Optimizing Real Estate Operations Post-COVID19 Pandemic: Sustaining Stakeholders' Needs with a Unified Web-Based Property Management System

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Abstract – In response to the real estate sector's recovery following the COVID-19 pandemic, along with the increase in e-commerce and improvements in supply chain management, there is a pressing need for highly efficient property management systems. This study presents the creation of a unified web-based Property Management System (PMS) designed to meet the needs of the property owners, managers, and tenants. 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, and lease management. 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. The real estate stakeholders, including tenants, property managers, and property owners utilizing PMS have validated and evaluated the developed system via an online questionnaire using Google Form. The results showed a mean rating of 4.56, indicating a high level of satisfaction and compliance with ISO/IEC 25010 Software Quality Standards. 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. Future development of the PMS may include integrating IoT, blockchain technology, AI tools, and predictive analytics, 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 Business, Property Management System, Usability Testing

1 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. Though the sector was heavily affected during the height of the pandemic [1] with delays and slowdowns due to lockdowns, movement restrictions, and supply chain issues [2], it has begun to recover and is projected to experience a revival by 2024 [3].

The pandemic has provided valuable insights for stakeholders in the country's real estate sector, encouraging a shift towards more proactive strategies, such as diversifying portfolios and adapting business models [4]. 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 [5]. The enduring impact of the COVID-19 pandemic is reflected in the increasing demand for properties in suburban or rural areas, as people seek larger homes that can support remote work arrangements [6]. These shifts present opportunities for developers, agents, and financial institutions to innovate by adopting versatile and scalable web applications [7], digital technologies [8], blockchain solutions [9], and comprehensive tools for real estate management. Such 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. This shift in 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 [10]. 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 [11]. They place a high value on convenience, sustainability, and technology-driven solutions when purchasing, investing in, or renting properties.

This study aims to meet the growing demands of a digitally-driven market, which calls for the advancement of efficient real estate property management systems. This research seeks to align with the lifestyle and financial goals of stakeholders. Specifically, the current study sought to answer the following questions: 1)What PMS can be developed to optimize the real estate operations after COVID19 pandemic?; 2) 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, security, maintainability, portability?

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 not only aims to develop a more efficient way to manage real estate assets but also sets a standard for the future evolution of property management systems.

2 Methods

2.1 The Unified Process in OOAD for System Developmen

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 [12]. 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 [13].

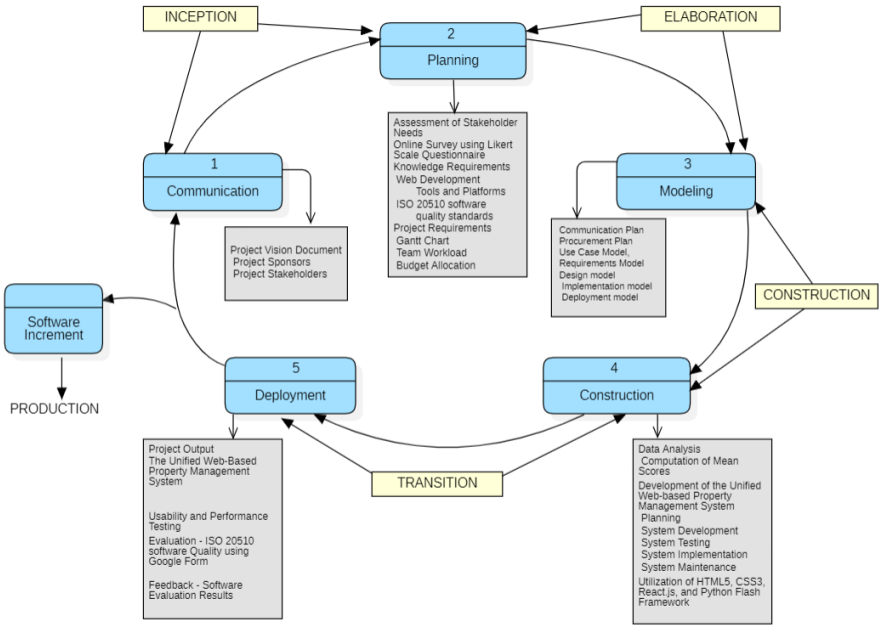

Fig. 1. The Framework of the Study

The methodology of this study follows a structured framework, beginning with dataset selection and preprocessing, followed by model training and validation, and concluding with model evaluation. This process ensures that the multilingual hate speech detection system is developed using robust machine learning techniques while addressing key challenges such as dataset imbalance, language diversity, and model generalization.

