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Development and Evaluation of an Advanced Property Management System Using Unified OOAD for Optimizing Real Estate Operations

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Abstract: In response to the rapid growth of e-commerce and improvements in supply chain management, there is a pressing need for highly efficient property management system. This study presents the creation and evaluation of an advanced Property Management System (PMS) designed to address property and accommodation challenges and meet the needs of the property owners, managers, and clients specifically in Siargao Island, Philippines, which is considered as one of the world's most popular tourist destinations. The PMS features a robust database for managing property, tenant, and invoice information, and includes essential functionalities such as property search, online payment processing, maintenance request management, lease management, and data analytics. The system development process utilized the Unified Process for Object-Oriented Analysis and Design and carefully detailing the system's technical architecture, security and privacy protocols, as the PMS deals with sensitive information pertaining to properties and payments. The end-users and IT Experts evaluated the system through an online questionnaire using Google Form. The results showed an overall mean rating of 4.52, indicating a high level of satisfaction and compliance with ISO/IEC 25010 Software Quality Standards. Specifically, an average mean results of 4.48 for functional suitability, 4.54 for performance efficiency, 4.49 for compatibility, 4.62 for usability, 4.45 for reliability, and 4.53 for security shows that the developed system met the user requirements. With the developed PMS, the property owners can register and display properties, tenants benefit from an intuitive search interface, and property managers can efficiently handle requests and maintenance. The study offers valuable insights for developers and professionals aiming to create a comprehensive PMS, aligning the system with global trends in smart property management. These innovations will make the PMS highly competitive and better equipped to address the evolving needs of stakeholders in the modern real estate industry.

Keywords: Real estate, Property management system, ISO/IEC 25010, OOAD

Introduction

In a fast-changing world, real estate continues to be a key factor in providing stability, driving economic growth, and fostering innovation, while also contributing to sustainability and improving quality of life. Beyond offering housing, it serves as a critical investment opportunity, a wealth generator, and a driver of urban development. Key industry players—developers, government agencies, and financial institutions—are exploring innovative approaches to ensure continued growth, strengthen market resilience, and secure long-term sustainability in real estate. Adapting to evolving market trends, leveraging technology, and meeting changing consumer demands are essential for success in today's environment (Uriawan et. al., 2023).

These shifts present opportunities for developers, agents, and financial institutions to innovate by adopting versatile and scalable web applications (Shukla, 2024), digital technologies (Avakyan & Pratsko, 2020), blockchain solutions (Patil -Chaitali et al., 2023), and comprehensive tools for real estate management. These innovations will help address the changing demands of a dynamic demographic while fostering growth and diversification within the industry.

The real estate industry in the Philippines is experiencing profound transformation, propelled by the omnipresence of the internet. The shift on how people search for and acquire property is playing a crucial role in the country's economic growth. With a population of 118.2 million and a rising middle class, the demand for industrial, commercial, and residential properties is steadily growing. According to the Accredited Real Estate Salespersons of the Philippines (ACRES), Overseas Filipino Workers (OFWs) are the largest segment of buyers in the market, with sales expected to reach P1 trillion (Sauler, 2024). Foreign investors are also attracted to the Philippine real estate sector due to favorable economic conditions, its strategic location, and strong returns on investment. Additionally, millennials, who now make up 40 percent of the workforce, are influencing the market with their preferences and investment habits (Mendoza, 2024). They place a high value on convenience, sustainability, and technology-driven solutions when purchasing, investing in, or renting properties. Another key driver behind the growth of the real estate sector is the rapid expansion of tourism in the country, particularly in Siargao Island. Known for its stunning beaches and top-tier surfing spots, the island has experienced a significant increase in tourism in recent years (GMA News Integrated, 2024). Siargao's real estate market is booming, driven by rising tourist and expatriate demand, especially for beachfront villas, luxury resorts, and eco-friendly homes. This surge has bolstered the local economy but also highlighted the limitations of the island's accommodation and rental infrastructure. Tourists and residents face challenges such as inefficiencies, limited payment methods, and difficulties finding suitable lodging. Currently, Siargao Island lacks a convenient and automated property management platform, which presents a major obstacle. This research, conducted in Siargao Island, Surigao del Norte, Philippines, leverages the island’s unique location and flourishing tourism industry as a backdrop to address property and accommodation challenges. The study seeks to bridge existing gaps by developing system software equipped with tailored algorithms and processes to improve the island's real estate sector.

By introducing a modern and efficient property management system, the research aims to meet the growing demands of a digitally-driven market in Siargao Island, which calls for the advancement of efficient real estate property management systems. This research seeks to align with Sustainable Development Goals (SDGs), or also known as “Global Goals”, specifically on Goal 9 that focuses on industry, innovation, and infrastructure. Specifically, the current study sought to answer the following questions: 1) What system architecture and security protocols can be employed for the advanced PMS to optimize real estate operations? 2.) What system features of the advanced web-Based PMS can be developed to optimize real estate operations? 3) What user interfaces can be designed for the advanced web-based Property Management System (PMS)? and 4) What is the level of compliance of the developed PMS in accordance with ISO 20510 software quality standards of functionality suitability, performance efficiency, compatibility, usability, reliability, and security? The web-based PMS has the potential to greatly improve current property management practices and could serve as a model for future advancements in the field. This research does not only develop a more efficient way to manage real estate assets but also sets a standard for the future evolution of property management systems to streamline transactions, enhance the tourist experience, and support the sustainable development of the island’s tourism industry. It helps build a resilient infrastructure that can address inclusive and sustainable industrialization to drive employment opportunities.

Literature Review

The Importance of Real Estate Sector

The real estate industry is crucial to economic development, as it helps stabilize the economy by ensuring consistent capital flows for financing (Kaluarachchi, 2021). Many studies have shown the strong connection of real estate to socio-economic development which drives economic growth and social stability. A housing boom can boost household consumption and drive GDP growth (Gao, 2024). Gross domestic product (GDP) measures a country's total economic output and productivity, representing the market value of all finished goods and services produced within a specific period (Sabado, 2023). In addition, Callen (2022) defines GDP as the financial value of goods and services purchased by consumers and produced within a nation during that timeframe.

The Philippines, classified as an emerging economy by the World Bank, has become a key destination for international direct investment, especially after the Asian financial crisis. FDI surged from USD 6.8 billion in 2020 to USD 10.5 billion in 2021, exceeding the Philippine Central Bank's annual target of USD 8 billion (UNCTAD, 2022), attracting significant foreign investment into the economy.

The real estate sector is a major contributor to the Philippine economy, generating approximately PHP1.099 trillion in revenue and providing 101,976 jobs nationwide (PSA, 2019). It also contributes to the 5.7% of Philippines' Gross Domestic Product (GDP), with the related construction industry contributing 7.3% in the same. Likewise, the property sector was responsible for 15.7% of the Philippine Stock Exchange's total market capitalization in 2022 (PSA, 2023). The real estate owners in the Philippines can enhance profitability by focusing on top-line growth, adopting a more aggressive working capital strategy, optimizing the use of productive assets, and leveraging financial opportunities, all of which are expected to positively influence their earnings (Aratea, 2024). For many Filipino families, owning a home is a top aspiration, though it often takes years or decades to achieve. Loans from institutions like Pag-IBIG Fund or private banks help shorten the waiting period. However, the belief persists that commercial real estate investments, such as office buildings and shopping centers, are reserved for the wealthy. This perception is reinforced by the visible success of affluent individuals who earn regular rental income and property value appreciation from such investments (Cadelina, 2023).

