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Implementation Of Rapid Application Development Methodology In UI/UX Design of Mangrove Forest Information System

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Abstract−Concentrates on utilizing the Rapid Application Development (RAD) approach to improve the User Interface (UI) and User Experience (UX) of an information system designed for mangrove forest conservation. Mangrove ecosystems are essential for coastal defense, biodiversity, and carbon storage. Nonetheless, insufficient access to information frequently impeded community involvement in mangrove conservation. The research tackles this deficiency by creating a user-centric information system that amalgamates environmental data, cartographic representations, and educational materials concerning the mangroves of Desa Kota Pari. RAD was selected for its iterative and adaptable characteristics, facilitating ongoing stakeholder feedback and expedited development cycles relative to conventional models. The study delineates a multi-phase Rapid Application Development (RAD) methodology, encompassing requirements elicitation, prototyping, and user evaluation to develop a functioning and user-friendly system. By engaging end-users, including local authorities, conservationists, and community members during the development process, the system's UI/UX was tailored to address the distinct requirements of its audience, facilitating usability and the clear conveyance of intricate ecological data. Preliminary responses from usability assessments indicated a notable enhancement in user engagement and comprehension of mangrove conservation initiatives. The Mangrove Forest Information System demonstrates that the RAD technique is highly effective in developing interactive and user-centric environmental information systems, particularly in contexts requiring swift adaptation to user requirements. This approach improves community involvement and supports the sustainability of mangrove ecosystems.

Keywords: Rapid Application Development; Design UI/UX; Information Systems; Mangrove; Pari City Village.

1. INTRODUCTION

Ensuring the usability and efficacy of modern applications relies heavily on developing User Interface (UI) and User Experience (UX) design for information systems. The Rapid Application Development (RAD) methodology has become a valuable strategy for simplifying the development process of UI and UX designs. By integrating findings from other studies, including the research conducted on the utilization of psychology in evaluating mental well-being, The research conducted by [1] and [2] on holistic monitoring using the TCSD technique emphasizes the importance of RAD phases in improving the quality and effectiveness of information systems. Furthermore, the incorporation of user-centric methodologies, as highlighted in [3] study on User Experience Design and [4] research on user-centred design for web marketplaces emphasizes the significance of aligning RAD processes with user requirements to enhance the system's overall usability. In addition, the integration of state-of-the-art technology in UI and UX design procedures[5], as demonstrated by the examination of quality attributes in Augmented Reality. The study conducted by [6] and [7] on wireframe design for user interfaces illustrates the progressive incorporation of technology in improving user experiences. The iterative nature of design updates, as emphasized in [8] study on User Experience Design Methodologies and [9] analysis of UI design for fintech apps underscores the iterative and adaptive aspects of the RAD approach in enhancing UI and UX designs[10]. The essay seeks to combine various research views to offer a thorough understanding of how RAD may be utilized to optimize UI and UX design processes for information systems[11], ultimately improving user happiness and system usability[12].

Moreover, the usability and efficacy of information systems are greatly dependent on the design and development of user interface (UI) and user experience (UX) components[13]. The significance of user interface and experience in software development is emphasized by [14] work on math balancing aids utilizing IoT and [15] research on User-Centered Design in the Simpeg application. The adoption of Rapid adoption Development (RAD) methodology, as seen in the study conducted by [16] on interactive geo-location mobile applications and the research conducted by [17] on application design using Design Thinking[18], provides a systematic and iterative way to improving user interface (UI) and user experience (UX) designs[19]. This research article intends to explore the role of Rapid Application creation (RAD) in enhancing User Interface (UI) and User Experience (UX) design processes[20]. It draws upon a wide range of studies to present a complete overview of the advantages and consequences of using RAD in creating information systems[21]. To summarize, including RAD approach in developing UI and UX design for information systems offers a promising opportunity to improve user happiness and system usability[22]. This article aims to examine the diverse effects of RAD on UI and UX design processes by combining findings from several research, including the use of RAD in mental health examinations and the

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development of mobile-based systems[23]. The iterative and user-centric nature of Rapid Application Development (RAD)[24], as demonstrated in the literature, highlights its potential to improve user interface (UI) and user experience (UX) designs to align with changing user requirements and technology progress. This study article seeks to enhance the ongoing discussion on improving user happiness and system usability by analyzing RAD techniques and their implications. The goal is to optimize UI and UX design processes for information systems.

