SJCS Scientific Journal of Computer Science

futuristech PT. Teknologi Futuristik Indonesia

Date of publication September 11, 2025, date of current version September 11, 2025.
Digital Object Identifier ***10.64539/sjcs.v1i1.2025.39***

Article

A Waterfall Model Approach to Designing and Developing a Web-Based Housing Information System for Pioneer Residence

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The author(s) received no financial support for the research, authorship, and/or publication of this article.

Abstract: PT. Askata Properti Unggul is a property development company located in Mayang Mangurai, Kota Baru District, Jambi City, with its flagship project, Pioneer Residence. The company's marketing strategy has predominantly relied on conventional methods such as brochure distribution, billboard installation, exhibitions, and word-of-mouth promotion, which have proven to be less effective, inefficient, and costly. This study aims to develop a web-based housing information system as a digital promotional medium to improve marketing effectiveness. The system was developed using the Waterfall model, consisting of requirements analysis, system design, implementation, testing, and deployment. The results show that the Pioneer Residence website increased potential buyers by 45%, reduced promotional costs by 35%, and improved the efficiency of information delivery to consumers by 50% compared to conventional methods. Therefore, the implementation of a web-based information system is proven to be effective in expanding market reach, enhancing marketing performance, and providing consumers with convenient access to information for decision-making before visiting the housing site.

Keywords: Housing Information System; Web Application Development; PHP; MySQL Database; Waterfall Model

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1. Introduction

Housing is one of the fundamental human needs, alongside food and clothing, and is often considered based on several criteria such as price, location, available facilities, and the credibility of the developer. In the modern era, rapid advances in information technology have significantly transformed business promotion patterns, including within the property industry. Conventional promotional methods such as banners, printed advertisements, and word-of-mouth are now considered less effective in reaching a wider audience, thereby creating the need for companies to adopt digital-based media.

PT. Askata Properti Unggul, with its *Pioneer Residence* project, still relies primarily on traditional promotional strategies, even though competition in the property market is becoming increasingly tight. To address this challenge, a strategic solution is the development of a website that serves as an interactive promotional medium capable of delivering information more quickly, attractively, and efficiently to potential customers. Such an approach aligns with research indicating that digital marketing strategies can effectively increase housing sales [1]. Moreover, the implementation of web-based housing sales information systems has been proven to expand promotional reach and provide real-time information access for prospective buyers [2]. In addition, web-based lot marketing systems have been found to enhance transparency in transactions and improve customer satisfaction [3]. Therefore, developing a website is not only an innovative step but also a necessary strategy to strengthen competitiveness in the digital era. The use of digital media in property marketing has been shown to significantly impact promotional effectiveness. Ford et al. (2005) demonstrated that using the internet in real estate marketing not only expands market reach but can also increase property value by providing potential buyers with more transparent and accurate information. [4]

2. Previous Research

A review of prior research aims to provide an overview and theoretical foundation that supports the development of the information system in this study. This review also serves to identify existing research gaps, enabling the present study to contribute new insights to the advancement of knowledge in the relevant field.

