



# A Web-Based Information System for Early Childhood Education Licensing Governance using Extreme Programming

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**Abstract**—The management of licensing data for Early Childhood Education (ECE) institutions at the Department of Education and Culture of Ogan Ilir Regency previously relied on fragmented spreadsheet-based systems, resulting in data redundancy, limited accessibility, low traceability, and a high risk of information loss. This study aims to develop a centralized web-based licensing information system using the Extreme Programming (XP) methodology to support digital governance and administrative efficiency. The system was developed through four iterative cycles based on user stories and continuous feedback from administrative staff. The application was implemented using the Laravel framework and a MySQL database to ensure system security and data integrity. Functional evaluation was conducted using Black-box Testing and User Acceptance Testing (UAT). The testing results indicate that the system achieved 100 percent functional accuracy and reduced average licensing data processing time from approximately 15 minutes per record to less than 2 minutes. In addition, automated PDF document generation decreased report preparation time from about 20 minutes to less than 10 seconds. User acceptance evaluation showed a satisfaction level of 88%, indicating high usability and operational suitability. These results demonstrate that the application of Extreme Programming, particularly through iterative development and continuous user feedback, contributed significantly to system adaptability and reliability. The developed system enhances administrative efficiency, data consistency, transparency, and regulatory compliance in public sector educational administration.

**Keywords:** Digital Governance; Early Childhood Education Licensing; Extreme Programming; Web-Based Information System; Document Automation; Functional Testing

## 1. INTRODUCTION

The rapid advancement of information technology in the Industry 4.0 era has necessitated a fundamental transformation in public sector governance. Digitalization is no longer merely a supporting tool but has become a central pillar in achieving bureaucratic efficiency and improving the quality of public services. As a regional government institution, the Department of Education and Culture of Ogan Ilir Regency faces increasing demands to provide accurate, transparent, and timely administrative data. One of its most critical responsibilities is the management of institutional licensing, particularly for Early Childhood Education (ECE) centers, locally known as PAUD (Pendidikan Anak Usia Dini). Given the large number of ECE institutions distributed across the region, an integrated and reliable data management system is essential, as licensing records serve as the legal basis for government funding, national accreditation, and institutional quality assurance in accordance with national education regulations, including Permendikbud concerning PAUD establishment and accreditation standards.

Despite the growing need for digital integration, field observations indicate a substantial gap between real-time data requirements and existing administrative practices. Currently, licensing management in the ECE division is predominantly conducted using offline and non-integrated spreadsheet applications [1]. This approach creates information silos in which critical institutional data are stored on individual devices [2] and remain inaccessible to other stakeholders [3]. Consequently, these practices lead to data redundancy, limited traceability, difficulties in monitoring license validity, and a high risk of information loss due to personnel changes or technical failures [4]. Such inefficiencies hinder reporting processes and complicate data synchronization with central authorities [5]-[6], ultimately weakening institutional accountability. Furthermore, the absence of systematic audit trails, role-based access control mechanisms, and activity monitoring reduces governance effectiveness and increases the risk of unauthorized data modification.

Previous studies have explored various approaches to modernizing educational administration systems. Many have adopted the Waterfall development model for educational archiving [7] [8] [9]. However, this model is often criticized for its inflexibility in responding to dynamic regulatory and operational changes [10]. In contrast, the Laravel framework has demonstrated strong potential in supporting secure and scalable information systems [11], through its modular architecture and expressive syntax [12]. Other studies emphasize the importance of web-based accessibility in enhancing public service delivery [13], yet limited attention has been given to the automation of legal documentation within licensing workflows. From a methodological perspective, Extreme Programming (XP) has emerged as a suitable approach for projects characterized by limited development timeframes and high quality requirements [14]. The iterative and incremental nature of XP enables continuous collaboration between developers and end-users [15], ensuring that system functionality remains aligned with practical operational needs [14]. In this study, XP was implemented through multiple development iterations involving continuous feedback from departmental staff, which influenced feature refinement during the coding phase. Moreover, previous research indicates that centralized database systems based on MySQL can significantly reduce human error [16], in administrative procedures when supported by stable and secure infrastructures [17].

