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Website-Based Coin-Operated Charging Station Management System

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ABSTRACT

The increasing use of mobile devices has led to a growing demand for charging facilities in public spaces, including coffee shops. This trend often results in uncontrolled electricity consumption, causing additional operational costs for business owners. This study aims to design and develop a website-based coin-operated charging station management system to enable real-time monitoring of electricity usage. The research adopted the Waterfall model within the System Development Life Cycle (SDLC), encompassing the phases of planning, analysis, design, testing, and implementation. The proposed system was developed using the CodeIgniter 3 framework, PHP, HTML, CSS, MySQL, and a web-based monitoring platform integrated with a coin sensor and an energy monitoring module. The results demonstrate that the system is capable of monitoring and displaying real-time electrical parameters, including current, power, voltage, and coin transaction data, while simultaneously storing the collected information in a database for historical monitoring and analysis. The developed system provides coffee shop operators with an efficient and reliable solution for monitoring electricity consumption, thereby supporting better energy management and reducing unnecessary operational costs.

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I. INTRODUCTION

Electrical energy has become one of the most fundamental resources supporting modern society, playing a critical role in residential activities, educational institutions, public services, industrial operations, and commercial businesses. The rapid advancement of information and communication technologies has significantly accelerated the adoption of mobile devices, particularly smartphones, which have evolved into indispensable tools for communication, information access, digital transactions, navigation, entertainment, and various productivity-related activities. As smartphone usage continues to increase worldwide, the demand for accessible charging facilities has also grown substantially, particularly in public environments such as coffee shops, restaurants, transportation terminals, libraries, universities, and other commercial or community service areas [1].

Providing free charging facilities has become a common strategy adopted by business owners to improve customer satisfaction and attract more visitors. However, unrestricted access to charging stations often results in excessive and uncontrolled electricity consumption, leading to increased operational costs. In many small and medium-sized businesses, electricity usage associated with public charging facilities is rarely monitored or managed systematically. Consequently, business owners have limited visibility into actual energy consumption patterns, making it difficult to evaluate operational efficiency or implement effective energy management strategies. The absence of monitoring mechanisms also increases the likelihood of energy waste and unnecessary financial expenditure [2].

Preliminary observations conducted at Warkop Pa'dok Pacul, located in Tegal Regency, Indonesia, revealed that the existing charging facilities operate without any monitoring or access control mechanism. Customers are able to use electrical outlets freely, while the business owner has no means of identifying individual electricity consumption, monitoring real-time electrical parameters, or maintaining historical usage records. As a result, electricity consumption cannot be effectively controlled, potentially reducing operational efficiency and increasing monthly electricity expenses [3].

To address these challenges, this study proposes the development of a website-based coin-operated charging station management system that integrates a coin acceptor as an access control mechanism with a real-time electricity monitoring platform. The proposed system authorizes charging access only after a successful coin transaction, thereby enabling controlled electricity usage based on a pay-per-use concept. Furthermore, the system continuously monitors essential electrical parameters, including voltage, current, power consumption, and coin transaction data, while storing historical information in a centralized database accessible through a web-based dashboard. This approach enables business owners to supervise charging station operations remotely and analyze historical energy consumption to support more informed operational decisions [4][5].

The proposed system contributes to the development of intelligent energy management

solutions for commercial charging facilities by combining payment-based access control with real-time web monitoring into a single integrated platform. Unlike conventional charging stations that merely provide electrical access, the proposed system offers comprehensive monitoring, historical data management, and operational transparency, thereby improving energy efficiency, reducing unnecessary electricity consumption, and supporting sustainable management of public charging facilities in small commercial businesses [6][7].

II. MATERIALS AND METHODS

This study employed the System Development Life Cycle (SDLC) using the Waterfall model as the primary framework for system development [8][9]. The Waterfall model was selected because it provides a systematic, structured, and sequential software development process, making it well suited for developing a web-based monitoring application that requires clearly defined stages from requirement identification to system evaluation. The proposed development process consisted of five phases: planning, analysis, design, implementation, and testing, as illustrated in Figure 1.