2. RESEARCH METHODOLOGY

2.1 Research Stage

The research is carried out utilizing a system development life cycle methodology comprising five distinct stages[25]. Figure 1 depicts each of these steps. Five steps are executed, specifically:

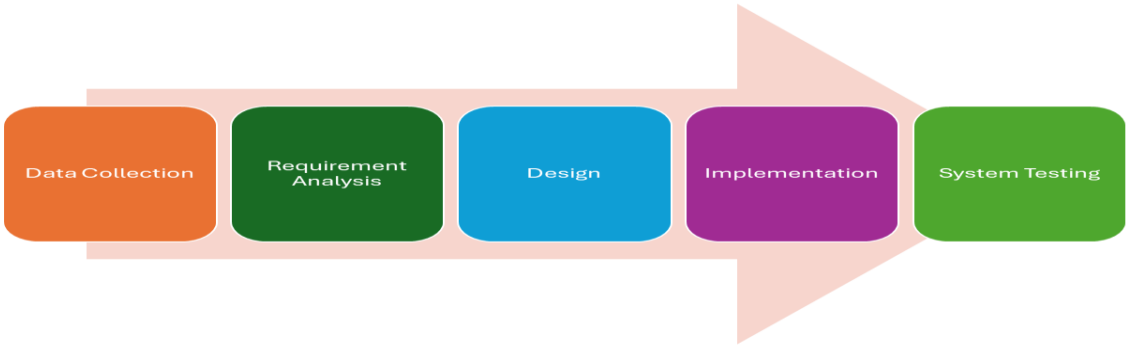

Figure 1. Research Stage With a System Development Life Cycle Methodology

The data-collecting phase in a study is a vital step that allows researchers to obtain the necessary information to address a research topic. Multiple studies across diverse scientific disciplines have emphasized the significance of data-gathering phases in the research process. In the study on developing a decision support system for selecting the best teachers, the data collection phase includes interviews with the school principal, observations at the research site, and analysis of relevant documents about the teachers chosen [25]. It is important to note that data collection is a crucial initial stage in research, which involves identifying problems and collecting data using specialized tools. In addition, [27] emphasized that data-gathering consists of data reduction, analysis, data display, and conclusion [27]. Meanwhile, it was stressed that thorough preparation, preliminary investigations, construction of research tools, data collection, data analysis, and findings are all important [28]. Based on multiple sources, it can be inferred that the data collection phase in research encompasses a series of actions, including problem identification, data collection, data reduction, analysis, and conclusion. This technique is crucial for ensuring the precision and dependability of the research findings.

The Requirement Analysis phase is a critical step in system or product development, ensuring a thorough understanding and accurate documentation of user requirements. Several studies have identified the necessary actions to be implemented during the needs analysis phase. The research conducted by [25] highlighted the significance of investigating user requirements by observing current systems to uncover issues related to sales data management. Meanwhile, it has been emphasized that needs analysis is performed by studying the operations of systems that handle customer data processing and service handling. The research phase, which involves designing, implementing, and testing systems, is a critical step in constructing an efficient and dependable system. Several research have identified the necessary actions to be implemented at this phase. In their study, [26] examined the many phases of creating expert system applications for diagnosing and maintaining Epson L3110 printers. This system's development phase encompasses data collecting, needs analysis, design, building, implementation, and testing. [26]. Furthermore, [27] emphasized utilizing the Waterfall technique for the design and development phases of the online complaint system in Labuhanbatu. This study demonstrates that the process involves several steps, namely system needs analysis, system design, system implementation, and system testing. The citation is from [27]. In addition, [28] examined the design and creation of the Instruction Scheduling Information System and Mobile-based Processing System at the State SMK. The study employs the Waterfall methodology, which comprises four distinct phases: analysis, design, coding, and testing[28].

2.2 Rapid Application Development Method Research Stage

In research [29] this study employs the Rapid Application Development (RAD) model as the software development approach. RAD is a software development process approach that focuses on short development cycles. RAD can serve as a standard for creating an information system that excels in speed, accuracy, and cost-effectiveness.