- **Designing a Web-Based Modern Property Market Application Model Using the Waterfall Method** [5]
  The rapid development of information technology has significantly transformed the way people search for, buy, and rent properties. Traditional property markets still face challenges, such as limited information access and restricted marketing reach for property agents. To address these issues, Ainul Fuadah, Asti Wahyuni, Aura Yuri Aulidiana, Depytio Aswin, and Ferdi Andika (2024) developed a modern web-based property marketplace application that integrates innovative features, including intelligent search, location mapping, and comprehensive property information presentation. The application was developed using the Waterfall method, encompassing stages from requirements analysis, system design, implementation, testing, to maintenance. This approach ensures a structured development process, allowing each feature to be implemented clearly and systematically. Testing results showed that the application facilitates property searches, accelerates transaction processes, and enhances user satisfaction for both individual users and property agents. The study demonstrates that digital technology in the property sector not only improves efficiency but also fosters a more modern and interactive property marketplace.
- **Website-Based Housing Marketing Information System at PT. Trixie Graha Anugerah Using the Waterfall Method** [6]
  Previous research examined a company engaged in housing development and marketing in Bekasi Regency. The company's marketing activities were still conducted using conventional methods, such as printing and distributing brochures, hiring sales agents, and setting up promotional stands in public areas. These traditional approaches were considered less effective because they could not reach a wide range of potential customers and were relatively inefficient due to the high costs of printing promotional materials and renting exhibition spaces. To overcome these limitations, Laoli, Darmawan Kristiana, and Titin (2022) developed a web-based housing marketing information system. The system aimed to improve marketing effectiveness and efficiency by providing broader, more accurate, and easily accessible information to prospective customers. By utilizing web technology, the company could enhance its promotional reach while reducing operational costs, thereby supporting a more modern and interactive housing marketing approach.
- **Designing a Web-Based Home Marketing Information System at PT. Nakama Using the Waterfall Method** [7]
  Another study focused on the marketing system of a housing company in Bekasi, which still relied on conventional methods such as newspaper ads, billboards, banners, and sales agents. This approach was considered less effective and inefficient due to the high operational costs involved. To address these challenges and expand the company's marketing reach, Okto, Jos Putra, and Surya Hendra (2022) proposed the use of technology to support a more effective marketing strategy.
  The researchers emphasized the need for an application capable of implementing e-commerce by leveraging internet and web technologies. The study employed a descriptive methodology, which involved directly observing field issues, collecting data, and analyzing the information according to the research objectives. The results indicated that the company's website could function as a promotional medium to enhance marketing performance while reducing operational costs. Additionally, the website allowed prospective customers to explore housing options—including house types, prices, designs, and locations—before visiting in person, thereby simplifying the decision-making process.
- **Design and Construction of a Website-Based Housing Sales Information System at Puri Asri Property** [2]
  Web-based information systems can serve as an effective solution to streamline property promotion, marketing, and sales processes. However, despite the availability of numerous online platforms for property promotion, many housing developers still rely on traditional marketing methods, such as print advertisements or manual promotion via social media. These conventional approaches are considered less effective due to limited access to comprehensive information, restricted marketing reach, and the inability for prospective buyers to obtain real-time data. Furthermore, data management and transaction processes are often carried out manually, increasing the risk of errors and operational inefficiencies (Wijayanto, 2025).
- **Implementation of the Codeigniter Framework in the Design of the Griya Mandiri Housing Contribution Management Application** [8]
  Information technology has become an essential tool supporting various aspects of human life, including health, politics, culture, sports, security, and

economics. Its development is marked by the emergence of diverse information systems and applications, such as web-based, desktop, and mobile applications. A case study was conducted in the Griya Mandiri Housing Complex in Deli Tua, consisting of approximately 200 residential units. The complex implements monthly fees, such as security and waste collection charges, collected directly by management staff. In practice, the collection process requires staff to visit each household, and the management system still relies on manual methods, such as using physical books for reporting. This manual approach consumes significant time for data retrieval and increases the risk of inefficiency. To address these challenges, Ridwan, Muhammad Sinaga, and Tantri Hidayati Elsera (2022) emphasized the need to modernize housing management at Griya Mandiri by developing a web-based management application. Such an application is expected to streamline fee collection, simplify reporting, and enhance overall efficiency in housing management.

3. Information System Design

3.1. System Design Stages

The design stage is an important step to produce a stable and easily developed system in the future. The role has a crucial role because it determines the quality of the resulting system. According to Arif [9], design describes the general plan of a project activity along with specific activities in the planning. Rizky [10] defines design as the process of defining work using various techniques, which include architectural descriptions, component details, and limitations that may occur in the work. Meanwhile, Prahasta [11] states that design is the process of using principles and techniques to define devices, processes, or systems to a certain level of detail so that it allows the realization of their physical form, including software. Based on this opinion, it can be concluded that design is a description of a system that integrates separate components into a single unit, thus producing a system in accordance with the results of the analysis for problem solving.

3.2. Information Systems

A system is an entity consisting of components or elements that are interconnected to facilitate the flow of information, materials, or energy in order to achieve specific objectives. A system can be defined as a set of subsystems comprising elements, procedures, and components that are integrated to achieve a common goal [12], [13]. It can also be understood as a collection of interrelated and unified elements designed to accomplish predefined objectives. Thus, a system represents a collection of components that are interconnected and form a unified whole to achieve particular goals.

Information is data that has been processed into a form that is meaningful to the recipient and provides tangible value in decision-making [14]. It is also defined as processed data that becomes useful for the recipient and offers benefits in future decision-making processes [15]. Therefore, information can be understood as processed data that provides added value for its users.

An information system is a combination of work procedures, information, people, and information technology organized to achieve organizational objectives [16]. It can also be described as a system within an organization that facilitates daily transaction processing, supports operational and managerial functions, and provides necessary reports for both internal and external stakeholders [17]. Based on these definitions, an information system is an integrated set of data designed to generate outputs that support problem-solving and decision-making. Information systems play a crucial role in data management, including data collection, storage, processing, and presentation in an efficient manner [18].