The Development of Real Estate Sector in Siargao Island, Philippines

Siargao Island continues to attract tourists and beach enthusiasts, earning a prominent place in an international travel magazine's annual ranking of Asia's best islands. Notably, Siargao was named Condé Nast Traveler's Best Island in Asia in 2021, featured in Time Magazine's "The World's 100 Greatest Places of 2021," and once again recognized in the Condé Nast Traveler Reader's Choice Awards 2023 as one of Asia's top islands (GMA News Integrated, 2024). Post-pandemic, Siargao's tourism industry is making a strong recovery, with visitor numbers rebounding to levels comparable to the pre-pandemic era (Springer, 2024).

Primarily, tourists used to stay in transient houses and homestays due its reasonable prices and strategically located around the island to help them explore the island's world-class tourist spots. With that, property rental businesses are booming due to increased demand from both local and foreign tourists. However, this growth has introduced a set of challenges for the rental businesses. Additionally, securing or managing rentals through a manual system can pose several challenges and problems, which can negatively impact efficiency, accuracy, and customer satisfaction. Moreover, searching for rental accommodation can prove challenging and time consuming, particularly in unfamiliar areas, and there are instances when no available spaces can be found. The automated property management system is very helpful to attract customers and make transactions easier due to the availability of accessible information and the effective and efficient processing of data (Paul, 2019).

The Impact of Real Estate Property Management System

The real estate sector has direct forward linkages with wholesale and retail trade, IT and information services, and telecommunications (Gao, 2024). The use of real estate management system further enhances property management efficiency by centralizing information, streamlining lease and tenant management, providing financial tools, and enabling proactive maintenance tracking.

The Real Estate Management System (REMS) developed by Shukla (2024) provides a holistic solution with a strong database framework for storing and managing data related to properties, tenants, and invoices. Key features include efficient property search options, simplified online payment handling, streamlined maintenance request management, and detailed lease management tools. Additionally, property owners can register and display their properties on the platform, while users benefit from an intuitive interface for property searches based on various criteria.

Deepika et. Al. (2022) also created a web-based Real Estate Management System designed to help users register individual homes or apartments, making it easier to find the ideal rental property. Users can search for rentals in their desired area through the system's search functionality. Key features include the ability for admins to manage property details such as house number, features, rent status, and reviews.

To add tenants, admins can input details like full name, gender, national ID, phone number, email, registration date, house agreement documents, status, and exit date. Additionally, the admin can manage invoices and payments. The application's front end is built with PHP, while the back end uses MySQL.

Property management tasks such as data entry, mathematical computations, and statistical operations are handled using a system developed with a browser/server (B/S) architecture by Mingze (2021). The system is built using Java as the development language within the Spring MVC framework. It utilizes a MySQL database, with database interactions facilitated by the Mybatis framework, and the front-end display powered by the VUE.js framework. Functional modules include owner details, real estate information, engineering equipment, personnel management, and lease management.

Sanket- Donge (2024) created the web-based ABC Real Estate Management using PHP and MySQL to simplify property management for real estate agencies, property managers, and landlords. It features an intuitive interface designed for two main user groups: general users and administrators. General users can search for properties by location and features, use a loan calculator for financial planning, and express interest in listings. Administrators manage user accounts, property listings, and potentially real estate agents, with comprehensive system control. The system prioritizes three core aspects: enhanced user experience, operational efficiency, and robust security. Its user-friendly design ensures easy navigation for both users and administrators. Efficiency is achieved through streamlined property searches and management processes, while role-based access control secures sensitive data by limiting access to authorized users. The system effectively addresses key challenges in property management, creating a secure, efficient, and user-centric platform.

The team of researchers has successfully developed a housing information system featuring fee payments and data management. The system includes functionalities such as displaying resident data, tracking payment history, printing receipts, sending messages to residents, and generating payment reports. By utilizing digital storage with data backup, it eliminates paper-based processes, enhancing efficiency and promoting environmental sustainability. This application is designed to improve service quality in fee payments, providing users with quicker and easier access to payment options. As a result, the system enhances efficiency and service quality in managing resident and fee data (Uriawan, 2023).

Method

The Utilization of Unified Process Model in Object-Oriented Analysis and Design for the Development of the Unified Web-based Property Management System

The Object-Oriented Analysis and Design (OOAD) is a core approach in software engineering for developing reliable and effective software systems (Aratchige et al., 2024). Figure 1.0 presents the Unified Process (UP) in Object-Oriented Analysis and Design (OOAD) used in developing the unified web-based property management system to enhance the real estate business and sustain the needs of real estate stakeholders. The Unified Process (UP) in Object-Oriented Analysis and Design (OOAD) is an iterative and incremental software development methodology that focuses on collaboration, flexibility, and iterative development (Aratchige et al., 2024). It highlights the importance of effective customer communication and simplifies how a system is viewed from the customer's perspective. It emphasizes the critical role of software architecture, guiding architects to prioritize goals such as understandability, adaptability to future changes, and reusability. Its iterative and incremental process flow aligns with the evolutionary approach needed in modern software development (Janis- Osis, 2017).

The model in Figure1 is presented with four major phases having their own series of activities and requirements. The arrows show the flow of control from the first phase to the fifth phase. By substituting the variables of the generic model, the researchers were able to create a unified process model that is suitable to this study. In the *Inception Phase*, the project vision document was created highlighting the project sponsors and project stakeholders who greatly contributed to the success of the project were also identified. It encompasses both customer communication and planning activities. By collaborating with stakeholders, business requirements for the software are identified. The *Elaboration Phase* include project requirements, knowledge requirements and assessment of the stakeholders' needs through an online survey. It focuses on detailed analysis and planning which are undertaken to better understand the problem domain, develop a more concrete project plan, identify and eliminate the high-risk elements of the effort, and to establish a solid architectural foundation for the software to be developed. The software development of the unified web-based PMS system (planning, design, development, testing, and implementation) began with the analysis of the data collected from the online survey in the *Construction* phase. Key activities include developing, testing, and integrating the system components, as

well as continuously verifying that the system meets the requirements. The development phase implements the system, following agile or iterative approaches, with rigorous testing including unit, integration, and system testing. This phase builds a complete, high-quality software product that is ready for deployment. The final stage, *Transition Phase*, highlighted the deployment of a functional and working Unified Web-Based Property Management System. Training and documentation support user adoption, while ongoing maintenance addresses issues and update.