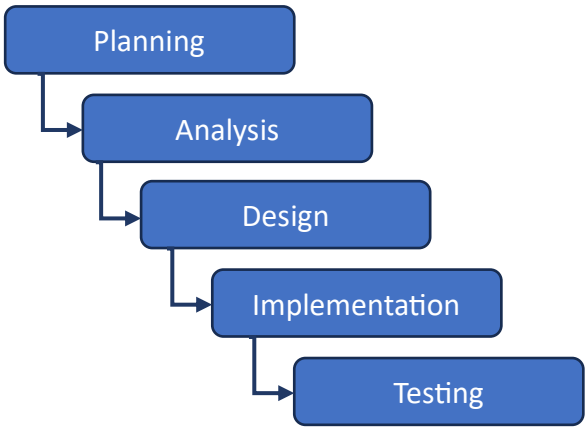

Figure 1. SDLC Method

A. Planning

The planning phase was conducted to identify system requirements and understand the operational problems encountered at the research site. Data were collected through direct field observations and semi-structured interviews with the coffee shop owner. Observations focused on the existing charging station facilities and electricity usage patterns, while interviews were conducted to identify operational challenges, user requirements, and the impact of electricity consumption on operational costs. The information obtained during this phase served as the foundation for defining both functional and non-functional requirements of the proposed system [10].

B. Analysis

The analysis phase aimed to determine the hardware and software specifications required for system development. Hardware analysis involved identifying the electronic components necessary to support the charging station, including the coin acceptor as the payment-based access control mechanism and the electrical energy monitoring module used to measure electrical parameters. Software analysis focused on selecting the development technologies required to implement the proposed system. The application was developed using Visual Studio Code as the integrated development environment (IDE), XAMPP as the local web server, PHP as the primary programming language, MySQL as the database management system, and the CodeIgniter 3 framework, which provides a lightweight Model–View–Controller (MVC) architecture for efficient web application development.

C. Design

The design phase involved modeling the proposed system to describe its structure, functionality, and interactions among system components. System modeling was performed using Unified Modeling Language (UML), including use case diagrams to illustrate interactions between users and system functions, activity diagrams to describe workflow processes, sequence diagrams to represent message exchanges among system objects, and class diagrams to define the relationships between classes, attributes, methods, and system entities. In addition, this phase included the design of the web-based user interface (UI), database schema, and system architecture to ensure efficient data processing and storage of monitoring information.

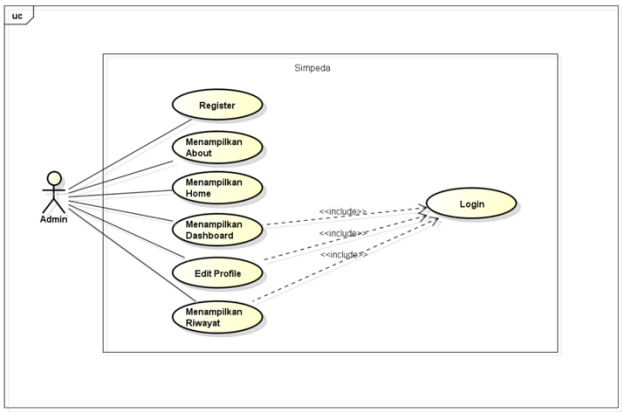

Figure 2. Use case diagram website-based coin-operated charging station management system

D. Implementation

During the implementation phase, the proposed design was transformed into a fully functional web-based charging station management system integrated with a coin acceptor and an electrical energy monitoring module. The system was developed to provide real-time monitoring of key electrical parameters, including voltage, current, power

consumption, and coin transaction data. All monitoring information is transmitted to the web server and automatically stored in a MySQL database, enabling users to access both real-time information and historical records through an interactive web dashboard. This integration allows business owners to supervise charging station operations efficiently and manage electricity consumption more effectively.