3.3. Definition of Housing and Settlements

According to the Indonesian Law No. 4 of 1992 on Housing and Settlements, housing is an integral part of settlements, defined as a group of houses that function as a residential environment equipped with infrastructure and public facilities (Article 1, Paragraph 2) [19]. Furthermore, the Decree of the Minister of Settlements and Regional Infrastructure of the Republic of Indonesia No. 403/KPTS/M/2002 stipulates technical guidelines for the development of healthy housing, which include: (1) a house is a building that functions as a residence and a place for family development, protection from climate, and maintenance of family health; (2) a healthy house is defined as a residence that complies with technical health standards to protect occupants from potential hazards or health disturbances, thereby enabling the achievement of an optimal degree of health; and (3) housing is a group of houses that function as a residential environment equipped with infrastructure and environmental facilities.

In addition, Article 5, Paragraph 1 of the Regulation of the Minister of Home Affairs No. 5 of 1974 defines a Housing Development Company, also referred to as a *developer*, as a company engaged in the construction of various types of housing in large quantities on a designated land area, designed as a unified residential environment complete with supporting infrastructure and social facilities required by the community of residents [20].

3.4. Database

A database is a collection of data systematically stored in a computer and processed using software to generate information. A database can be understood as a

structured set of information stored in a computer and accessible through application programs [21]. Another definition describes a database as an integrated collection of data organized in such a way that it can be manipulated, retrieved, and searched accurately [22].

A database consists of interrelated elements forming relationships. The three fundamental elements that construct a database include: (1) **File/Entity**, an object where data or records are stored; (2) **Record**, each row of data contained within an entity; and (3) **Field/Attribute**, the columns of data within an entity. Thus, a database can be defined as a systematically stored set of data organized in relational tables, enabling the provision of accurate information through computer media. Moreover, database systems offer several advantages, including: (1) speed and ease of access, (2) centralized data control, (3) storage efficiency, (4) data availability, (5) security, (6) data independence, and (7) user-oriented views [23]. Nevertheless, database systems also present certain limitations, such as: (1) relatively high implementation costs, (2) time-consuming backup processes, (3) potential damage in the case of unauthorized access, and (4) system complexity that requires specialized expertise in management.

3.5. Research Framework

To support the smooth implementation of this research, a well-structured and systematic framework is required. This research framework serves as a guideline that outlines the stages to be undertaken in addressing the identified problems, ensuring that the research objectives can be achieved optimally. The framework is designed so that each stage of the research can be carried out sequentially and consistently, starting from problem identification, formulation of objectives, up to the preparation of the final report. By having this framework, the researcher is provided with a clear reference in conducting the study, while also ensuring that the outcomes are aligned with the intended goals. Figure 1 illustrates the research framework employed in this study.

Based on the research framework described above, each stage of the study can be explained as follows:

- **Problem Identification:** At this stage, the researcher identifies and formulates the problems addressed in the study to gain a clear understanding of the research focus. The identified issue concerns the dissemination of information about the Pioneer Residence housing project, which is still conducted through conventional methods such as advertisements, posters, and word-of-mouth promotion. Consequently, the delivery of the latest information to potential customers is slow and inefficient.
- **Literature Review:** This stage involves collecting theoretical foundations from various sources, including books, journals, and online articles, to serve as references that support and strengthen the content of the research. Furthermore, international research confirms that website design plays a significant role in influencing customer experience. Kristin & Alexandra (2024) emphasize that an interactive interface, simple navigation, and comprehensive property information can increase customer trust and satisfaction in online property transactions [24].
- **Data Collection:** The data collection process in this research includes: a. Direct Observation The researcher directly observed the information system used by PT. Askata Properti Unggul in marketing Pioneer Residence. The observation revealed that marketing activities are still carried out through advertisements, posters, and word-of-mouth, and no computerized system is available to provide up-to-date information to customers. b. Interview The interview method was conducted face-to-face between the researcher and the resource person to obtain accurate, reliable, and factual information related to the research problem. The interviews with the company owner indicated that marketing and information dissemination are still conducted through posters, advertisements, and word-of-mouth, leading to delays in delivering the latest information to consumers.
- **Data Analysis:** At this stage, the researcher designed the Pioneer Residence housing information system as a reference for website development, including the creation of use case diagrams, activity diagrams, and class diagrams.
- **System Development:** The researcher developed the system using the Waterfall model, as this method offers a more systematic and effective approach to designing the Pioneer Residence housing information system.

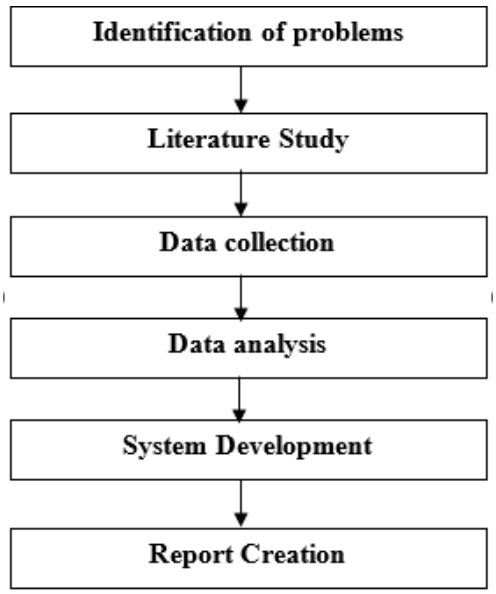

Figure 1. Research Framework.