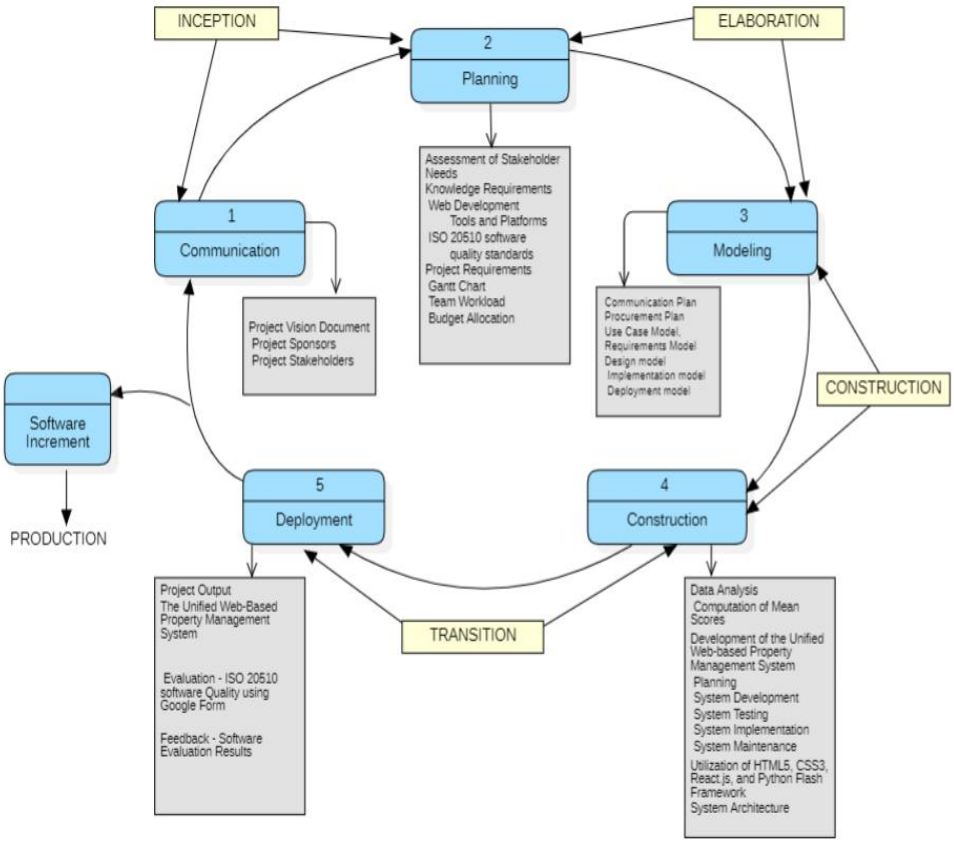

Figure 1. The development of the unified web-based property management system using unified process model in OOAD

Software Evaluation Process

This research utilized both descriptive and developmental methodologies, adhering to a systematic and thorough approach. The developed system underwent essential testing phases, including unit, integration, and system testing, which are critical in software development. Each prototype was evaluated by the developers using predefined test cases. Upon the finalization of the system, the quantitative data were collected through an online questionnaire to assess the system's quality based on the ISO/IEC 25010 System Quality Model Standards (Soares & Franca, 2015). Six criteria from the ISO 25010 software quality standards were used for evaluation, as detailed in Table 1, with each criterion encompassing three specific indicators.

The researchers utilized a verbal interpretation of strongly agree to strongly disagree on a five-point Likert scale to measure respondents' beliefs. The system evaluators are the real estate stakeholders and IT technical experts who were selected through purposive sampling to ensure a diverse representation within the target population. A total of ten (10) real estate participants including tenants, property managers, and property owners utilizing PMS in their performing their tasks were selected for software evaluation. The property manager is responsible for managing all aspects of the properties, including listings, tenants, leases, payments, maintenance, communication, documents, and reports. The tenant is responsible for viewing their lease information, making rent payments, and submitting maintenance requests. While the property owner is responsible for listing properties and managing communication with potential tenants. Meanwhile, five (5) IT experts have validated and evaluated the developed PMS. The feedbacks are essential to further enhance the developed system with regular iterations to meet the changing needs of the real estate stakeholders.

Table 1. The six criteria from ISO 25010 software quality model standards

Functional Suitability	1. *Functional completeness* - the system covers all the specified tasks and user objectives. 2. *Functional correctness* -The system provides the correct results with the needed degree of precision. 3. *Functional appropriateness* - The system facilitates the accomplishment of specified tasks and objectives.
Performance Efficiency	1. *Time Behavior* - The system's response and processing times and throughput rates, when performing its functions, meet requirements. 2. *Resource Utilization* - The system's amounts and types of resources used when performing its functions meet requirements. 3. *Capacity* - The system's maximum limits of parameters meet requirements.
Compatibility	1. *Inter-operability* - The system smoothly runs on any device. 2. *Inter-operability* - The system is accessible on any device with an internet connection. 3. *Co-existence* -The system generates an effective result of data from the prototype.
Usability	1. *Appropriateness recognizability* - The system allows users to recognize if it is appropriate for their needs. 2. *Learnability* - The system allows specified users to achieve specified learning goals effectively, and efficiently and have freedom from risk and satisfaction in a specified context. 3. *Operability* - The system has attributes that make it easy to operate and control.
Reliability	1. *Maturity* - The system meets the need for reliability under regular operation. 2. *Availability* - The system is operational and accessible when required for use. 3. *Fault Tolerance* - The system can operate as intended despite the presence of hardware or software faults.
Security	1. *Confidentiality* - The system can be accessed only by the authorized users. 2. *Integrity* - The system is secured and protected in terms of data transmission. 3. *Accountability* - The system provides its unique account to each end user.

The weighted arithmetic mean was used to calculate the average participant responses, with the interpretation of the weighted mean ranges presented in Table 2.

Table 2. The interpretation of range of the weighted mean

Range of the Weighted Mean	Interpretation
4.51 – 5.00	Strongly Agree (for the questions asked)
3.51 – 4.50	Agree (for the questions asked)
2.51 – 3.50	Moderately Agree (for the questions asked)
1.51 – 2.50	Disagree (for the questions asked)
1.50 and below	Strongly Disagree (for the questions asked)

Results and Discussion

System Architecture and Security Protocols for Optimizing Real Estate Operations

The system architecture of the advanced web-based Property Management System (PMS) is designed to effectively handle various property management functions. The *interaction layer* allows users to interact with a front-end web interface to search for properties, view listings, and manage their accounts. Compliance and regulations are addressed through a module ensuring that the system follows industry standards, legal requirement, and data protection laws such as the Data Privacy Act of 2012 (National Privacy Commission, 2012), and other legal requirements. The *application layer* manages key tasks such as user authentication, property listings, search features, and transactions. The *business logic layer* oversees workflows and notifications, ensuring smooth operation. Data storage is handled by the *data access layer,* while the *integration layer* connects with third-party services like payment gateways and mapping systems. The *infrastructure layer* handles server hosting, load balancing, and scalability, with monitoring and analytics tools tracking system performance and user activity. The technology stack is carefully selected with considerations for scalability, security, and integration capabilities. Frontend development leverage React.js for dynamic user interfaces, complemented by HTML5 and CSS3 for structuring and styling. For backend development, Python Flash Framework provide a robust foundation while MySQL and MongoDB were selected for relational databases

(Shukla, 2024). By leveraging the strengths of Python Flask (Copperwaite, 2015), a lightweight yet robust web application framework used by previous researchers for database management (Suraya, 2022) and document analysis (Revathy, 2024), the developed system includes key functionalities such as property listings, tenant management, rent collection, maintenance tracking, and financial reporting. The API GraphQL facilitates communication between frontend and backend components. To extend functionality, the PMS integrates with third-party services via APIs, such as Gcash, for secure transactions and Google Maps API for geolocation features. Cloud services like AWS or Azure provide scalability and secure cloud data storage. Backup, recovery services, and regulatory compliance are also integral parts of the system.