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Furthermore, RAD approaches can meet the requirement for current information and facilitate close personal engagement with the unique attributes of its consumers. Figure 2 provides a concise summary of the RAD model:

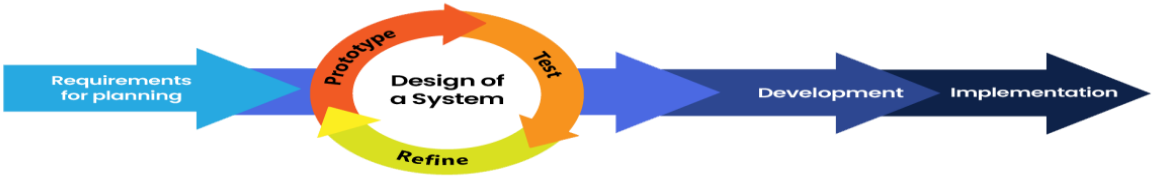

Figure 2. Rapid Application Development Method Research Stage

The software development step of the Rapid Application Development approach is referred to as [30]:

1. Requirements for planning
   During this stage, users and authors collaborate to analyze and resolve existing issues and identify the requirements for developing an application system. This stage is an initial step toward creating a successful system and helps prevent miscommunication between users and writers.
2. Design of a system
   The stage devises a strategic proposal tailored to address the existing issues, ensuring it is executed as intended and effectively resolves the current challenges. The design step of the system involves preparing the manufacturing process for a system that will be sold through a website. The stages involved in designing a new sales system are as follows:
   a. Prototype
      This procedure involves creating an offline website design to showcase the outcomes of the design.
   b. Test
      During the procedure, a website prototype test is conducted to ascertain the functionality of the prototypes.
   c. Refine
      This procedure carefully evaluates the design to determine if it aligns with the owner's preferences.
3. Development
   This is the initial phase in developing a deliberate system. This stage involves compiling a program code, generally called coding, to transform the design of an existing system into a functional application.
4. Implementation
   The implementation stage involves the execution of a system design that has been authorized in a prior step. Before implementation, a testing procedure is conducted on the program to identify any problems in the produced system. During this phase, the entire system undergoes comprehensive testing, and all components are subjected to rigorous Black Box Testing to minimize the likelihood of system malfunction[31].

2.3 Design UI/UX

UI/UX design is essential for creating user-friendly and engaging digital interfaces. Various methodologies and approaches have been developed to enhance user experience and usability. For example, User-Centered Design (UCD) focuses on understanding user needs to provide effective solutions [32]. The integration of Material Design for Android (MDfA) and Common Element Sets (CES) in mobile application UI design emphasizes the importance of combining different design elements to create a cohesive and intuitive interface [33]. Design Thinking has been effectively used in website design to meet user needs, as demonstrated in studies focusing on small and medium enterprises [34]. These approaches underscore the significance of considering user preferences and behaviours in UI/UX design to ensure positive interaction between users and digital platforms. The stage of Design Thinking[35] can be shown in Figure 3 as:

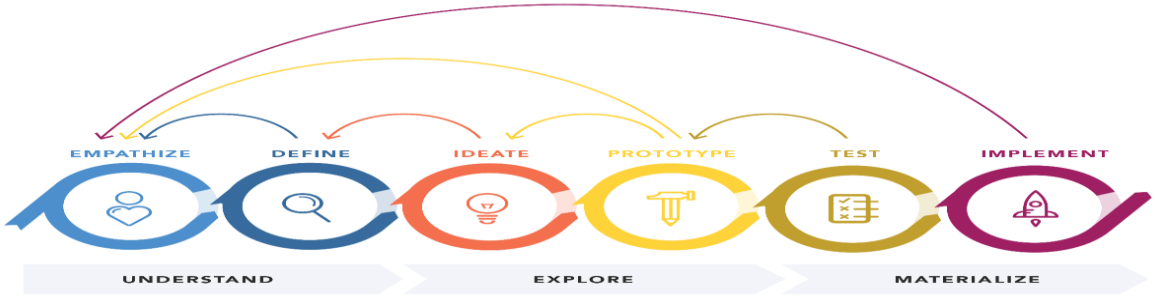

Figure 3. Stages of Design Thinking.

