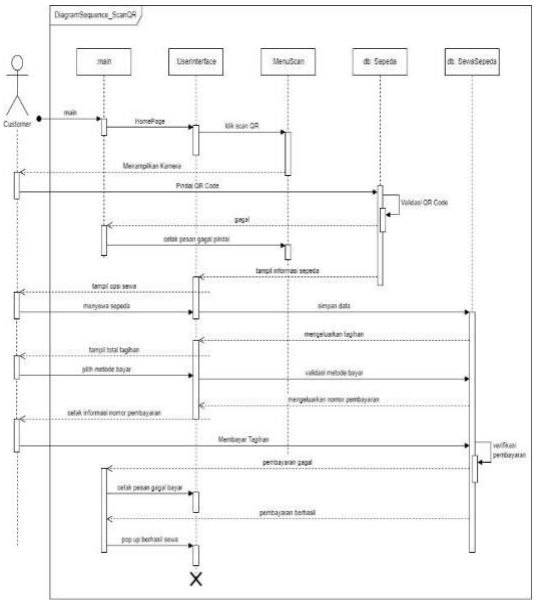

Fig. 13. Scan Sequence Diagram

Profile Sequence Diagram

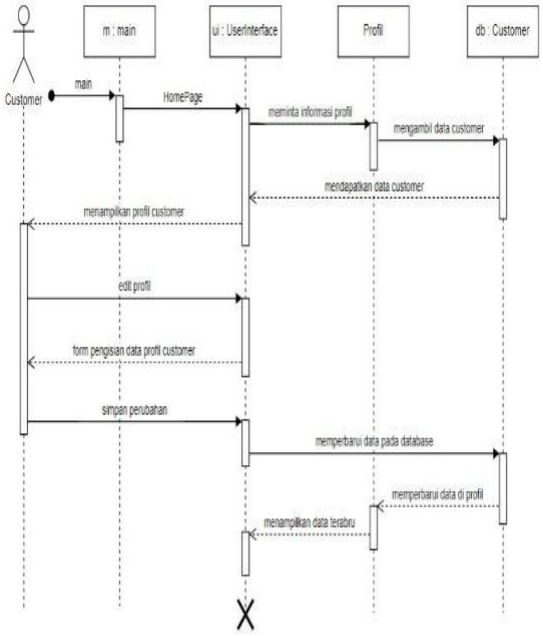

Fig. 14. Profile Sequence Diagram

Setting Sequence Diagram

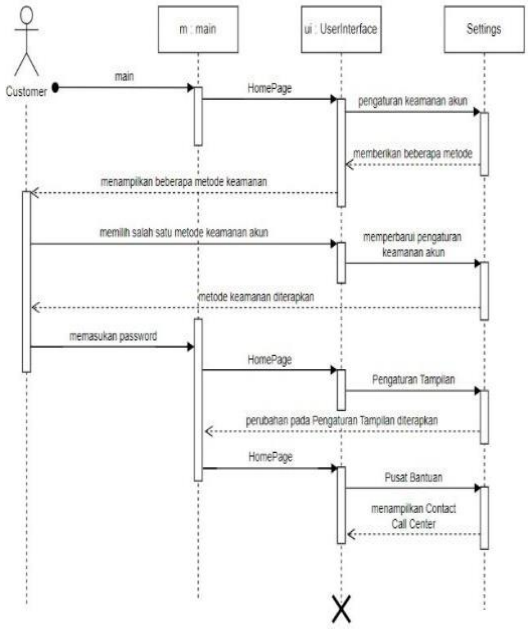

Fig. 15. Setting Sequence Diagram

Rent Location Sequence Diagram

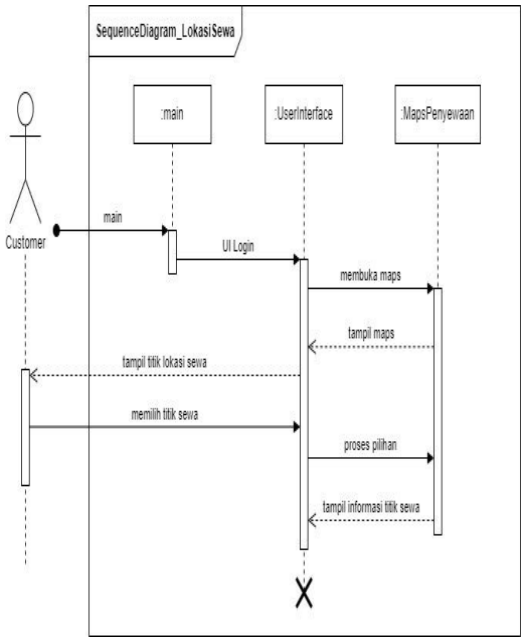

Fig. 16. Rent Location Sequence Diagram

History Sequence Diagram

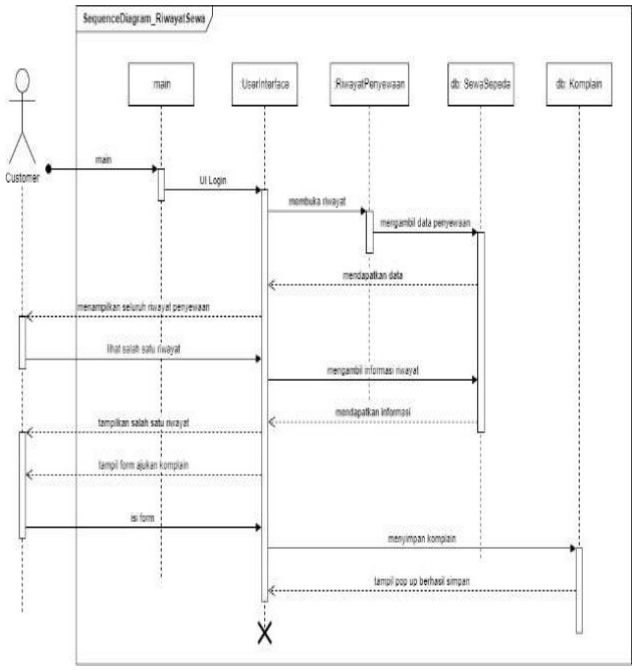

Fig. 17. History Sequence Diagram

Logout Sequence Diagram

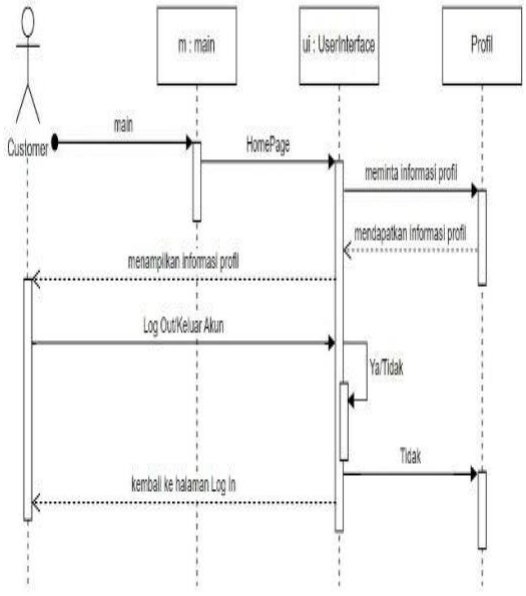

Fig. 18. Logout Sequence Diagram

Class Diagram

As shown in Figure 19, the class diagram depicts the structural relationships between the classes inside the system, along with their attributes/methods. This diagram also describes an overview of the Electric Bicycle Rental System as a whole, serving as the culmination of the preceding diagrams.