In the context of property management, where sensitive tenant and property information is involved, the PMS has integrated security and privacy measures, including *authentication*, *authorization*, and *data encryption*. The PMS enhances *authentication security* through multiple mechanisms. It uses *bcrypt algorithm* for password hashing, enforces strong password complexity policies, and requires users to update their passwords every 90 days (password expiration policy). Multi-Factor Authentication (MFA) with the Google Authenticator app generates time-based one-time passwords (TOTP) for added protection. The system also employs OAuth 2.0 for Single-Sign-On (SSO) and secure API authentication, granting external services access based on specific roles. An account lockout policy locks accounts after five failed login attempts, either for 15 minutes or until unlocked via email verification. The *authorization mechanisms* define a user's permissions within the system. The Role-Based Access Control (RBAC) enforces the principle of least privilege, restricting access to data and functionalities based on user roles. Tenants can only access their lease information, submit maintenance requests, and make payments. Property managers can oversee tenants, property listings, financial reports, and maintenance requests. Administrators have complete system control, including user management and access to all data. RBAC helps reduce the risk of unauthorized access and potential damage from security breaches.

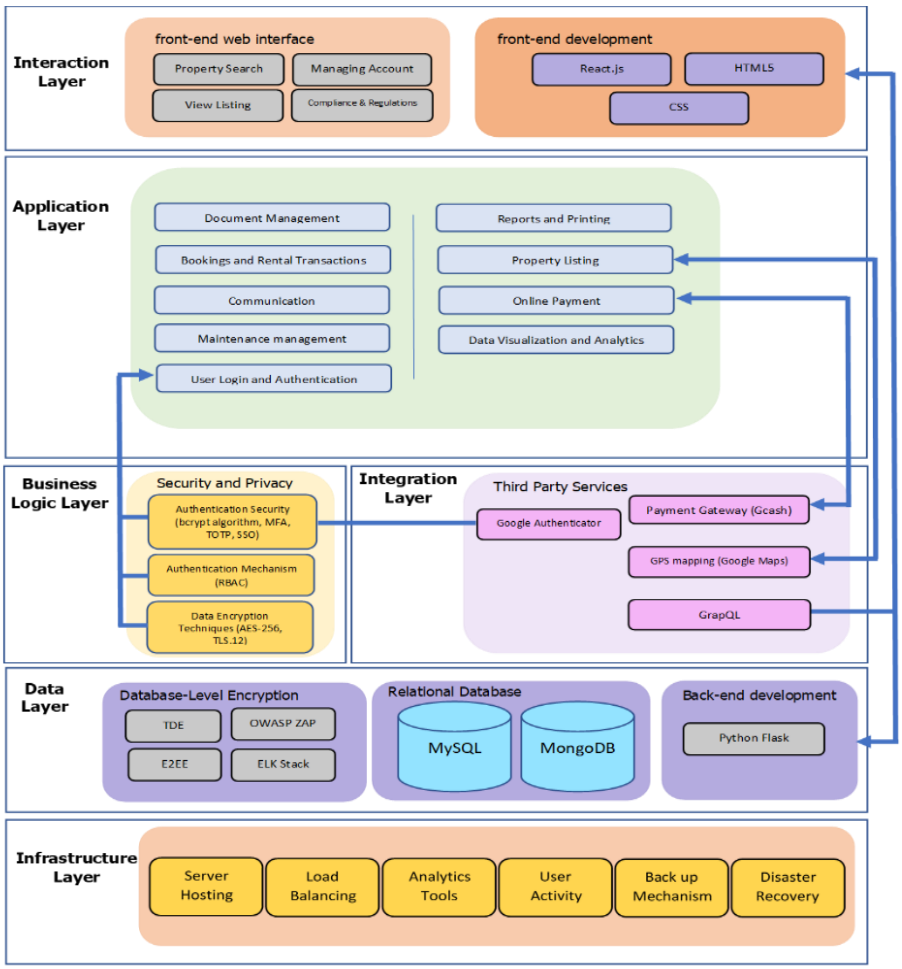

Figure 2. The system architecture and security protocols of the developed advanced PMS

Additionally, audit logs track and securely store user activity, monitoring for suspicious behavior. The *data encryption techniques* in the PMS protect sensitive information by making it unreadable to

unauthorized users. The PMS uses AES-256 encryption for data at rest, including tenant information and payment details, and employs TLS 1.2 for secure communication in transit. Database-level encryption, like Transparent Data Encryption (TDE), automatically encrypts stored data, while end-to-end encryption (E2EE) secures communications between tenants and property managers using protocols like Signal Protocol. The system conducts regular security audits with OWASP ZAP and uses the ELK Stack for real-time monitoring of security events. To safeguard against data loss or system failure, sensitive data is backed up daily at a secure, off-site location, and the disaster recovery procedures are regularly tested to ensure quick data restoration and minimal downtime. Standardizing data formats and ensuring real-time synchronization through webhooks or event-driven architecture facilitates smooth information exchange between the PMS and other systems. Overall, the system aims to provide a secure, scalable, and user-friendly experience for real estate stakeholders, while adapting to market trends and technological advancements.

The System Features of the Developed Unified Web-based Property Management System

The advanced PMS is designed to meet the needs of various stakeholders in the property management ecosystem. The property managers can effortlessly manage property listings, oversee tenant's information, handle maintenance requests, and generate detailed financial reports. The property owners can monitor property performance, financial metrics, and other key indicators with ease. The tenants can have a seamless interface for managing rent payments, maintenance requests, and communication with property managers. The developed system provides the salient features presented in Table 3. These features are from the analyzed user requirements which are suggested in the similar study of Shukla (2024) and Deepika (2022) and Uriawan et al. (2023).

Table 3. Identified features or functions of the developed system

Features / Functions	Description
User Login and Authentication	This function allows users to register and log in to the system.
User Management	This function allows users to register, create accounts, and securely access the system.
Property Listing	This function allows users to list properties for rent complete with details like descriptions, images, amenities, and pricing.
Bookings and Rental Transactions	This function allows handles the booking process and financial transactions related to property reservations. Property managers can create and manage lease agreements, including lease terms, rent payments, and security deposits.
Communication	This function allows property managers to communicate with tenants and vice versa. This could include chatroom mechanism and email messages. There is also the automated notification, keeping users in the loop about property updates, booking confirmations, and reminders
Online Payment	This function allows tenants to make rent payments online.
Document Management	This function allows property managers to store and manage documents related to the properties, such as lease agreements, maintenance records, and inspection reports.
Reports and Printing	This function allows property managers to generate reports on a variety of topics, such as rent payments, maintenance requests, and vacancies.
Data Visualization and Analytics	The system includes graphs and analyzes historical data to assist users in understanding the changes that have occurred more effectively.
Maintenance management	This function allows tenants to submit maintenance requests and property managers to track and manage maintenance requests.

