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Implementation of the Advanced Encryption Standard 128 Algorithm in the Web-Based Management Information System

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Abstract

The manual management of student dormitory administration at Manado State University presents several challenges, particularly related to record accuracy, service effectiveness, and information protection. This research focuses on the development of a web-based dormitory management information system using the Advanced Encryption Standard (AES) 128-bit algorithm as a data security mechanism, particularly for payment documents. The research method used is a prototype model, which includes communication, rapid planning, modeling, prototype development, and testing. The system is implemented using PHP and MySQL, with the integration of AES-128 encryption in the payment receipt upload feature to ensure data confidentiality. The results of black-box testing show that all system functions run according to user requirements. The implementation of AES-128 has been proven to maintain the security of sensitive data and increase user trust in the system. Key features provided include user registration, room reservations, payments, facility reporting, and notifications, while administrators are given full access rights to manage resident and room data, as well as encrypt and decrypt important information. Overall, this research produces a system that not only improves the efficiency and effectiveness of dormitory management but also strengthens data security aspects. The developed system has the potential for further enhancement through mobile application integration and the implementation of an automated payment system to be more responsive to user needs. Cryptography is a field of science that utilizes mathematical techniques to ensure data and information security, including authentication, integrity, and validity

Introduction

Student dormitories are crucial facilities provided by higher education institutions to meet the accommodation needs of students, especially those from outside the region (Oke et al., 2017; Amoah et al., 2025; Shakantu & Simpeh, 2018; Utile, 2024; Bondinuba et al., 2013). Dormitories serve not only as a place to live but also as a forum for guidance and supervision, ensuring students can pursue their academic activities in a focused manner. However, dormitory management at UNIMA is currently still manual.

Alam et al. (2024) and Hsieh et al. (2013) said that, Resident data recording, room reservations, and payment management still use conventional methods, which often lead to various obstacles. Some of the issues that arise include delays in receiving information regarding room availability, inefficiencies in administrative processes, and weak protection

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of sensitive data such as resident identities and payment receipts. This situation can lead to the risk of information leaks and data misuse if not managed properly (Wong et al., 2019; Stone et al., 2019).

One frequently used cryptographic algorithm is the Advanced Encryption Standard (AES). This algorithm was designed by the National Institute of Standards and Technology (NIST) and is widely recognized as a modern encryption standard due to its high level of security, efficient performance, and flexible key length. The AES-128 variant was chosen because it provides an adequate level of security with a relatively low level of computational complexity, making it suitable for application in web-based information systems (Sahal et al., 2025; Sukiman et al., 2026; Ramakrishna & Shaik, 2024).

Based on this explanation, this study focuses on the application of the AES-128 algorithm to a web-based student dormitory management information system at Manado State University. This system is expected to improve administrative efficiency while ensuring the security of dormitory resident data. Previous research conducted by Siagian et al. (2020) "Designing a Web-Based and Android Application Information and Management System for Telkom University Female Dormitories," aimed to design and develop a web-based and Android-based information and management system for Telkom University Female Dormitories.

This application was designed to address various challenges in dormitory management, such as recording resident data, key handover processes, package management, guest management, and complaints, which were previously handled conventionally. The application was developed using the PHP and Java programming languages, with a MySQL database, while the Android application was developed using Android Studio. System testing was conducted using the Mean Opinion Score (MOS) method.

Previous research conducted by Esra Krismonika Siagian et al., "Designing a Web-Based and Android Application Information and Management System for Telkom University Female Dormitories," aimed to design and develop a web-based and Android-based information and management system for Telkom University Female Dormitories. This application is designed to address various challenges in dormitory management, such as resident data recording, key handover process, package management, guest management, and complaints, which were previously carried out conventionally.

The application was developed using PHP and Java programming languages, with a MySQL database, while the Android application was developed using Android Studio. System testing was carried out using the Mean Opinion Score (MOS) method. Research conducted by Putra compared the performance of the Advanced Encryption Standard (AES) and Twofish algorithms in encrypting National Identification Number (NIK) data using the Strict Avalanche Criterion (SAC) method.