The design thinking process is a structured methodology that emphasizes a human-centred approach to problem-solving, consisting of five key stages: empathize, define, ideate, prototype, and test. Each stage plays a crucial role in ensuring that the final product or service effectively meets the needs of users:

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1. Empathize involves understanding users' needs through observation and engagement. This stage is critical as it lays the foundation for the design process. By immersing oneself in the users' experiences, designers can gather insights that inform the subsequent stages. For instance, it highlights that design thinking is used to uncover the in-depth characteristics of existing problems, emphasizing the importance of empathy in understanding user needs. Similarly, Rahayu notes that the design process centres around the user, reinforcing the necessity of empathy in identifying issues that require resolution.
2. Define the stage, which focuses on synthesizing the insights gathered to articulate the problem statement clearly. This stage is essential for ensuring design efforts address the right challenges. Emphasize that this phase is about comprehending and catering to the interests of potential customers, which is vital for effective strategy development. Moreover, the definition of the problem must be precise to guide the ideation process effectively as highlighted, who discusses the importance of understanding the problem before generating ideas.
3. The ideate stage encourages the generating of various ideas and potential solutions. This phase is characterized by divergent thinking, where creativity is paramount. Guo et al. explain that designers must engage in convergent thinking after generating numerous solutions to select the most viable options. This iterative process allows for the refinement of ideas, ensuring that the solutions developed are innovative and practical.
4. The selected ideas are transformed into tangible representations in the prototype stage. This phase is crucial for testing concepts in a real-world context. Prototyping allows for the visualization of ideas, making it easier to identify potential flaws and areas for improvement. The iterative nature of prototyping enables designers to refine their solutions based on feedback and observations.
5. The test stage involves evaluating the prototypes to gather user feedback and assess the solutions' effectiveness. This stage is critical for validating the design choices made throughout the process. Durski et al. illustrate how design thinking can redefine challenges and identify user-centered strategies, particularly in high-stakes environments like health emergencies. Testing confirms the solutions' viability and provides insights that can lead to further iterations and enhancements.

In conclusion, the design thinking process is a comprehensive methodology that integrates empathy, problem definition, ideation, prototyping, and testing. Each stage is interconnected and essential for developing solutions that are not only innovative but also aligned with user needs. The iterative nature of design thinking ensures that the outcomes are refined and effective, making it a valuable approach in various fields, from education to healthcare. Evaluating and improving UI/UX design are continuous processes to optimize user satisfaction and engagement. Incorporating adaptive user interface models has been shown to enhance user performance and satisfaction significantly [36]. Additionally, distinguishing primary and secondary information in interfaces can improve cognitive efficiency and user experience [37]. User experience design methodologies have been successfully applied in building interfaces for specific purposes, such as telerounds in Intensive Care Units, highlighting the importance of tailoring UI/UX design to meet the unique requirements of different user groups [8]By continuously evaluating and refining UI/UX design based on user feedback and behaviour, developers can create visually appealing, highly functional, and user-centric interfaces, ultimately enhancing user experiences.

2.3.4 System Design Design

The system design stage intends to meet the needs of system users and provide a clear picture and complete design of the decision support system to be built. Here, the author uses the Use Case Diagram as a system design, including the following:

2.3.4.1 Use Case Diagram

A Use Case Diagram visually represents the interactions between external actors and the system, illustrating the functions or services offered by that system. This diagram facilitates comprehension of the system's functional needs by illustrating usage scenarios and the interconnections between actors and the many use cases involved. The process of the system to be design is illustrated with a use case diagram in figure 4:

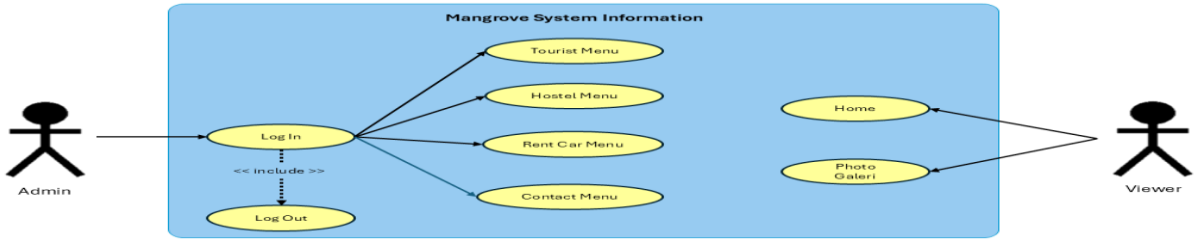

Figure 4. Use Case Diagram for Admin and Viewer

A Use Case Diagram for the Mangrove Forest Information System at Desa Kota Pari, involving both Admin and Viewer roles, outlines each user type's interactions with the system.

1. Admin: The Admin can access key functionalities such as managing user accounts, updating mangrove forest data (e.g., adding new reports, updating maps, or uploading educational content), and monitoring system

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performance. They also have permissions to generate reports, control content visibility, and maintain the system's overall functionality. In the diagram, the Admin is associated with multiple use cases like "Manage Users," "Update Data," "Generate Reports," and "Monitor System Activity."

2. Viewer: The Viewer, typically a general user or community member, can only access and interact with publicly available information. They can view mangrove-related data such as species information, conservation status, educational resources, and maps. The use cases linked to the Viewer include "View Home" and "Photo Gallery." The diagram shows that Viewers interact with the system for informational purposes without the ability to modify or update content.

The diagram demonstrates how the Admin oversees and manages the system, while the Viewer consumes the information it provides.

2.3.4.3 Sequence Diagram

A Sequence Diagram depicts the interactions among items inside a system according to the temporal sequence of events or messages transmitted. This figure illustrates the sequential flow of communication among system components, commencing with the initiation of an action and concluding with the received response. To create a sequence diagram for a system involving actors User and Admin, we need to outline the interactions and functionalities associated with each actor. Here's a step-by-step guide to creating the sequence diagram shown in figure 5:

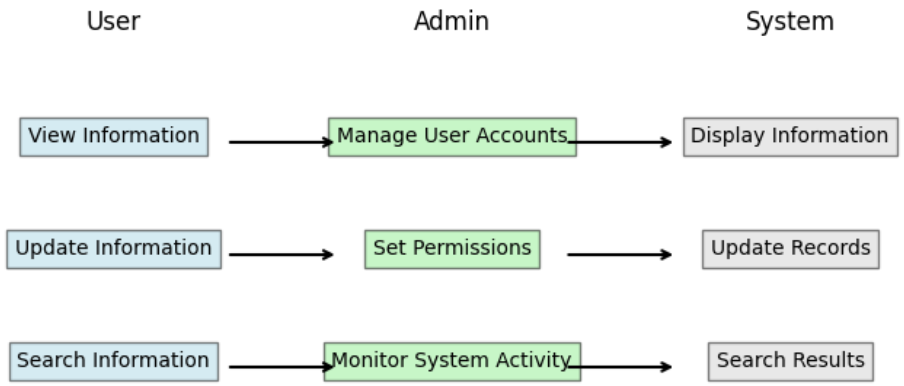

Figure 5. A Sequence Diagram for System Information

A sequence diagram is a vital component of Unified Modeling Language (UML) that visually represents the interactions between objects in a system over time. It is particularly useful for illustrating how processes operate and how different components of a system communicate with each other. This diagrammatic representation aids in understanding the dynamic behaviour of a system, which is crucial during the design and implementation phases of software development. The primary purpose of a sequence diagram is to depict the sequence of messages exchanged between objects, highlighting the order of interactions. As noted by Shinkawa, UML sequence diagrams are essential for expressing the behaviour of systems composed of multiple objects. They allow developers to visualize and analyze the interactions during system execution (Shinkawa, 2010). This visualization is critical for ensuring the system behaves as intended and meets user requirements. In system design, sequence diagrams serve as a bridge between abstract design concepts and concrete implementation. They provide a clear framework for understanding how different components interact, which is particularly important in complex systems. For instance, Ciraci et al. emphasize that sequence diagrams can specify all possible software system uses, thereby generating execution sequences that may not be explicitly modelled but are feasible due to polymorphism (Ciraci et al., 2010). This capability is vital for ensuring comprehensive coverage of system interactions during the design phase. Moreover, creating sequence diagrams often involves collaboration among various stakeholders, including developers, designers, and end-users. This collaborative approach ensures the diagram accurately reflects the system's intended functionality.