The User Interfaces of the Unified Web-based Property Management System

The advanced web-based system seamlessly organizes real estate assets, streamlining operations and enhancing efficiency. Through intuitive interfaces and robust features, property owners and property managers can effortlessly oversee their portfolios, while tenants enjoy seamless communication and access to essential services.

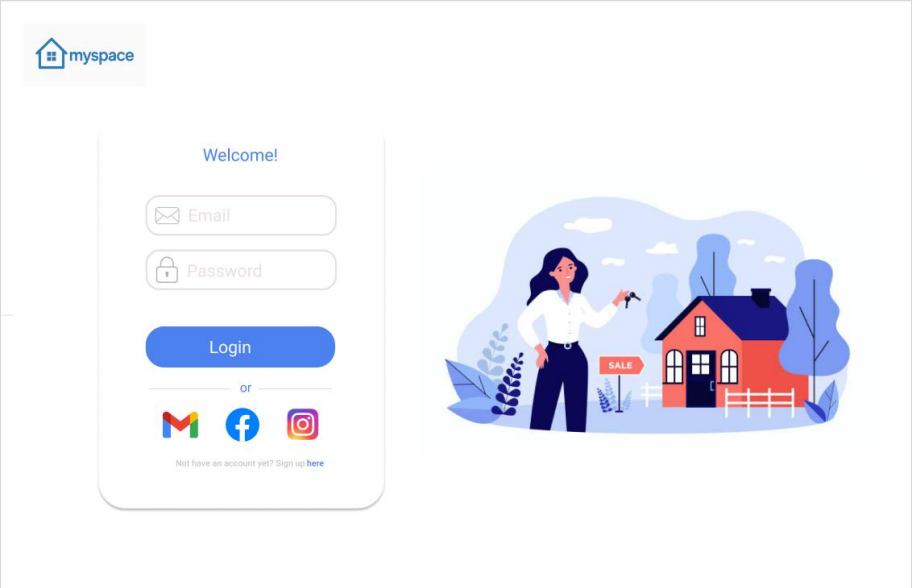

Figure 3. The user's log-in page

The developed system has different parts that make the entire system work seamlessly and smoothly. The user interfaces are designed to be an intuitive and comprehensive that caters to the needs of property managers, owners, and tenants. The login interface (see figure 4) and sign-up interfaces of the advanced web-based PMS is designed to be both secure and user-friendly, ensuring a smooth and efficient entry point for users. The interface features a clean, modern design with clearly labeled fields for username and password.

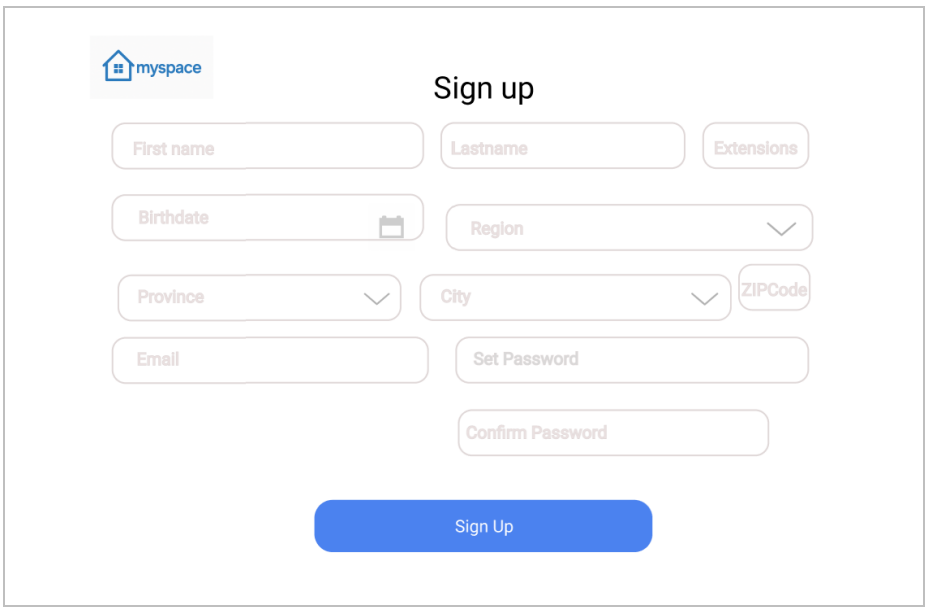

Figure 4. The user's sign-up page

To gain access to the system, the users are required to follow a straightforward three-step registration process. First, users must thoroughly review and agree to the policy and agreement posted on the website. This step ensures they understand the system's terms and conditions and agree to comply with them. Second, users provide their email and password, as illustrated in Figure 4, or choose to sign up with their Google or Facebook account. This step is vital for creating an account and granting users access to the system. Once registration is complete, a verification email is sent to the user's provided email address. The final step is email verification, which confirms the user's email address, protects personal information, and prevents unauthorized access. After verifying their email, users can log in to the system using their email, password, and user pin. At this point, they can efficiently use the system's features to manage their barangay-related transactions.