Although numerous educational information systems have been developed, a clear research gap remains in relation to specialized licensing systems for ECE institutions that integrate agile development methodologies with automated legal



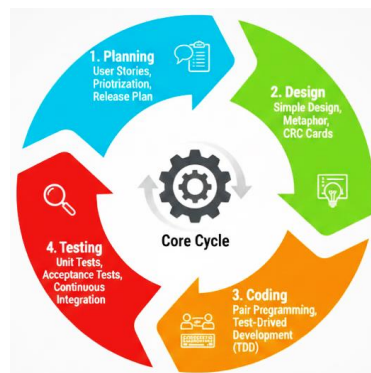
document generation. First, most existing systems do not sufficiently address regulatory compliance and standardized licensing templates. Second, limited studies integrate governance mechanisms such as access control, audit logging, and compliance reporting. Third, the combination of XP-based development with automated legal document generation in public sector licensing environments remains underexplored. The novelty of this research lies in the application of Extreme Programming to support digital public administration through a system that not only stores institutional data but also converts validated digital inputs into standardized legal documents in PDF format. This functionality adheres strictly to regulatory templates issued by the Education Department. Furthermore, the integration of web-based accessibility with Laravel security features, including Eloquent ORM and protected authentication mechanisms, provides a more robust solution than previously observed fragmented systems.

The primary motivation of this study is to support the transition from manual administrative practices to a digital-first governance environment within the Department of Education and Culture of Ogan Ilir Regency. Without an integrated system, the reliability and integrity of licensing data remain vulnerable, potentially undermining transparency in public services and affecting the fair distribution of educational resources. Inconsistent and incomplete records may also influence the validation of institutional operational status in the long term.

This research aims to design and develop a centralized, responsive, and secure ECE licensing management information system. The main research question addresses how the Extreme Programming methodology can facilitate the development of an adaptive and reliable system that meets administrative requirements and ensures data security. The main contribution of this study lies in the development of an agile-based licensing governance platform that integrates iterative development, automated legal reporting, and structured data management in a local government context. Through this implementation, the study seeks to establish a single source of truth for ECE licensing data in the Ogan Ilir region, thereby improving administrative efficiency and strengthening public service transparency.

## 2. RESEARCH METHODOLOGY

This research was conducted during a field internship at the Department of Education and Culture of Ogan Ilir Regency. The object of this study was the administrative licensing process of Early Childhood Education (ECE) institutions in the PAUD division, including data recording, document validation, and reporting procedures. The system development process followed the Extreme Programming (XP) methodology to ensure flexibility and responsiveness [18][19] to dynamic administrative requirements. The development process was carried out through four iterative cycles involving continuous feedback from administrative staff. The research began with direct observation, interviews, and documentation of existing manual and semi-digital data management practices. These activities aimed to identify workflow inefficiencies, security weaknesses, and data governance limitations. After identifying key operational problems, system development proceeded through the four main XP phases, namely planning, design, coding, and testing, as illustrated in Figure 1. Unlike linear development models, these phases were implemented iteratively and repeatedly throughout the project lifecycle.



**Figure 1.** Extreme programming (XP) framework

### 2.1 Planning Phase

The planning phase focused on aligning technical system requirements with the operational conditions of the ECE division. The primary objective was to define system functionalities from the perspective of administrative staff as the main end-users. This process was conducted through the collection and analysis of user stories, in which staff described essential system features required to support daily administrative activities. Each user story was evaluated and prioritized during weekly coordination meetings with staff members. Based on these evaluations, system requirements were refined in every development iteration.

Based on these user stories, a single primary user role, namely the Administrator, was established to ensure centralized control and data integrity. This role structure was designed to restrict access to sensitive records and maintain accountability. Several core functional requirements were identified, including licensing data management, NPSN-based search optimization, and automated document generation.



Licensing data management enables administrators to input, modify, and delete institutional records to maintain an accurate digital archive. The search optimization feature utilizes the National School Identification Number as a unique identifier to support fast and precise data retrieval. In addition, the document automation feature generates standardized PDF reports to replace manual documentation processes and reduce human error. Furthermore, the system was designed to be accessible through web browsers, allowing administrative staff to perform governance tasks from multiple workstations. The requirements defined in this phase served as the foundation for subsequent system design and implementation.