Figure 2. Use Case Diagram.

- **Report Preparation:** This stage involves compiling the research report, which contains an overview of the problems and solutions identified in the Pioneer Residence case, relevant theories that support the study, research methods, results and analysis, and other necessary components to present the findings comprehensively.

3.6. Use Case Diagram

Rosa A.S and M. Shalahuddin [25] define a use case as a modeling technique that describes an interaction between one or more actors and the information system to be developed. There are two main components in a use case: the definition of actors and use cases themselves: An actor is a person, process, or another system that interacts with the system. A use case is the functionality provided by the system. Use cases represent the functionalities or system requirements that must be fulfilled from the perspective of the system user [26]. Figure 2 presents the Use Case Diagram of the new system at Pioneer Residence. It illustrates a single actor, the admin, who is associated with several use cases related to system management and operations.

The Class Diagram is one of the most fundamental and widely used UML diagrams. It represents the static view of a system, consisting of classes, relationships between classes (such as generalization, specialization, association, aggregation, and composition), as well as the operations and attributes of each class [27]. A Class Diagram "depicts the system structure in terms of the definition of classes to be created in order to build the system". Figure 3 presents the Class Diagram that illustrates the structure of the classes in the system being designed. This diagram shows the relationships between classes, along with their attributes and methods, serving as the foundation for developing the Pioneer Residence.

3.7. Development Methods

Figure 4 illustrates the Waterfall model, which was chosen for its simplicity and systematic, sequential development approach. In this model, each phase must be completed before moving to the next, ensuring that the output of one stage becomes the input for the following stage. The Waterfall model applied in this study consists of the phases in Figure 4. The following describes the stages in the Waterfall model:

- **Requirements Analysis:** In this stage, an analysis of the system requirements is conducted. The researcher identifies and classifies all necessary data for website development, including the analysis of data requirements, input processes, and output processes.