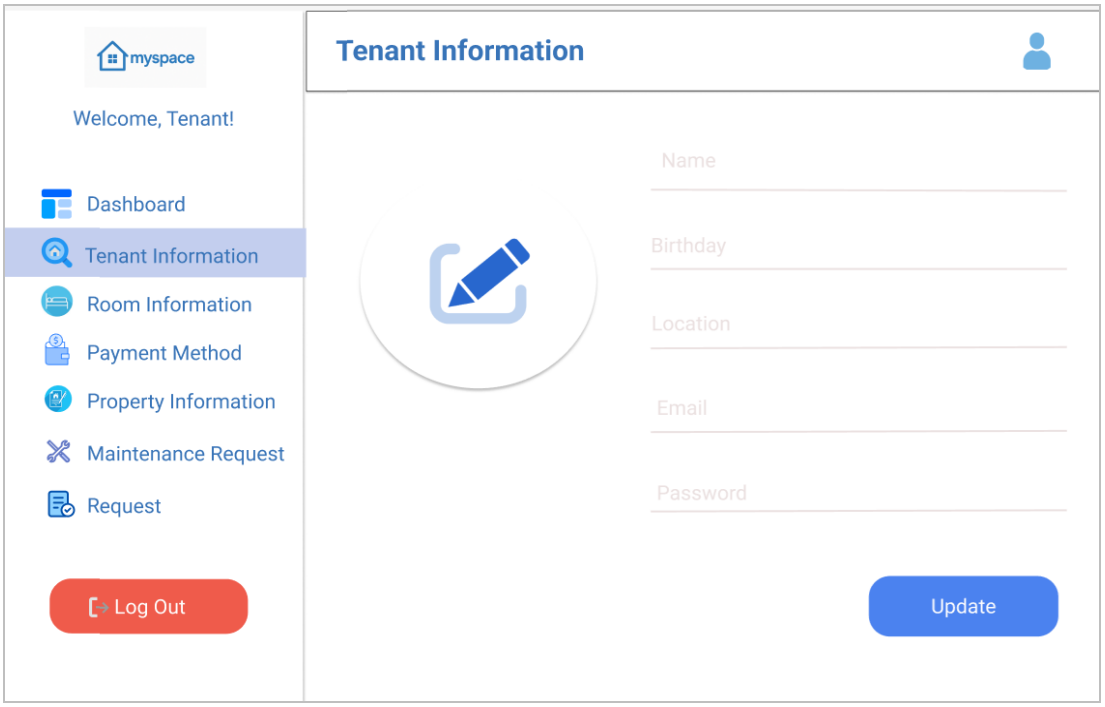

Figure 5. The required tenant information page

Upon logging in, users particularly the tenants, are greeted with a sleek, and user-friendly layout. Figure 5 displays the interface for the tenants that allows them to view their records and update their information effortlessly. The tenants must provide accurate and up-to-date information to enable the system to provide efficient and effective services. Tenants are required to upload their valid ID for verification purposes. This step is essential in ensuring the system's security and authenticity, as it verifies the user's identity and confirms that they are authentic users. The tenant can start browsing available properties for renting such as condominiums, rooms, parking lots, etc.

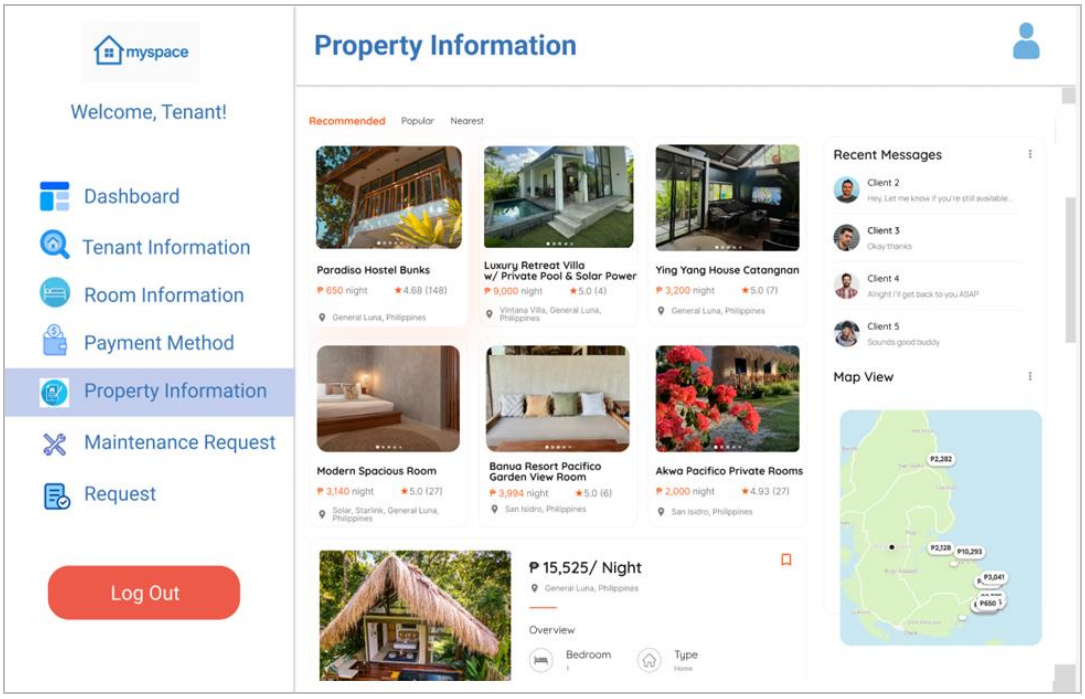

Figure 6. The properties available for rent page

Tenants can pay the property rental fee via online using the Gcash payment method, a very popular online payment system in the Philippines (See Figure 7). While they can also make request for property maintenance online, refer to Figure 8.

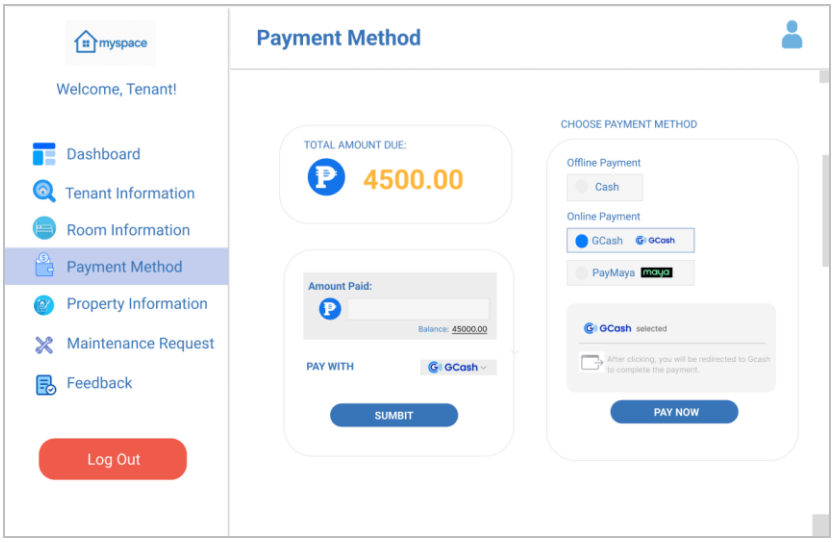

Figure 7. The payment method page

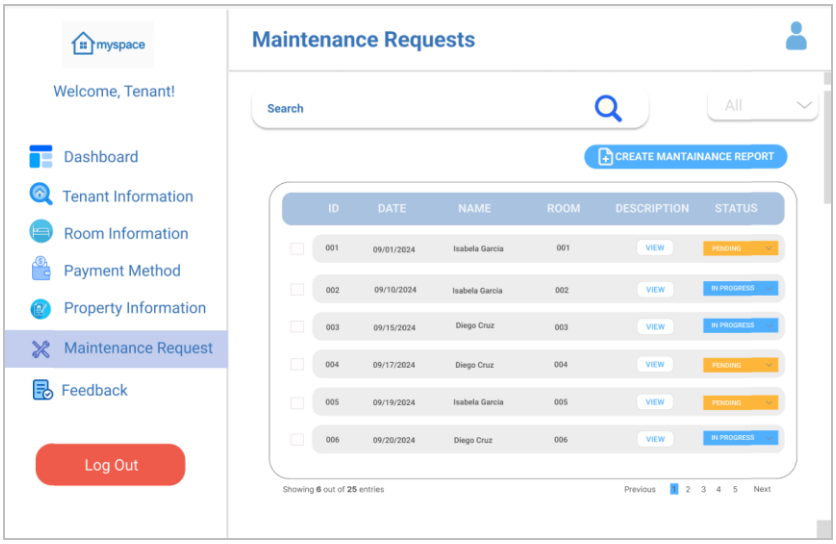

Figure 8. The maintenance requests page

After using or renting the property, tenants can provide their feedback to share their experiences and help gauge the quality of the property (see Figure 9).