The results showed that AES encryption time ranged from 1.1 ms to 4.4 ms, while Twofish had an encryption time between 1.9 ms and 7.1 ms. Although the difference in decryption time between the two was not too significant, the AES algorithm had a margin of error of 0.27, which was smaller than Twofish with a value of 1.03. This indicates that AES is more consistent in meeting the SAC criteria, which is an important indicator in assessing the strength of bit propagation in symmetric cryptographic algorithms (Putra et al., 2021).

Methods

Research Stages

This research was structured using a systematic research flow to achieve its objectives in a focused manner. The method used was a prototyping approach, as the information system

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design was based on the characteristics of the problems encountered in the UNIMA student dormitory. The main issues encountered relate to dormitory management and the limited use of information technology to support the needs of students residing there. Therefore, a research approach is needed that not only analyzes the internal and external conditions of the dormitory but also produces a management information system design as a solution. The prototyping method was deemed appropriate because it can realistically illustrate both the potential and challenges faced. The following are the stages that will be developed in this research.

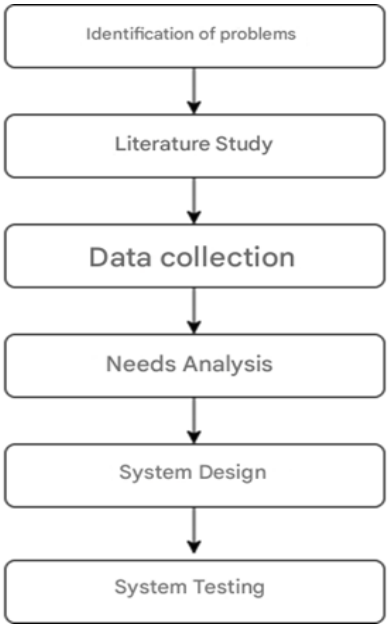

Figure 1. Research stages

This research was conducted through several stages: (1) The initial stage of this research was carried out by identifying a problem within the student dormitory management system. The main problem that emerged was the lack of manual dormitory data management, which hampers the fast and efficient delivery of information, particularly regarding student registration and room availability; (2) This research reviewed relevant literature regarding system development approaches using a prototype method. The literature review phase was conducted by searching and reviewing various references from online sources. The primary focus was on the implementation of the AES algorithm in a web-based system, with the aim of building an adequate theoretical foundation as a basis for system design and development; (3) This research collected data using two different approaches: primary data and secondary data. Primary data was obtained through direct observation in student dormitories and interviews with dormitory managers. Secondary data was obtained from official reports from dormitory managers and students residing in the dormitories; (4) System requirements analysis to determine functional requirements. This system must have the following features: User Features: Users must be able to create accounts, register, view available rooms, book rooms, and make online payments. They must also be able to view the history of occupied rooms and report any damage to facilities. The system will also send automatic notifications regarding payments. Non-Functional Requirements: Overall, this system must be accessible anytime and anywhere. It supports the registration, payment, and reporting processes for facilities; (5) This research conducted a system design. The system development process began with rapid planning after data and information were collected from the student dormitory management. At this stage, observation and interview results were

ISSN: 2716-3865 (Print), 2721-1290 (Online)

comprehensively analyzed to evaluate various aspects of dormitory management. Data related to room reservations was then used as the basis for developing a system development plan. In this process, the implementation of the AES-128-bit algorithm was crucial for analyzing dormitory management patterns in a more structured and secure manner; (6) System Testing Conducted in This Research: In the final phase of the research, we evaluated the dormitory management information system at Manado State University using the Black-Box Testing method. This approach focuses on testing the system's functionality through the interface, without requiring knowledge of internal program code. The results of this testing included evaluations of the admin interface (back-end) and the user interface (front-end), aiming to ensure each function worked according to specifications.

Data Collection Instruments

The following are the types of data and data collection instruments contained in the design of this system. It can be seen in Table 1.

Table 1. Data Collection Instruments

Instruments	Objectives	Respondents	Respondents
Literature Study	To study various references from relevant sources	Research Journal	Research Journal
Observation	To evaluate the condition of existing facilities and infrastructure	Hostel Location	Hostel Location
Interview	To identify obstacles and needs in developing a strategic development strategy	Management	Management

Table 2. Dormitory Student Data

Dormitory Student Data 2025	
Month	Number of Visits
January	24
February	23
March	23
Total	70

System Development Methods

This research will apply software development methods, This prototype method focuses on development that is carried out iteratively, involving users in every step. The main goal is to ensure that the final product of the developed system can match the expectations and needs of users. The prototype method is one way in system development, where the initial design of an application or software is designed to show its basic ideas and functions (Camburn et al., 2015; Miller, 2021). In this stage, the model created generally does not include all the features planned in the final version, but is able to provide an image of how the system works. This process involves creating an initial prototype which is then tested directly by users to get feedback that is used as a basis for making improvements and refinements until the system can finally be developed.