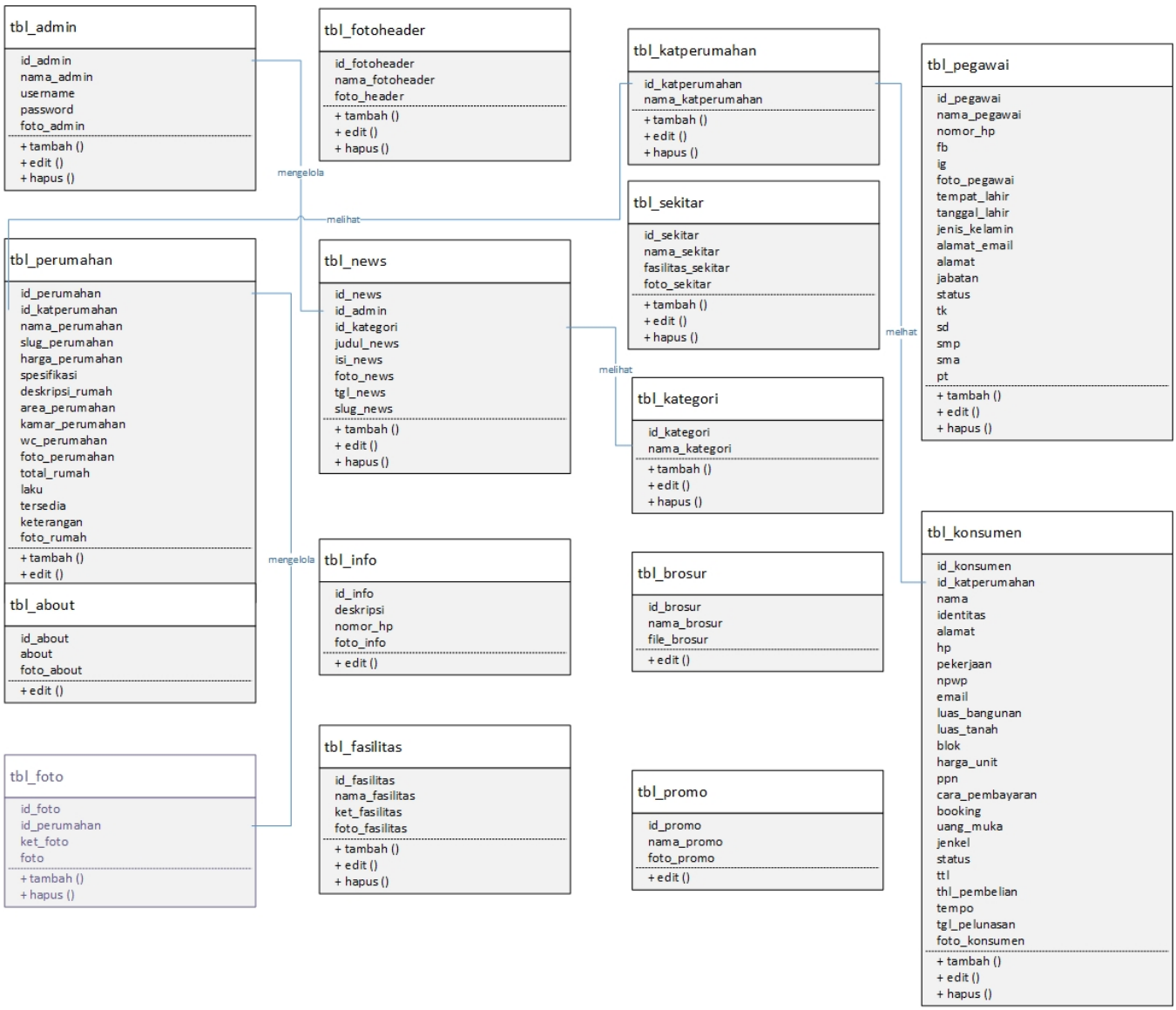

Figure 3. Class Diagram.

- **System Design:** This stage involves creating a blueprint for the system to be developed. The blueprint includes the design of use case diagrams, activity diagrams, class diagrams, input forms, output reports, and the database schema. This structured design ensures that the coding process will be more organized and efficient.
- **Implementation & Unit Testing:** In this stage, the website is developed based on the designs created in the previous stage, using the PHP programming language, MySQL database, and XAMPP as the local server environment. Each completed unit/module undergoes specific functional testing, followed by testing of the integrated modules and user interface to ensure that the program is free from errors.
- **System Testing:** The system testing of the Pioneer Residence Housing Information System was conducted using the Black-Box Testing approach, which focuses on verifying functional correctness based on input–output behavior without considering the internal code structure. Core features such as login, housing data management, unit search, booking, and report generation were tested to ensure compliance with user requirements. Each test case was marked Pass if the actual output matched the expected result, and Fail otherwise, with necessary corrections applied. This method has been proven effective for validating web-based information systems, as demonstrated by Febriyanti et al. [28] and Melo et al. [29].

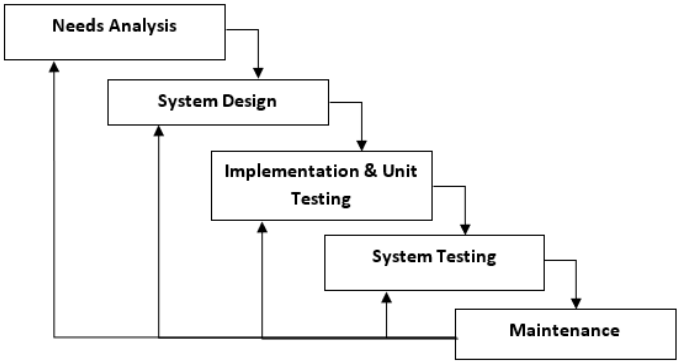

Figure 4. Waterfall Model (Agus Mulyanto) [30].

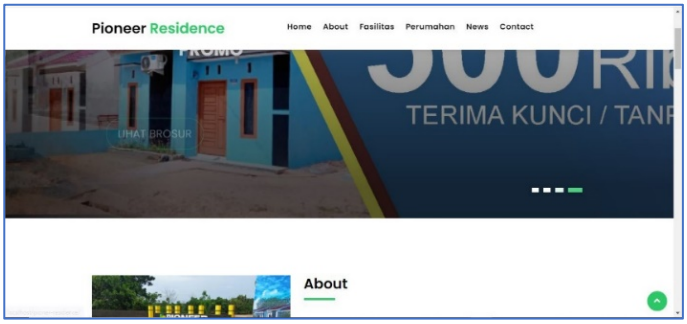

Figure 5. Home Page.

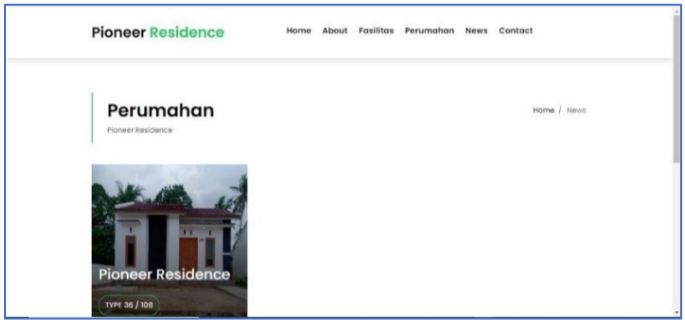

Figure 6. Housing Home Page.