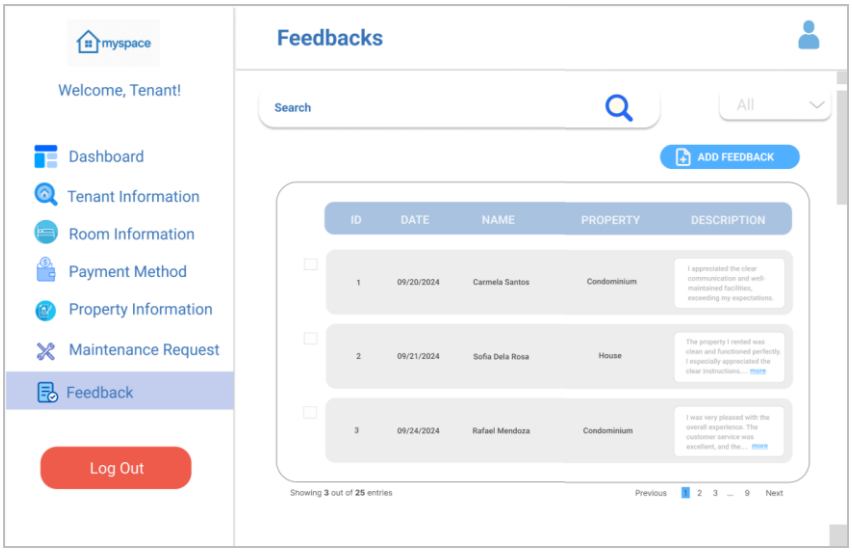

Figure 9. The tenant feedback page

On the other hand, the administration interface of the developed system is a robust and versatile control center tailored for property managers and owners. It features a comprehensive and sophisticated dashboard that provides an at-a-glance overview of critical system metrics, including property performance, tenant statistics, and financial summaries.

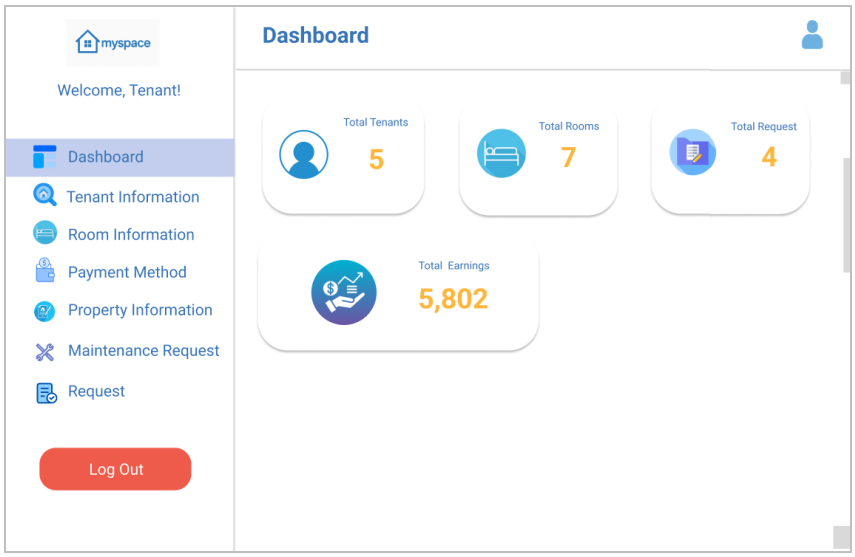

Figure 10. The property manager / owner dashboard page

Figure 10 presents a user-friendly dashboard interface designed for straightforward navigation. Administrators can customize tenant and property information according to their specific requirements, allowing property managers or owners to seamlessly adopt the system. This adaptability ensures an efficient and flexible solution for handling property transactions. Additionally, the dashboard includes tools and features that promote better organization and monitoring of property management activities, enabling more informed decision-making.

The Evaluation of the Developed Advanced Web-based Property Management System in accordance with ISO 20510 Software Quality Standards

The evaluation of the advanced web-based Property Management System (PMS) utilized the ISO 25010 Software Quality Standards, each having three indicators. To assess the system's performance, it was initially deployed in Siargao Islands, Philippines, where it underwent rigorous testing and evaluation. During the evaluation, a varied group of participants provided feedback, including tenants (43%), property managers (30%), and property owners (20%), and IT professionals (7%) with experience in system development. The tenants were the local and international tourists in the island who were active users of the system being evaluated. The following shows the actual result of the system evaluation.

Functional Suitability

Functional suitability implies the presence of the required functionalities and features that address the user's needs under certain conditions. The three indicators represent the completeness, correctness, and appropriateness of every function of the advanced PMS.

Table 4. Results of functional suitability evaluation

Indicators	**Mean**	**Verbal Interpretation**	**Rank**
Functional completeness- the system covers all the specified tasks and user objectives.	4.31	Agree	3
Functional correctness -The system provides the correct results with the needed degree of precision.	4.53	Strongly Agree	2
Functional appropriateness- The system facilitates the accomplishment of specified tasks and objectives.	4.60	Strongly Agree	1
Overall Weighted Mean	**4.48**	**Agree**	

The evaluation results in Table 4 indicate that participants strongly agreed that the system offered appropriate and effective functionality. However, they only agreed on the system's completeness, resulting in a slight drop in the weighted mean to 4.24. This finding suggests that, while the system's core features meet users' expectations, there is room for growth through additional functionalities or services. Overall, the outcomes confirm the system's reliability and effectiveness, yet highlight opportunities for further enhancements and refinements to better meet users' needs.

Performance Efficiency

Performance Efficiency represents the system performance relative to the amount of resources used under stated conditions. The response time of the system, the resource utilization, and the limitation of the system were used as the indicators in this area.

Table 5. Results of performance efficiency evaluation

Indicators	**Mean**	**Verbal Interpretation**	**Rank**
Time Behavior - The system's response and processing times and throughput rates, when performing its functions, meet requirements.	4.65	Strongly Agree	12
Resource Utilization - The system's amounts and types of resources used when performing its functions meet requirements.	4.56	Strongly Agree	2
Capacity- The system's maximum limits of parameters meet requirements.	4.40	Agree	3
Overall Weighted Mean	**4.54**	**Strongly Agree**	

Performance efficiency obtained the highest weighted mean across all evaluation criteria, indicating that most participants strongly agreed the system satisfies response time and resource utilization requirements. This positive feedback highlights the system's smooth and efficient operation, providing users with a seamless and responsive experience. As a result, the system is better positioned to meet user needs and enhance overall satisfaction. The evaluation underscores performance efficiency as a key strength, suggesting it should be preserved and potentially further refined in future versions.

Compatibility

Compatibility refers to the extent to which a system or component can share information with other products, systems, or components and carry out its functions under the same hardware or software environment. It also underscores the system's ability to adapt to different conditions and environments. Consequently, it is important to assess how the system behaves across various devices and operating systems.