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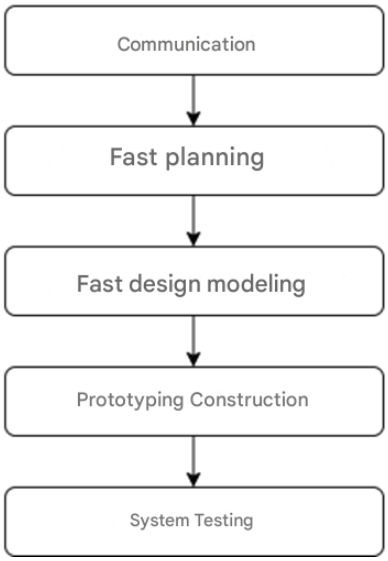

Figure 2. System Development Method

The following are the steps in the system development method:

Communication

Communication is the phase where developers and users engage in dialogue to deepen and define the objectives of the system to be created (Misnevs & Demiray, 2017; Pacheco-Velazquez, 2023; Kocielnik et al., 2018). There are two phases: functional requirements analysis and non-functional requirements analysis.

Transparency of Room Availability

Students reported significant difficulties in obtaining real-time information regarding room vacancies, often resulting in physical visits that were inefficient. This specific insight drove the requirement for the "Room Search" and "Dormitory Dashboard" features, which allow users to view occupancy status in real-time without administrative intervention.

Payment Verification Latency

Managers highlighted that manual reconciliation of payment receipts with bank transfers was the primary cause of administrative delays and data errors (Kusumba, 2023). Consequently, the planning phase prioritized the "Payment Receipt Upload" feature integrated with a verification backend to streamline this workflow.

Data Privacy Concerns

A key finding from the interviews was the anxiety regarding the storage of sensitive personal data (identities and financial proofs) in an open web environment (Kusumba, 2023; Mahmud & Fitriani, 2025). This direct feedback necessitated the inclusion of a cryptographic security layer, specifically leading to the decision to encrypt sensitive fields rather than storing them as plain text.

Rapid Planning

Once the software overview is understood, the next stage is to develop a structured yet flexible work plan to adapt to feedback and maintain research focus and direction. Based on the specific pain points identified above, the rapid planning phase focused on designing a structured yet flexible work plan. Unlike generic system designs, the planning for this system was tailored to address the "inefficiencies in administrative processes" found during the

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investigation. The plan prioritized the development of a secure backend capable of handling AES-128 encryption for file uploads a direct response to the identified risk of information leaks. This stage established that the system would not merely record data, but actively protect it, ensuring that the solution was proportionate to the risks identified by the stakeholders

Rapid Plan Modeling

Design modeling involves developing an initial prototype of the system, including user interfaces, key features, and a basic data framework to support occupant registration, room assignments, payment processing, facility monitoring, and dormitory payment reminders.

Prototype Construction

In this phase, researchers create a prototype based on the design, incorporating the AES-128 algorithm to analyze dormitory registration, and conduct initial testing to ensure feature functionality before proceeding with more in-depth testing with users.

System Handover

In this phase, users evaluate the prototype and provide feedback for improvements. This stage is repeated until the system meets the objectives, then the researcher submits the results to the student dormitory manager along with recommendations for improving the specifications.

Results and Discussion

The prototype method was chosen as the approach to developing the application of the AES (Advanced Encryption Standard) 128 algorithm to the student dormitory management information system. Five prototypes will be produced during the implementation and tested to ensure the system meets the criteria and standards desired by potential users. The following are the results of the five prototypes tested.