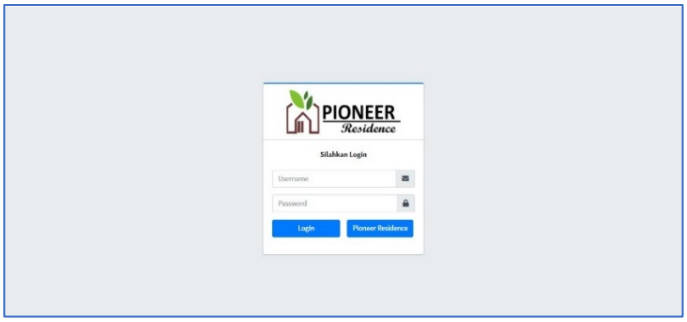

Figure 7. Login Page.

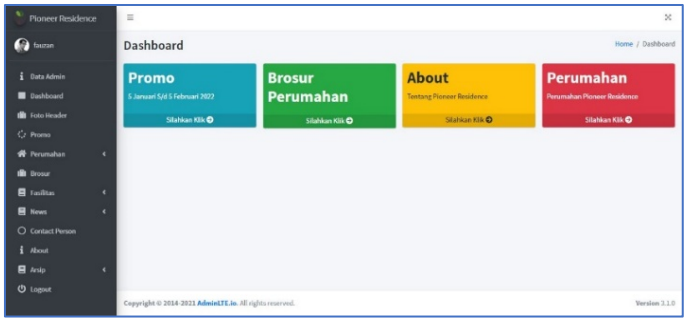

Figure 8. Admin Dashboard Page.

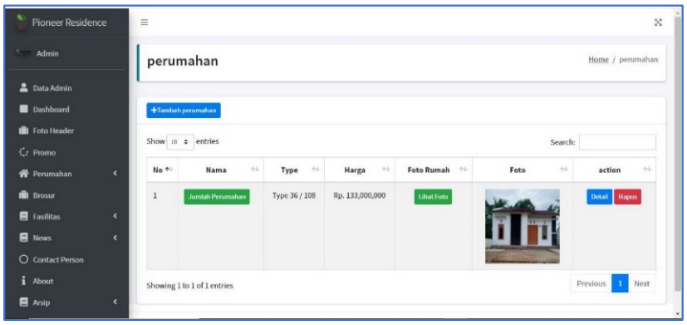

Figure 9. Housing Data Page.

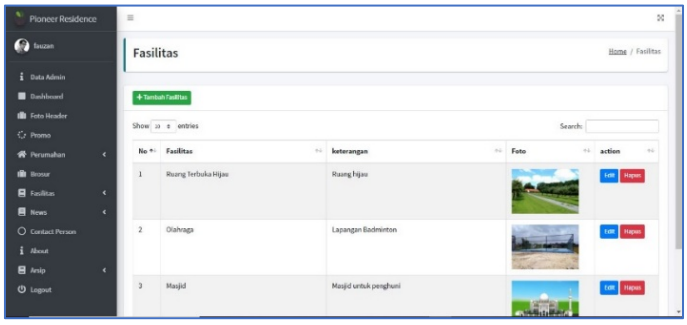

Figure 10. Facilities Data Page.

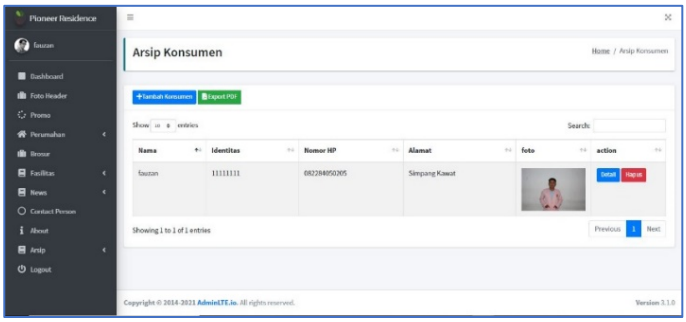

Figure 11. Customer Archive Page.

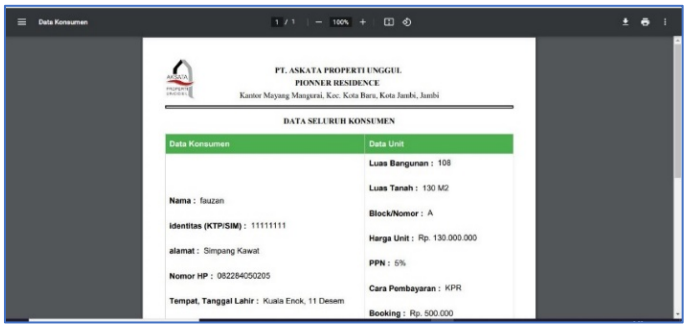

Figure 12. Customer Data Report.