As highlighted by Songsom et al., the design of systems such as a Student Relationship Management System incorporates relevant actors and processes, including sequence diagrams, to facilitate a comprehensive understanding of system behaviour (Songsom et al., 2020). This integration of various modelling techniques enhances the clarity and effectiveness of the design process. Automated verification of sequence diagrams is another critical aspect that enhances their utility in software development. Automated tools can check the correctness of UML sequence diagrams, ensuring that they accurately represent the intended interactions and behaviours of the system. Vidal-Silva et al. discuss the importance of automated verification in modelling critical algorithmic behaviours, which is essential for maintaining the integrity of software products (Vidal-Silva et al., 2018). This verification process helps identify discrepancies between the designed interactions and the actual implementation, thereby reducing the risk of errors in the final product. In summary, sequence diagrams are a fundamental tool in the design and analysis of software systems. They provide a clear and structured way to

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visualize components' interactions, facilitate stakeholder collaboration, and support automated verification processes. By effectively capturing the dynamic behaviour of systems, sequence diagrams play a crucial role in ensuring that software products meet their intended requirements and function correctly.

3. RESULT AND DISCUSSION

3.1 Results

Rapid Application Development (RAD) is a software development methodology that prioritizes the swift construction of applications via prototyping and fast iteration. This strategy facilitates the rapid acquisition of user feedback, permitting modifications and enhancements during the development process.The use of Rapid Application Development (RAD) in User Interface (UI) and User Experience (UX) design for information systems has drastically altered the development environment by emphasizing expediency and user-centricity. RAD prioritizes iterative prototyping and ongoing user feedback, enabling developers to swiftly adjust to evolving requirements and enhance the overall user experience. After this research is carried out, the next stage is to show the results of the research and test the system. This system runs only admin access. The pages that will be displayed are as follows:

3.1.1 Mangrove Forest Information System Home Page

The initial display of the system created is the main page, and this page serves to open access from the system created, for the access itself for the display can be seen in the following Figure 6:

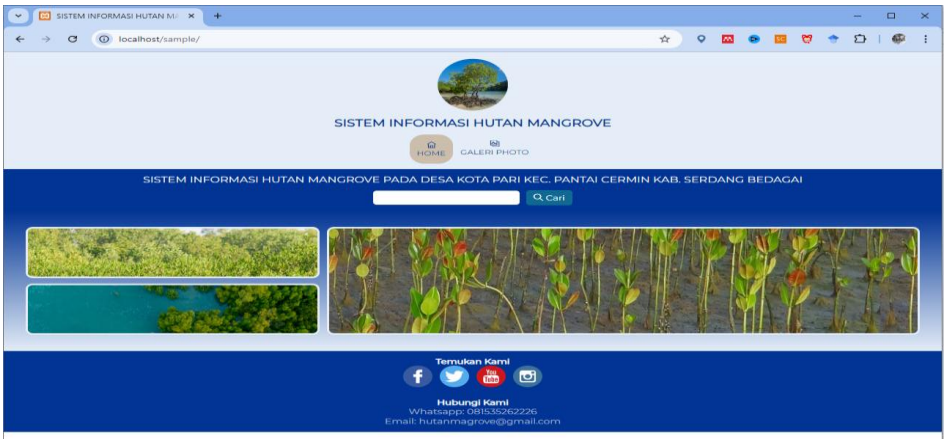

Figure 6. Mangrove Forest Information System Home Page

The Mangrove Forest Information System Home Page is the system's main page that provides data related to the mangrove forest ecosystem, including its condition, monitoring, and conservation. This page is designed to facilitate access to information for researchers, government officials, and the public in efforts to protect and manage mangrove forests sustainably.