Justification for Selecting AES-128 Algorithm

The implementation of the Advanced Encryption Standard (AES) with a 128-bit key length was a calculated decision based on a balance between security strength, computational performance, and data proportionality. While higher-bit variants such as AES-256 offer a marginally higher theoretical resistance to brute-force attacks, the selection of AES-128 for this dormitory management system is justified by three key factors:

Performance vs. Computational Overhead

AES-128 requires fewer processing rounds (10 rounds) compared to AES-256 (14 rounds). In the context of a web-based system accessed by multiple users simultaneously, maintaining low latency is crucial for user experience. Previous research by Putra et al. (2021) comparing AES and Twofish algorithms demonstrated that AES encryption times are significantly efficient (1.1 ms to 4.4 ms), providing a faster response time than competitors while maintaining superior consistency in bit propagation. Implementing a heavier algorithm like AES-256 would impose unnecessary computational load on the server without providing a practical security benefit relevant to the nature of the data.

Proportionality of Data Sensitivity

The data managed in this system primarily student identities and payment receipts is classified as sensitive but does not constitute top-secret or military-grade intelligence requiring the maximum existing cryptographic depth. AES-128 provides a security margin that is exponentially difficult to breach with current computing power, making it entirely sufficient for protecting administrative data from unauthorized access or interception.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Consistency and Standard Compliance

AES-128 is a NIST-standardized algorithm known for its stability. The study specifically utilized AES because it has a smaller margin of error (0.27) in meeting Strict Avalanche Criterion (SAC) compared to algorithms like Twofish (1.03), ensuring that the encrypted data (ciphertext) is robustly randomized and secure against pattern analysis attacks. By choosing AES-128, this research avoids the pitfall of "over-engineering" security at the cost of system performance, ensuring the dormitory system remains responsive for students while providing a proven, robust layer of protection for their personal information.

Communication

Alipour et al. (2024) said that, the communication phase of this research includes the process of collecting data obtained while the researcher was staying in the student dormitory. During the communication phase, the researcher conducted direct observations of the research subjects and conducted face-to-face interviews with dormitory managers to obtain relevant information. From these interviews, two types of needs analysis were obtained as the basis for system development.

Rapid Planning

The first step in the system development process begins with rapid planning after information and data are collected from the dormitory managers (Wen & Fang, 2021). At this stage, the results of the observations and interviews are thoroughly analyzed to assess various aspects of dormitory management. Data related to room reservations is then used as the basis for designing a system development plan. In this process, the application of the AES-128 algorithm is a crucial element in analyzing dormitory management patterns in a more structured and secure manner.

Rapid Design Modeling

At this stage, the research planning for implementing the AES security algorithm in the web-based student dormitory management system at Manado State University begins with the creation of a system architecture as a foundation for development. The design was carried out using the Unified Modeling Language (UML), which includes use case diagrams for interactions between users (admins and students), activity diagrams for the dormitory registration process, and class diagrams that illustrate the data structure and relationships between system elements.

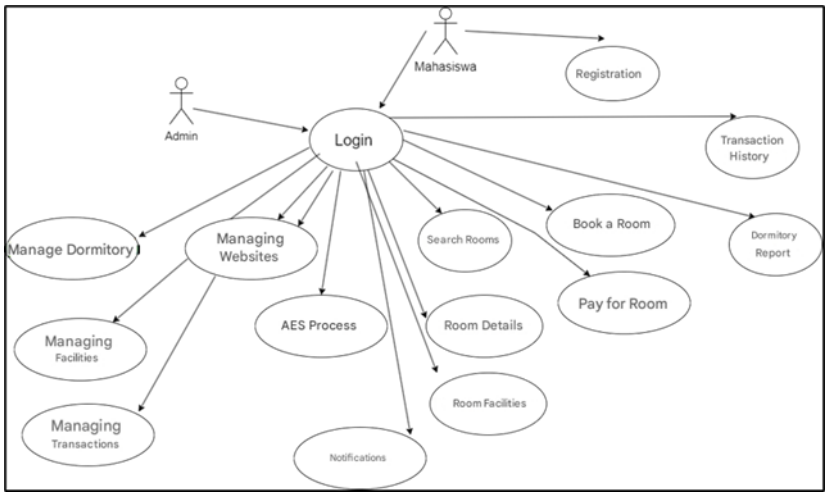

Figure 3. Use Case Diagrram

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Figure 3 depicts a use case diagram with two main actors: students and administrators, each with istinct roles within the system. Students are required to register an account as the initial step to gain access. Students can then log in to the system to view room and facility availability, make reservations, monitor payment status and transaction history, report facility damage, and receive notifications regarding late payments. Admins, on the other hand, play a role in the overall management of the dormitory system and operations (Altinay et al., 2024). Through an account with valid credentials, admins have access to manage dormitory and facility data, process room reservation transactions, and implement data encryption using the AES algorithm. Admins are also tasked with ensuring system stability so that all functions can run as designed.