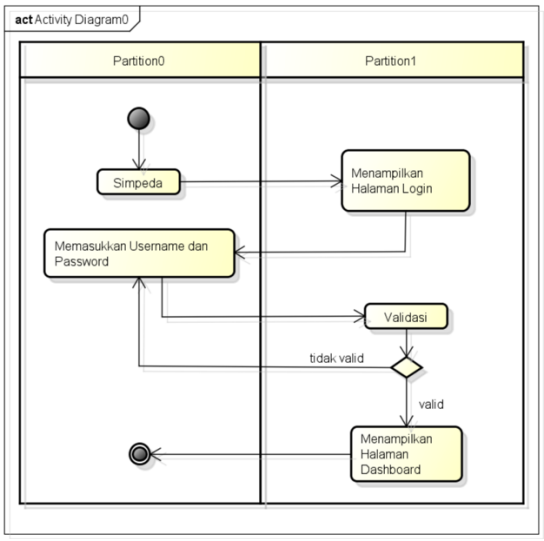

Figure 3. Activity diagram login form

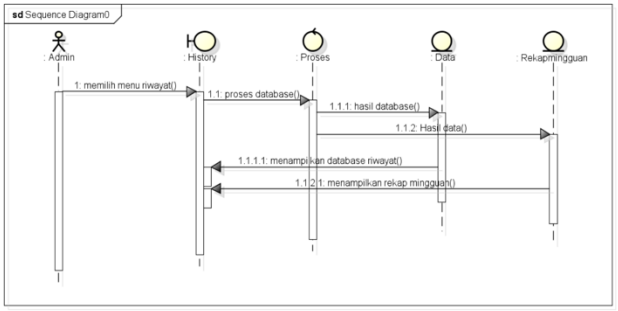

Figure 4. Sequence diagram form history

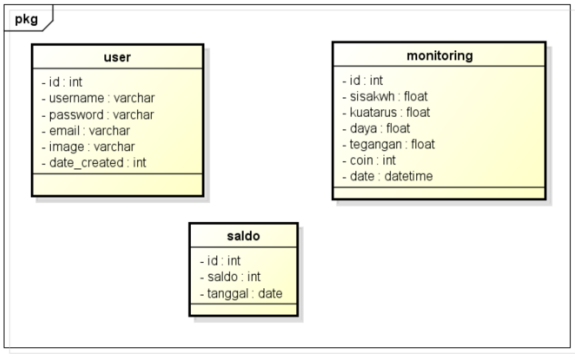

Figure 5. Class diagram system

E. Testing

The testing phase was conducted to verify that all system functionalities satisfied the predefined functional requirements. Functional testing included evaluation of user authentication, account registration, dashboard visualization, profile management, historical data storage, and data communication between the hardware modules and the web-based monitoring platform. Furthermore, the reliability of real-time data transmission and database storage was validated to ensure consistent system performance. The testing results were used to evaluate the functionality, reliability, and operational readiness of the proposed system before deployment in the actual coffee shop environment.

III. RESULTS AND DISCUSSION

The implementation results demonstrate that the proposed website-based coin-operated charging station management system was successfully developed as an integrated platform for managing and monitoring electricity consumption in commercial charging facilities. The web application consists of several core modules, including a Home page that serves as the main interface, Login and Register pages for user authentication and account management, a Monitoring Dashboard for real-time visualization of electrical parameters, an Edit Profile page for user information management, a History page for accessing historical monitoring records, and an About page containing general information about the developed system. The integration of these modules indicates that the proposed application functions not only as a real-time monitoring platform but also as a comprehensive management system for electricity usage and charging station operations [11].

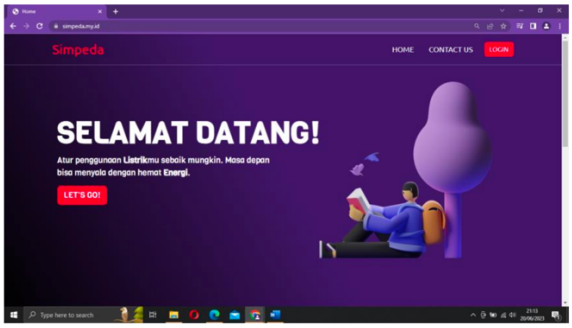

Figure 6. Home page system

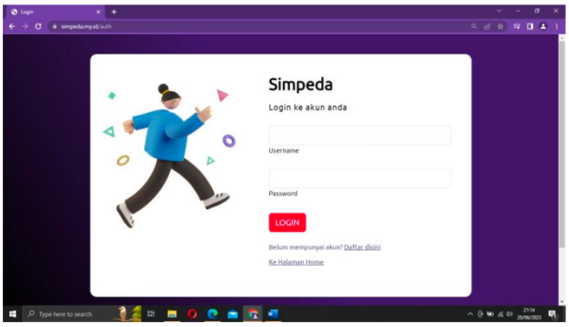

Figure 7. Login page

The monitoring dashboard was designed to present electrical parameters in real time, including voltage,

current, power consumption, and coin transaction information [12]. The displayed data are acquired from the integration between the coin acceptor, the electrical energy monitoring module, and the web server, enabling continuous acquisition, transmission, and visualization of operational data. This real-time monitoring capability allows both users and business owners to observe electricity consumption instantly, thereby improving operational transparency and facilitating more informed energy management decisions.