The model above 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 researcher was 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.

2.2 Use Case Model

As depicted on Figure 2.0, the actors in the system are the Property Manager, Property Owner, and Tenant. 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. The unified web-based system seamlessly organizes real estate assets, streamlining operations and enhancing efficiency. Through intuitive interfaces and robust features, property owners effortlessly oversee their portfolios, while tenants enjoy seamless communication and access to essential services.

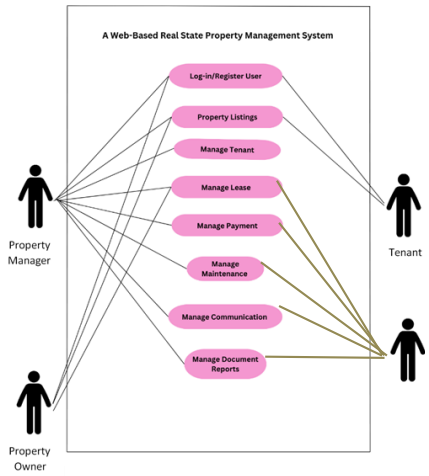

Fig. 2. The Use Case Diagram of the Unified Web-based Real Estate PMS

2.3 System Architecture and Security Protocols

The system architecture of the unified 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 [14], 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. By leveraging the strengths of Python Flask [15], a lightweight yet robust web application framework used by previous researchers for database management [16] and document analysis [17], 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 PayMaya and 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. 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.

2.4 Participants

The participants of this study are the real estate stakeholders 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 have validated and evaluated the developed PMS using the instrument of ISO 20510 software quality. The feedbacks are essential to further enhance the developed system with regular iterations to meet the changing needs of the real estate stakeholders.

2.5 Research Approach and Data Analysis

This research employed both descriptive and developmental methods, following a systematic and comprehensive approach. Quantitative data were gathered through an online survey of key stakeholders to understand their requirements, needs, and preferences for managing real estate properties. To evaluate the quality of the developed system, a survey based on the ISO/IEC 25010 System Quality Model Standards was conducted. The weighted arithmetic mean was used to calculate the average participant responses, with the interpretation of the weighted mean ranges presented in Table 1.0.

Table 1. 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)

3 Results and Discussion

3.1 The Developed Unified Web-based Property Management System

The Unified Web-based Property Management System have different parts that make the entire system work seamlessly and smoothly. The home interface is designed to be an intuitive and comprehensive that caters to the needs of property managers, owners, and tenants. Upon logging in, users are greeted with a sleek, and user-friendly layout. See Figure 3.0.

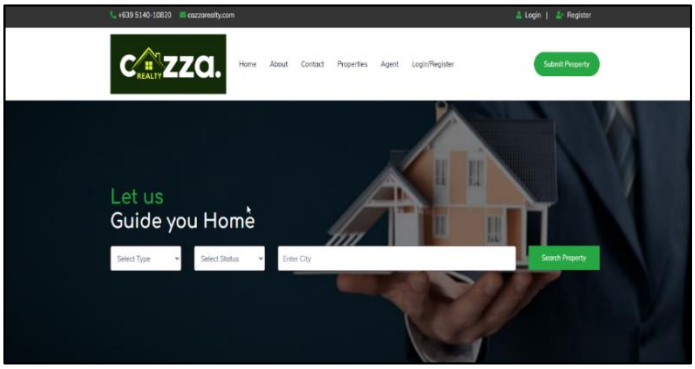

Fig. 3. Administrator Interface of the Developed System

The login interface of a web-based real estate property management system 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.