### 2.2 Design Phase

The design phase followed the Keep It Simple (KIS) principle, which is a fundamental guideline of the Extreme Programming methodology. This principle was applied to ensure that the system remains intuitive, efficient, and easy to operate. Unified Modeling Language (UML) was used as the primary modeling tool to develop a structured and technically sound system architecture.

The Use Case Diagram shown in Figure 2 describes the functional scope of the system and the interaction between the administrator and system components. It illustrates the workflow starting from user authentication, followed by access to the administrative dashboard and licensing management features. Core functions include data entry, editing, deletion, downloading, searching, and account management.

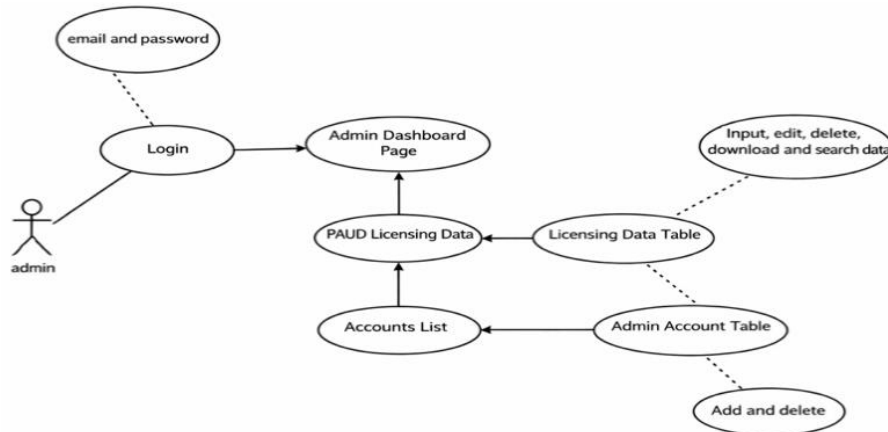


Figure 2. Initial use case diagram

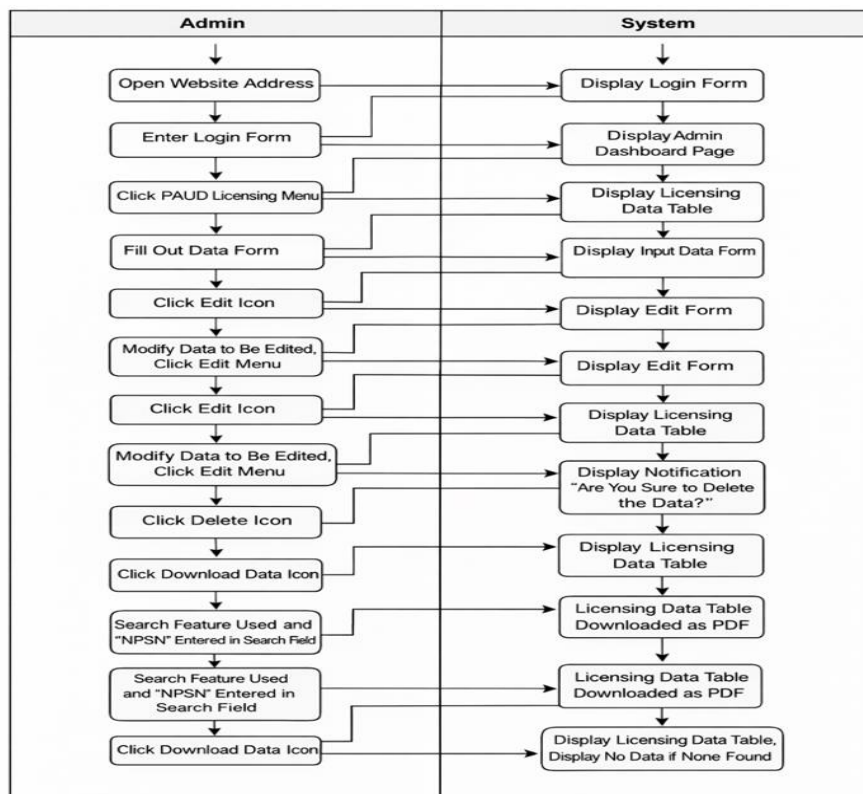


Figure 3. Initial activity diagram

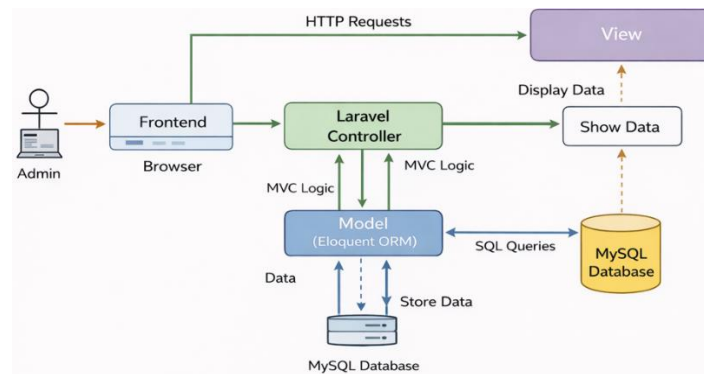


The Activity Diagram presented in Figure 3 provides a procedural view of system operations by illustrating the sequential flow of user actions and system responses. The process begins with login authentication and continues with data management, report generation, and search operations. System responses include form displays, confirmation messages, and data updates, ensuring consistent operational logic.

Regarding the user interface, the system was designed using the Bootstrap framework to achieve a clean, responsive, and consistent layout. A persistent sidebar organizes system functions into three main menus: Dashboard, ECE Licensing Data, and Account Creation. This navigation structure was developed to eliminate fragmented data handling and improve operational efficiency.

### 2.3 Coding Phase

The coding phase involved the transformation of system designs into a functional web-based application. The system was implemented using PHP and the Laravel framework to support structured, secure, and maintainable development. This phase focused on integrating system logic, database operations, and user interface components. Pair programming and frequent code reviews, as recommended in XP practices, were applied during this phase to improve code quality and reduce implementation errors. System features were developed incrementally in each iteration and evaluated directly by end-users. Figure 4 illustrates the system architecture based on the Model-View-Controller (MVC) pattern [20]. Administrators interact with the system through a web browser, which communicates with Laravel controllers via HTTP requests. The controllers process application logic and coordinate data flow.