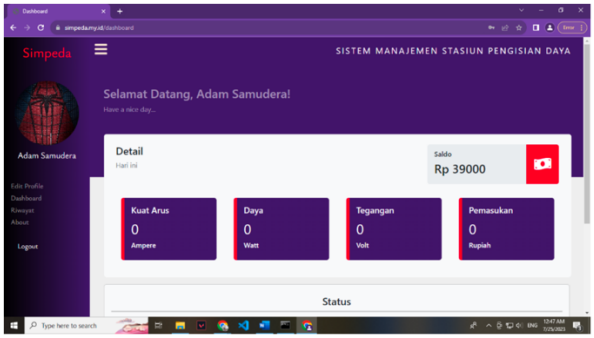

Figure 8. Dashboard

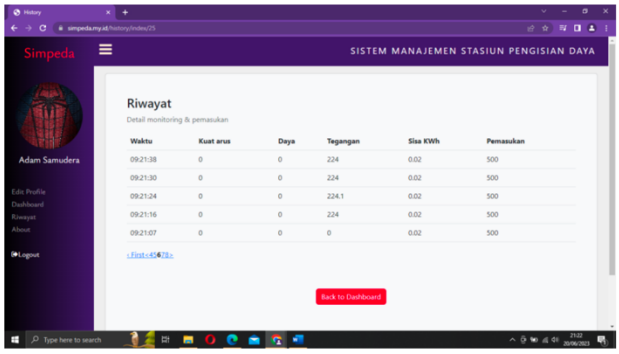

Figure 9. History page

Functional testing confirmed that all implemented features operated according to the predefined system requirements. User authentication, account management, dashboard visualization, monitoring data acquisition, historical data storage, and profile management were successfully executed without significant operational issues. Furthermore, the system reliably stored monitoring data in the MySQL database, allowing electricity usage records to be retrieved and analyzed for historical reporting and operational evaluation [13]. The successful synchronization between the hardware components and the web-based platform demonstrates the reliability of the proposed monitoring architecture for continuous operation.

The implementation of the coin-operated access mechanism significantly improves electricity management compared with conventional charging facilities that provide unrestricted access to electrical outlets. By requiring users to complete a coin transaction before activating the charging service, the system establishes a controlled pay-per-use mechanism that minimizes unnecessary electricity consumption. This approach enables business owners to regulate electricity usage more effectively while simultaneously generating operational revenue from charging services.

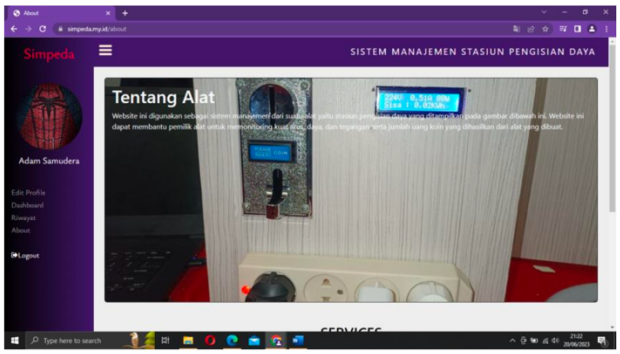

Figure 10. About page

Overall, the developed system provides an integrated solution that combines payment-based access control, real-time electricity monitoring, and historical data management within a single web-based platform. The implementation contributes to improved operational efficiency by reducing uncontrolled electricity consumption, increasing transparency in energy usage, and supporting evidence-based decision-making through continuous monitoring and historical data analysis [14]. Consequently, the proposed system represents a practical and cost-effective solution for managing public charging facilities in small commercial environments such as coffee shops, where electricity consumption must be monitored and controlled without compromising customer convenience.

IV. CONCLUSIONS

This study successfully developed a website-based coin-operated charging station management system capable of monitoring electricity consumption in real time. The proposed system effectively displays essential electrical parameters, including voltage, current, power consumption, and coin transaction information, while automatically storing historical monitoring data in a centralized database for subsequent analysis and operational evaluation. The integration of payment-based access control with real-time web monitoring provides a practical solution for managing public charging facilities more efficiently.

The implementation results demonstrate that the proposed system can assist business owners, particularly coffee shop operators, in controlling electricity usage, improving operational transparency, and minimizing unnecessary energy consumption. By enabling continuous monitoring and historical data analysis, the system supports more informed decision-making for energy management and operational cost optimization. Consequently, the proposed approach

offers a cost-effective and scalable solution for the management of commercial charging stations and has the potential to be adopted in various public service environments that require controlled access to electrical energy.

Future work will focus on integrating Internet of Things (IoT) technologies, cloud-based data analytics, mobile application support, and intelligent energy management algorithms to further enhance system scalability, accessibility, and automation.

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