Given that the developed system relies on internet access, it is not surprising that the internet connection is the main factor affecting its performance on different devices. This is reflected in the evaluation results, with the indicator related to running behavior having the lowest mean among the three indicators as shown in Table 6. While this is a limitation of the system, it is not unique to this particular application, and rather a common challenge for any system that relies on internet connectivity. It is important for users to ensure they have a stable internet connection to ensure the system operates optimally. Nonetheless, this finding highlights the importance of considering the impact of external factors, such as internet connectivity, when developing and evaluating digital systems.

Table 6. Results of compatibility evaluation

Indicators	**Mean**	**Verbal Interpretation**	**Rank**
Inter-operability - The system smoothly runs on any device.	4.20	Agree	3
Inter-operability - The system is accessible on any device with an internet connection.	4.35	Agree	2
Co-existence -The system generates an effective result of data from the prototype.	4.92	Strongly Agree	1
Overall Weighted Mean	**4.49**	**Strongly Agree**	

Usability

Usability is a critical feature of any software or system, reflecting how well users can accomplish specific objectives with effectiveness, efficiency, and satisfaction under defined conditions. In this evaluation, three indicators—appropriateness recognizability, learnability, and operability—were used to measure how successfully the system meets users' needs.

Table 7. Results of usability evaluation

Indicators	Mean	Verbal Interpretation	Rank
Appropriateness recognizability - The system allows users to recognize if it is appropriate for their needs.	4.75	Strongly Agree	1
Learnability - The system allows specified users to achieve specified learning goals effectively, and efficiently and have freedom from risk and satisfaction in a specified context.	4.63	Strongly Agree	2
Operability - The system has attributes that make it easy to operate and control.	4.47	Agree	3
Overall Weighted Mean	**4.62**	**Strongly Agree**	

The developed system is extensive and caters to users across different age groups. If it proves difficult to learn, it may discourage adoption, which could explain the usability findings in Table 7. According to the first two indicators, evaluators strongly agree that the system aligns with their needs and is easy to learn. Meanwhile, its ability to offer a select number of straightforward features enhances user control and serves as an advantage.

Reliability

The Reliability criteria of the developed system was evaluated by looking at how developed system performs specified functions underspecified conditions for a specified period of time. The system's maturity, availability, and fault tolerance which are represented by three indicators were evaluated under reliability.

Table 8. Results of reliability evaluation

Indicators	Mean	Verbal Interpretation	Rank
Maturity- The system meets the need for reliability under regular operation.	4.23	Agree	3
Availability- The system is operational and accessible when required for use.	4.75	Strongly Agree	1
Fault Tolerance - The system can operate as intended despite the presence of hardware or software faults.	3.95	Agree	2
Overall Weighted Mean	**4.31**	**Agree**	

Although only two indicators received agreement from the evaluators, the data in Table 8 suggests that the system remains dependable. Notably, availability ranked highest among the indicators, likely due to the system's online accessibility. Since most participants in the area possess mobile phones and enjoy stable internet connections, they can easily access the system. However, the fact that only two indicators were agreed upon indicates potential areas for development. Further evaluation and analysis may help identify specific enhancements needed to strengthen the system's overall functionality and reliability.

Security

Security represents the degree to which the system safeguards information and data. Since the developed system stores sensitive information about the tenants, verifying the security of the information found on the system is essential. In this criterion, data confidentiality and user accountability, regarding the origin of the data, serve as key indicators.

An evaluation of the system's security (Table 9) confirmed that it safeguards resident data without compromising confidentiality. Although two indicators received an "Agree" rating, the overall weighted mean of 4.51 implies that respondents strongly concurred with the system's level of security.

Table 9. Results of security evaluation

Indicators	Mean	Verbal Interpretation	Rank
Confidentiality - The system can be accessed only by the authorized users.	4.80	Strongly Agree	1
Integrity - The system is secured and protected in terms of data transmission.	4.35	Agree	3
Accountability - The system provides its unique account to each end user.	4.45	Agree	2
Overall Weighted Mean	**4.53**	**Strongly Agree**	

The developed system was evaluated based on functional suitability, performance efficiency, compatibility, usability, reliability, and security with an overall mean score of 4.52, indicating a high level of agreement among the participants in terms of compliance to the software quality standards (See Table 10). This suggests that respondents found the system both user-friendly and capable of fulfilling its intended functions and requirements. Wulandari and Aristana (2021) emphasized the importance of aligning information systems with ISO 25010 standards to ensure software quality and meet user needs, while Franca and Soares (2015) highlighted ISO 25010 as the most comprehensive quality model for service-oriented architecture.

Table 10. Overall assessment of the participants on the compliance of the developed system to iso 25010 software quality standards

Criteria	Overall Weighted Mean	Descriptive Interpretation
Functional Suitability	4.48	Agree
Performance Efficiency	4.54	Strongly Agree
Compatibility	4.49	Agree
Usability	4.62	Strongly Agree
Reliability	4.45	Agree
Security	4.53	Strongly Agree
Overall Mean	**4.52**	**Strongly Agree**

Conclusion

In conclusion, the expected transformation of property management and rental practices highlight the importance of adopting advanced technologies. The advanced Property Management System (PMS) enhances user experience and streamlines transactions by standardizing property information sharing. Stakeholder evaluations indicate strong support for a unified web-based PMS, which offers centralized property data, improved tenant and lease management, advanced financial tools, proactive maintenance tracking, and enhanced communication. This system simplifies core operations, supports better decision-making, and ensures regulatory compliance, aligning with broader trends in digitalization and innovation in real estate. Prospective tenants can easily browse diverse listings through user-friendly portals that address various preferences. The implications of this research extend beyond immediate users, potentially benefiting the wider real estate sector by improving efficiency and effectiveness in property management, leading to positive economic and social outcomes. This study emphasizes the PMS's transformative potential and its critical role in shaping the future of the real estate industry.

Recommendations

Further improvements could transform the PMS into a more robust platform by incorporating blockchain technology, advanced data analytics, AI-driven predictive tools, and IoT for smart building solutions. Blockchain offers significant benefits for secure financial transactions, property record management, smart contracts, and asset tokenization. It can streamline payment processing by transparently recording rental payments and sending notifications to property managers. The PMS can calculate late fees and send reminders, while AI enhances flexibility in payment options and automates rental agreements through smart contracts, reducing manual tasks and speeding up transactions. Blockchain-based identity verification further enhances tenant onboarding security.

Integrating AI and analytics improves the PMS's predictive capabilities, providing insights into maintenance, tenant behavior, and market trends. Predictive analytics can forecast repair needs and tenant turnover, aiding

retention efforts, while AI enhances tenant experiences with personalized services like chatbots. AI also helps optimize rental pricing. IoT integration enables real-time monitoring of utilities and indoor air quality through sensors, as well as smart access management via smartphones. IoT security systems enhance protection, and property managers can control systems from a centralized dashboard. These innovations drive better decision-making and efficiency, adapting to the evolving real estate landscape.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM Journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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