Prototype Construction

The prototype for the Manado State University dormitory management information system was developed using PHP version 8.0.5 and MySQL, managed through phpMyAdmin within the Laragon environment. Visual Studio Code was used as the text editor, and Mozilla Firefox served as the web browser.

Admin/User Web Page Display (Front-End)

The user interface includes several essential features designed to support dormitory management and user interaction in an integrated manner. It begins with a Login Page that functions as the main access gateway, allowing users to enter their registered accounts and passwords, followed by a Registration Page that enables new users to create accounts by submitting their identity data in order to access services such as room availability and facility information. Once logged in, users are directed to the Dormitory Dashboard, which presents room reservation details, available facilities, and navigation to the payment process. An Info Page is provided to display payment instructions and dormitory management contact information for booking confirmation. The My Room menu allows users to view transaction history, room details, and payment schedules, and requires users to upload proof of payment for verification purposes. In addition, the system includes a Facility Report Page that allows users to report facility damage by entering location information, descriptions, and additional authentication through an encrypted password; in this process, the AES-128 algorithm is implemented to ensure the confidentiality and security of the reported data.

Admin Web Page View (Back-End)

The admin panel provides comprehensive access for managing dormitory operations in a secure and integrated manner. It begins with a Login Page that ensures system security through encrypted authentication using a username and password. After successful login, the Admin Dashboard displays student payment data to support the verification process. The Dormitory Menu enables administrators to manage dormitory building data, including updating or deleting records as needed. The Room Menu is used to update information on vacant rooms, manage room facilities, and verify students' proof of payment, which is encrypted and then decrypted using the AES-128 algorithm to display the data in its original form. In addition, the Facility Report Menu supports the monitoring of facility damage reports submitted by students; each report is stored in encrypted form and can only be accessed through AES-128 decryption, thereby ensuring the confidentiality and security of sensitive information.

Class Diagram

Class diagrams represent the attributes and elements of a system, while also presenting the methods or functions that modify or manipulate the state of those elements (Ben et al., 2016).

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Furthermore, class diagrams serve as a visualization tool to show the structure and relationships between classes and objects within the system. The following section shows a class diagram of a website under development.