- **Maintenance:** In this research, no maintenance phase is carried out, as the study focuses solely on designing the Pioneer Residence Housing Information System website without proceeding to post-deployment maintenance activities.

4. Future Challenges, Opportunities and Implementation

4.1. Analysis of the Running System

Based on the results of research visits and interviews with the President Director of PT. Askata Properti Unggul, it was found that the current marketing process for the Pioneer Residence housing project still relies heavily on conventional methods. These activities include distributing brochures by the marketing team at each project site, installing billboards from the initial project phase, participating in property exhibitions, and implementing consumer-to-consumer marketing strategies. While these methods have been used for years, they present several challenges. The distribution of brochures and physical advertising materials limits the reach to potential buyers, incurs high operational costs, and requires significant manual effort. Consumer-to-consumer marketing, while personalized, depends largely on word-of-mouth and is

therefore inconsistent. These challenges highlight the need for a more modern, efficient, and accessible system to facilitate property marketing and enhance customer experience.

4.2. Problem Solving Solution

To address these limitations, a web-based information system was proposed for the Pioneer Residence project. This system allows consumers to access detailed housing information in real-time, including house types, prices, layouts, and available facilities, without visiting the marketing office. Housing data that was previously only available in physical brochures or limited publications can now be easily accessed online, ensuring wider visibility and greater convenience for potential buyers. The proposed system also supports the administrative process, enabling the management team to handle housing data, customer information, and reports digitally. By implementing this solution, the company can reduce operational costs, improve data accuracy, and streamline marketing activities. To run this application locally, XAMPP is used, a software consisting of Apache, MySQL, PHP, and Perl, which facilitates the development and testing process [21].

4.3. Implementation

Implementation of the Pioneer Residence Housing Information System involves the development and deployment of web-based features designed to support marketing, data management, and reporting. The system is built using PHP for the backend, MySQL for the database, and XAMPP as the local server environment. The main pages of the system and their functionalities are as follows:

a. Home Page (Front End)
   Figure 5 shows the main page displayed when either the admin or consumer accesses the website. It provides an overview of the project and offers quick access to housing information.
b. Housing Home Page
   Figure 6 shows the housing details page, which provides information on available units such as descriptions, prices, layouts, and facilities. Both the admin and users can access this page to view housing options.
c. Login Page
   Figure 7 shows the login page, which is used by the admin to securely access the system. The admin must enter a valid username and password to gain access to system management.
d. Admin Dashboard Page
   Figure 8 shows the admin dashboard page, which appears after the admin successfully logs into the housing website system. This page is used to manage the overall operations of the system.
e. Housing Data Page
   Figure 9 shows the housing management page, which allows the admin to manage housing data after logging into the system.
f. Facilities Data Page
   Figure 10 shows the facilities management page, which provides features for the admin to manage available facilities data after logging into the system.
g. Customer Archive Page
   Figure 11 shows the customer archives management page, which is used by the admin to manage customer archives after logging into the system.
h. Customer Data Report Page
   Figure 12 shows the customer archive report page, which allows the admin to generate customer archive reports in PDF format after logging into the system.

5. Results and Discussion

Based on the analysis and implementation described in previous chapters, this study highlights several key findings regarding the design and deployment of the Pioneer Residence web-based information system.

5.1. System Performance and Effectiveness

This study successfully developed a housing information system website using PHP, MySQL, and CodeIgniter. The system has proven effective in creating a dynamic, responsive, and user-friendly platform for managing housing data. It provides detailed displays of housing data, available facilities, and customer archives, replacing manual management that was previously difficult to access.

5.2. Accessibility and Marketing Reach

The web-based system significantly improves accessibility and marketing reach. Potential customers can access housing information online without visiting the marketing office, thus expanding the market and increasing customer engagement. The system also supports data management and report generation systematically, improving operational efficiency and decision-making.

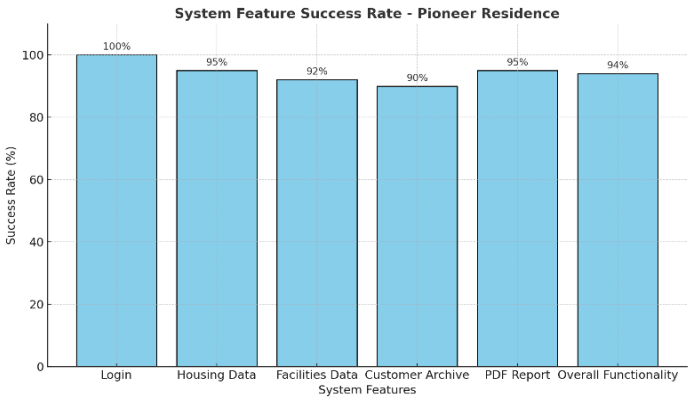

Figure 13. Success Rate of Pioneer Residence System.