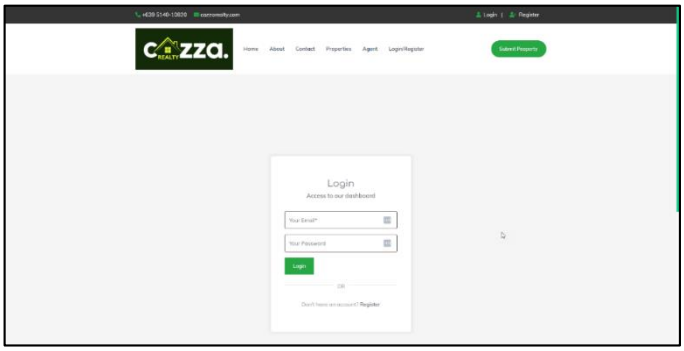

Fig. 4. Administrator Interface of the Developed System

The administration interface of a web-based real estate property management system is a robust and versatile control center tailored for property managers and administrators. It features a sophisticated yet user-friendly dashboard that provides an at-a-glance overview of critical system metrics, including property performance, tenant statistics, and financial summaries.

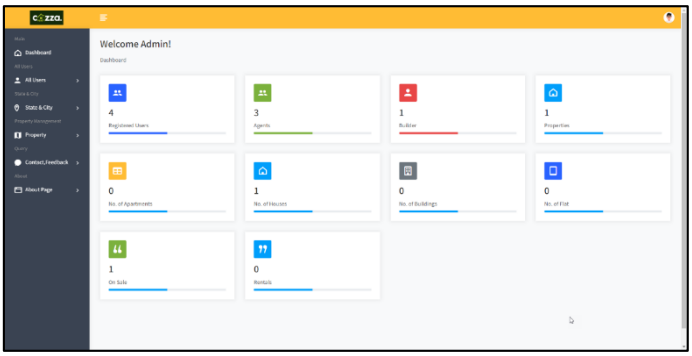

Fig. 5. Administrator Interface of the Developed System

With intuitive navigation, administrators can effortlessly manage property listings, oversee tenant information, handle maintenance requests, and generate detailed financial reports. The developed system provides the following functions:

a) User Login and Authentication: This function allows users to register and log in to the system.
b) User Management: This function allows users to register, create accounts, and securely access the system.
c) Property Listing: This function allows users to list properties for rent complete with details like descriptions, images, amenities, and pricing.

d) 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.
e) 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
f) Online Payment: This function allows tenants to make rent payments online.
g) 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.
h) Reports and Analytics: This function allows property managers to generate reports on a variety of topics, such as rent payments, maintenance requests, and vacancies.
i) Maintenance management: This function allows tenants to submit maintenance requests and property managers to track and manage maintenance requests.

3.4 The Evaluation of the Web-based PMS using ISO 25010

The evaluation of the unified web-based Property Management System (PMS) by stakeholders, including tenants, property managers, and real estate agents, confirmed that it meets the ISO 25010 Software Quality Standards. Table 3.0 summarizes this study's assessment of the developed system's compliance with the ISO 25010 Software Quality Standards.

Table 2. Stakeholders' Assessment of System Compliance to ISO 25010

Criteria	Weighted-Mean	Descriptive Interpretation
Performance Efficiency	4.65	Very Great Extent
Functional Suitability	4.55	Very Great Extent
Compatibility	4.35	Great Extent
Usability	4.60	Very Great Extent
Reliability	4.68	Very Great Extent
Security	4.56	Very Great Extent
Maintainability	4.30	Great Extent
Portability	4.80	Very Great Extent
Overall Mean	**4.56**	**Very Great Extent**

The system was evaluated based on functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, with a mean score of 4.56, indicating a "very great extent" of compliance. This suggests that stakeholders found the system both user-friendly and capable of fulfilling its intended functions and requirements. It emphasized the importance of aligning information systems

with ISO 25010 standards to ensure software quality and meet user needs, which highlighted ISO 25010 as the most comprehensive quality model for service-oriented architecture.

4 Conclusion and Future Considerations

In conclusion, the expected recovery of the real estate sector to pre-pandemic levels highlights the importance of adopting advanced technologies, which are transforming property management and rental practices. The ongoing impact of COVID-19 has increased demand for suburban and rural properties, as people seek larger homes suitable for remote work. Sustainability has become a priority, with buyers favoring eco-friendly features. 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.

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.

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