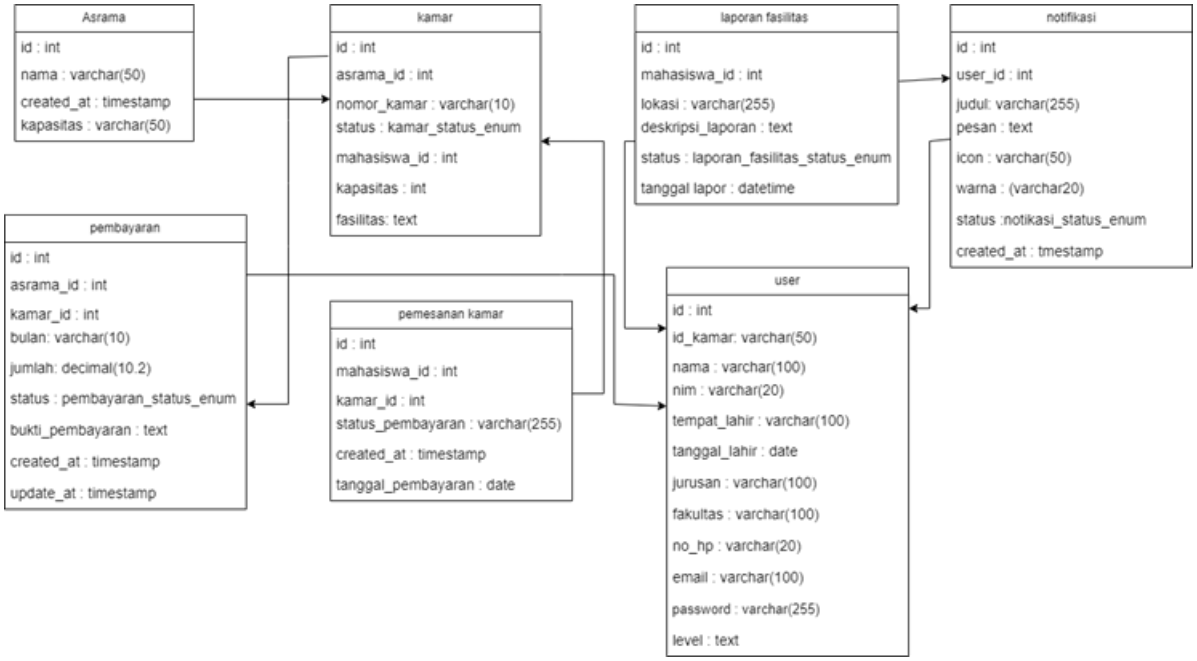

Figure 4. Class Diagram

System testing In the final stage of this research, the author evaluated the student dormitory management system using the black-box testing method. This method is a software testing approach that focuses on observing the system's functionality through the user interface, without requiring an understanding of the internal structure of the program code. This testing aims to ensure that every function in the system operates according to predetermined specifications. The test results were conducted on two sides of the system: the admin interface (backend) and the user interface (front-end).

Login Page Menu Display

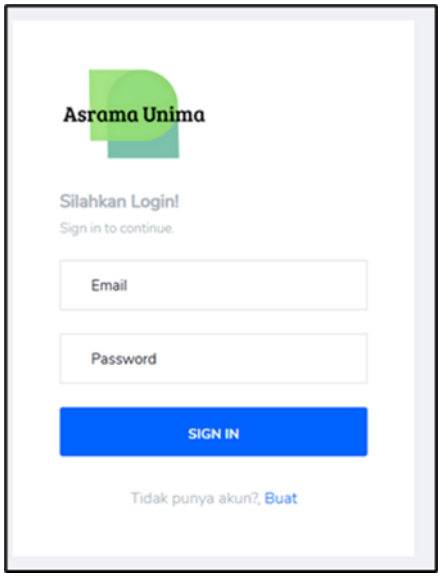

Figure 5. Menu Login

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Figure 5 shows the user login screen. This page serves as a gateway for users to access the dormitory management system. On this page, users are asked to enter the username and password previously registered in the database.

Dormitory Dashboard Page Menu Display

Figure 6. Menu Dashboard Asrama

Figure 6 displays the dormitory site, which contains a complete guide to booking a room. On this page, users can find various functions accessible after successfully logging in and then making a room reservation. This process begins by selecting a dormitory and an unoccupied room. The system then displays details of the room's amenities. Once all selection steps are complete, users are directed to the payment page to complete the booking process.