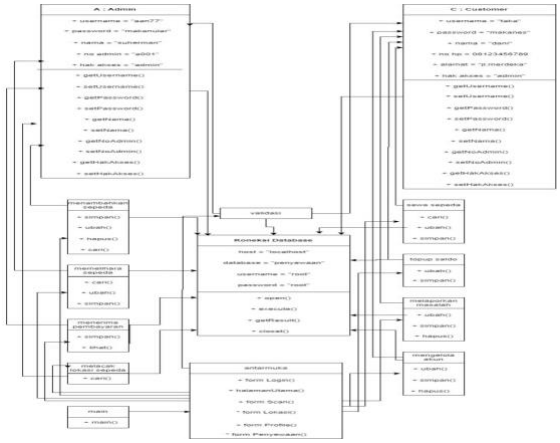

Fig. 19. Pedal Pal Class Diagram

IV. CONCLUSION

Information Technology advancements have significantly transformed the Transportation Industry, with the adoption of various innovations such as Cellular Transportation Booking and Electric Vehicles. Nevertheless, obstacles such as traffic safety and transportation system integration still require serious attention from regulators and industry experts [11-12]. The result of this study presents a comprehensive design of the Electric Bicycle Rental System, which is marked by well-structured UML Diagrams, efficient Database design and intuitive user interface. It is expected that this System will be an innovative solution in conquering efficiency and convenience hurdles in renting an Electric Bicycle.

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