3.1.2 Photo Gallery Page on the Mangrove Forest Information System

The photo gallery showcases the diverse and vibrant mangrove ecosystem of Desa Kota Pari, highlighting its rich biodiversity and scenic landscapes. Each image captures key aspects of the mangrove forest, from thriving plant life to the local community's conservation efforts. This gallery aims to raise awareness about preserving these vital ecosystems for environmental sustainability. The display can be seen in the following Figure 7:

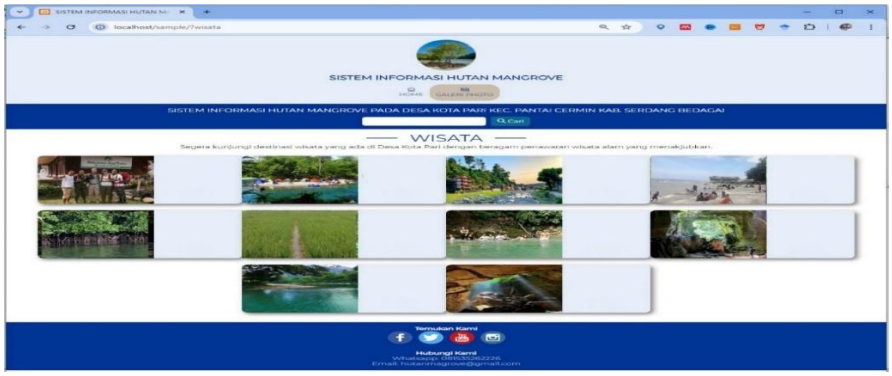

Figure 7. Photo Gallery Page on the Mangrove Forest Information System

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The Photo Gallery Page on the Mangrove Forest Information System showcases a collection of photos of mangrove forests, including flora, fauna, and conservation activities in the area. This page aims to provide a visualization that supports understanding the importance of the mangrove ecosystem and raise awareness of the conservation efforts being undertaken.

3.1.2 Admin Login Page on The Mangrove Forest Information System

The admin login page provides secure access to the Mangrove Forest Information System management panel at Desa Kota Pari. Authorized administrators can enter their credentials to manage user data, update system content, and monitor conservation-related information. This portal ensures only verified users can perform critical updates and maintain the system's functionality. The display can be seen in the following Figure 8:

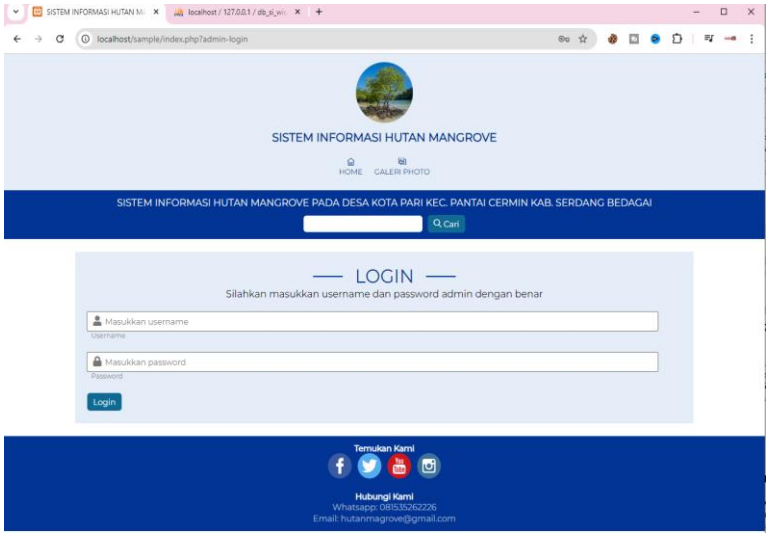

Figure 8. Admin Login Page on The Mangrove Forest Information System

3.1.3 Admin Main Page on the Mangrove Forest Information System

The Admin Main Page is the central dashboard for managing the Mangrove Forest Information System at Desa Kota Pari, offering easy access to key features like data management, user settings, and content updates. Administrators can efficiently monitor system activity, update mangrove conservation information, and oversee user interactions through an intuitive interface. This page ensures streamlined administration, helping maintain the accuracy and effectiveness of the information system. The display can be seen in the following Figure 9:

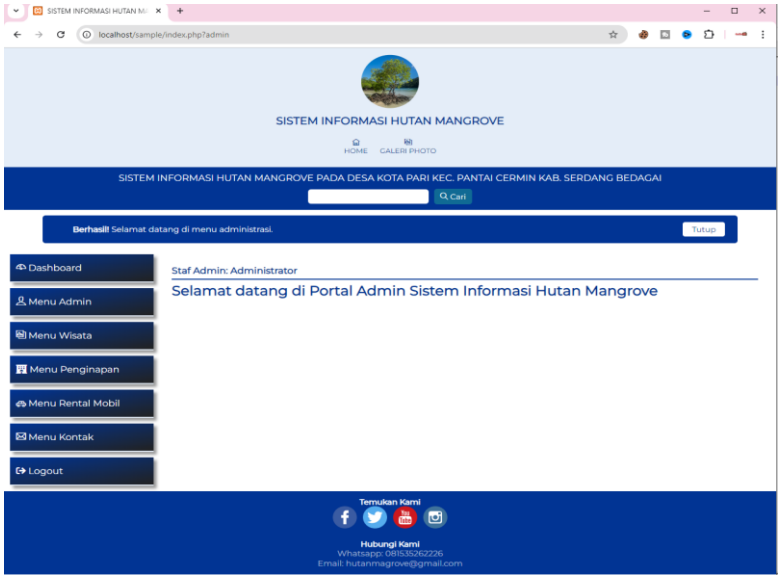

Figure 9. Admin Login Page on The Mangrove Forest Information System

3.2 Discussion

Applying the Rapid Application Development (RAD) methodology in the UI/UX design of the Mangrove Forest Information System at Desa Kota Pari underscores the significance of an iterative and user-centric approach in environmental conservation technology. RAD's focus on rapid prototyping and ongoing input enabled the

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development team to swiftly adjust to the requirements of local stakeholders, such as conservationists, community members, and governmental entities. Incorporating end-users during the initial design phases allowed for the UI/UX of the system to be customized to the particular requirements of individuals involved in mangrove conservation, guaranteeing a functioning and user-friendly interface. This iterative process allowed engineers to adapt the information system using real-time user feedback, leading to a more intuitive platform that improves user engagement and facilitates community-driven environmental management. Moreover, the RAD technique demonstrated efficacy in meeting the dynamic and growing requirements of the information system. Due to the intricate nature of ecological data and the varied user demographic, RAD's adaptability was essential for implementing swift modifications without substantial delays or expensive redesigns. This method expedited the development process while enhancing user satisfaction by providing a system that was both efficient and responsive to feedback. The research illustrates that employing Rapid Application Development (RAD) in the UI/UX design of environmental information systems can enhance usability and user experience, especially when addressing a heterogeneous user base with differing degrees of technological expertise. The RAD technique provides significant insights for future studies incorporating technology into conservation initiatives. Implementing the Rapid Application Development methodology in the UI/UX design of the Mangrove Forest Information System at Desa Kota Pari demonstrated the effectiveness of an iterative, user-centred approach in creating a functional, adaptable, and user-friendly platform for diverse conservation stakeholders.

4. CONCLUSION

The RAD methodology is an effective approach for developing user-friendly and adaptable environmental information systems. By emphasizing rapid prototyping and continuous user feedback, the system designed for mangrove forest conservation was able to meet the specific needs of its target audience, which included local communities, conservationists, and government officials. The iterative nature of RAD allowed for adjustments to be made quickly based on user input, resulting in an intuitive UI/UX design that improved the accessibility and usability of important ecological data. This process led to higher user satisfaction and engagement, which are critical for the success of conservation programs. Additionally, the research highlights the importance of involving end-users in the development cycle of environmental information systems. The system was tailored to address the real-world challenges of mangrove conservation in Desa Kota Pari by actively engaging stakeholders throughout the design and testing phases. The study demonstrated that the RAD methodology accelerates the development process and ensures that the final product is highly relevant to its users. Overall, this approach can serve as a model for future environmental information systems, emphasizing the importance of user-centred design in fostering community participation and promoting sustainable ecosystem management. The Mangrove Forest Information System at Desa Kota Pari is a user-centred platform designed to provide accessible ecological data and resources to support mangrove conservation efforts in the local community.

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