Encryption View

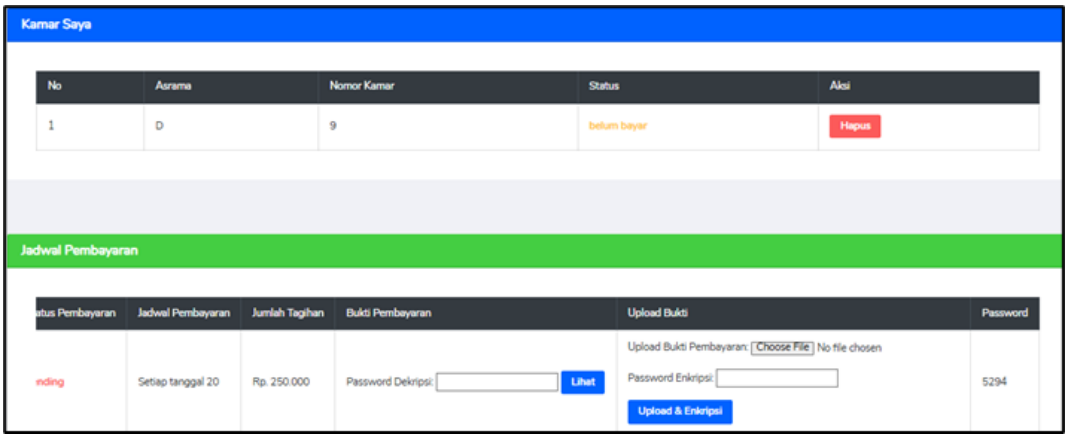

Figure 7. Enkripsi

In Figure 7, it displays the dormitory fee payment menu section where students or dormitory residents after making a payment will upload proof of payment and enter an encryption password where the AES-128 application in the proof of payment section is uploaded to the student's account. In this section, information such as transaction number, dormitory name, room number, and payment status is listed. In addition, there are also details regarding the dormitory fee payment schedule which has a deadline of every 20th of each month. Users are required to upload proof of payment through the system so that the manager can verify that the payment has been made.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Description Display

Figure 6. Description Display

Figure 6 shows the description section, where the administrator can view students who have paid or uploaded proof of dormitory fees by entering the encrypted password. Students who have uploaded proof of dormitory fees can also view their own. The administrator's job here is to verify students who have paid the dormitory fees.

Program Design

The program design of the web-based Student Dormitory Management Information System was developed to ensure usability, data security, and efficient administrative processes. The design is structured into two main components: system architecture design and user interface design.

System Architecture Design

The system adopts a client–server architecture, where users access the application through a web browser as the client, while the server is responsible for processing application logic and managing data storage. The system was developed using PHP as the server-side programming language and MySQL as the database management system. The implementation of the AES-128 encryption algorithm is embedded at the application layer, particularly in handling sensitive data such as payment receipts and facility damage reports. Before being stored in the database, sensitive user data are encrypted using AES-128 to ensure confidentiality and prevent unauthorized access. Only authorized administrators with valid credentials and encryption keys can perform the decryption process for verification purposes.

The overall system workflow can be summarized as follows: (1) Users authenticate themselves through the login module; (2) Users submit dormitory-related data, including room reservations and payment information; (3) Sensitive data are encrypted using the AES-128 algorithm; (4) Encrypted data are stored securely in the database; (5) Administrators retrieve and decrypt the data for validation and management. This architectural design ensures a balance between system performance and data security, making it suitable for a multi-user web-based environment.

User Interface Design

The user interface (UI) design emphasizes simplicity, accessibility, and role-based access control. The system interface is divided into two categories based on user roles: students and administrators.

Student Interface Design

The student interface provides several functional modules, including: (1) Login and Registration Module, which allows users to create and authenticate accounts; (2) Dormitory Dashboard, which displays real-time information on room availability and dormitory facilities; (3) Room Reservation Module, enabling students to select and reserve available rooms; (4) Payment Module, where students upload payment receipts that are encrypted using the AES-128 algorithm; (5) Facility Reporting Module, allowing students to submit damage

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reports with encrypted data to maintain confidentiality. This interface design enables students to independently access dormitory services in an efficient and secure manner.

Administrator Interface Design

The administrator interface is designed to support comprehensive dormitory management functions, including: (1) Administrator Dashboard, which presents summarized information on occupancy and payment status; (2) Dormitory and Room Management Modules, used to manage dormitory, room, and facility data; (3) Payment Verification Module, where administrators decrypt encrypted payment receipts using AES-128 for validation; (4) Facility Report Management Module, which allows administrators to review and respond to encrypted facility damage reports. Through this program design, the developed system enhances administrative efficiency while ensuring the confidentiality and integrity of sensitive user data through the application of AES-128 encryption.

Conclusion

This research was conducted to answer the problem Based on the results of the research and implementation of the student dormitory management information system with the application of the AES-128 algorithm, there are several suggestions that can be developed for future system development. Development of mobile applications to increase access flexibility. The proposed system should be made in the form of a mobile application (Android/iOS) so that students and administrators can obtain services in an easier way without having to rely on computers. With the mobile application, convenience and comfort for users. Automatic payment services. Future systems should be equipped with automatic payment transaction features, for example through integration with e-wallet services or bank transfers. This feature allows students to make payments directly through the system, while proof of transactions can be automatically verified by the administrator without requiring a manual confirmation process. Application of cryptographic methods. This study applies the Advanced Encryption Standard (AES) algorithm with a 128-bit key length as a data security mechanism. For future research, it is recommended to explore more complex and adaptive cryptographic algorithms or methods to increase the effectiveness, integrity, and resilience of the system in protecting sensitive data.

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