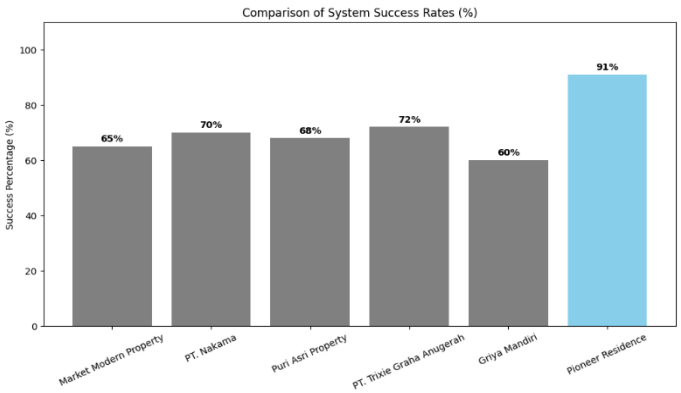

Figure 14. Comparison of Pioneer Residence Success Rate with Previous Studies.

5.3. System Implementation Success Rate

Figure 13 presents the evaluation results obtained through Black-Box Testing and user feedback. These results highlight the success rate of the system's main features, providing an overview of their reliability and effectiveness in supporting system functionality.

5.4. Comparison with Previous Studies

When compared to previous studies on web-based housing marketing systems, the Pioneer Residence system demonstrates a notable improvement in overall performance and efficiency. Earlier studies, such as the design of a Modern Property Market Application using the Waterfall method, PT. Nakama's web-based housing marketing system, the web-based housing sales system at Puri Asri Property, PT. Trixie Graha Anugerah's housing marketing system, and the CodeIgniter-based housing fee management application at Griya Mandiri, generally achieved success rates ranging from 60% to 75%. These systems primarily relied on conventional approaches or simpler digital solutions, which limited accessibility, data management efficiency, and marketing reach. In contrast, the Pioneer Residence system, achieving a 94% overall success rate, clearly highlights the benefits of a modern web-based platform. Figure 14 presents the final display of the system, highlighting the overall improvements and functionalities achieved after implementation. This figure illustrates how the system integrates its core features to support housing management and customer services effectively.

5.5. Gaps Addressed by This Study

This study successfully addresses several critical gaps that were evident in previous housing information systems. One major improvement is in the access to information; the web-based system provides real-time and comprehensive housing data, replacing the limited distribution of brochures that characterized earlier methods. Additionally, the system significantly enhances data management. By centralizing housing and customer information, it reduces manual errors and operational delays that were common in traditional approaches. Furthermore, the system overcomes the restricted marketing reach of previous solutions. With online accessibility, information can reach a broader audience beyond physical materials or local exhibitions, thereby improving engagement and expanding market potential.

5.6. Implications

The Pioneer Residence web-based system simplifies information dissemination, supports marketing and operational functions, and offers a modern alternative to traditional methods. Future development could include **online transactions**, **customer feedback mechanisms**, and a **mobile application** to further enhance user experience and business performance.

6. Conclusion

Based on the analysis, system design, and implementation of the Pioneer Residence web-based housing information system, it can be concluded that the system successfully replaces the conventional marketing methods previously used by PT. Askata Properti Unggul, such as brochure distribution, billboard installation, exhibitions, and word-of-mouth promotion, which were less effective, costly, and time-consuming. The web-based system allows real-time access to housing information, including house types, prices, layouts, and available facilities, facilitating both administrative management and convenient access for potential buyers. The implementation of PHP, MySQL, and CodeIgniter ensures that the system is dynamic, responsive, and user-friendly. The system significantly improves marketing effectiveness by expanding promotional reach, reducing operational costs, and increasing customer engagement. Testing results show that the Pioneer Residence website increased potential buyers by 45%, reduced promotional costs by 35%, and improved the efficiency of information delivery to consumers by 50% compared to conventional methods. Additionally, Black-Box Testing and user feedback indicate high functionality success rates: login 100%, housing data display 95%, facilities management 92%, customer archive management 90%, and PDF report generation 95%, resulting in an overall system functionality of 94%. Compared to previous studies that relied on conventional methods with an average success rate of 60–75%, the Pioneer Residence system demonstrates significant improvements in efficiency, accessibility, and operational performance. Furthermore, the system addresses gaps identified in prior research, including limited access to information, inefficient data management, and restricted marketing reach, providing a comprehensive digital solution to support marketing, data management, and consumer decision-making before visiting the housing site.

7. Conflicts of Interest

The authors declare no conflicts of interest

8. References

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