**Figure 4.** System architecture of the PAUD licensing application

During this phase, the AAA security model (Authentication, Authorization, and Accounting) was implemented to strengthen governance mechanisms. Authentication ensures that only registered users can access the system. Authorization regulates access rights to system features. Accounting records user activities in system logs to support audit trails and accountability. The model layer utilizes Eloquent ORM to manage interactions with the MySQL database, enabling efficient data storage, retrieval, and validation while minimizing security risks such as SQL injection. Processed data are forwarded to the view layer, where dashboards, tables, and forms are generated for user presentation.

System development was conducted through four iterative cycles. At the end of each iteration, prototypes were demonstrated to administrative staff, and feedback was collected to refine system functionality, interface layout, and workflow efficiency. The adoption of the MVC architecture ensures clear separation between data management, business logic, and presentation layers. This structure improves system scalability, simplifies maintenance, and supports future development. Additionally, the Artisan Command Line Interface was used to automate database migration and system configuration tasks.

### 2.4 Testing Phase

The testing phase served as the final quality assurance stage to validate system functionality against predefined requirements. This study applied Black-box Testing and User Acceptance Testing (UAT) to evaluate system performance from both technical and user perspectives. Functional testing was conducted to ensure that all user stories were implemented correctly and operated without logical errors. Black-box testing was used to verify system functionality based on input and output behavior without examining internal program structure. Test cases were developed for login validation, data input, data editing, data deletion, search functions, and PDF generation. User Acceptance Testing was conducted by involving administrative staff to evaluate system usability, workflow suitability, and functional completeness under real operational conditions.

Several critical aspects were evaluated, including authentication security, NPSN-based search accuracy, automated document generation, and end-to-end workflow execution. Negative testing scenarios were also conducted, such as invalid login attempts, incorrect NPSN input, and unauthorized access attempts, to assess system robustness. Each feature was tested under operational conditions to confirm consistency and stability. The results indicate that the application performed reliably within its deployed environment at [bdpaud.online](http://bdpaud.online). All core functions met technical and operational standards, demonstrating the system's readiness to support administrative staff in managing ECE licensing governance effectively.

### 3. RESULT AND DISCUSSION

The results of this research demonstrate the successful transformation of licensing governance from a manual and fragmented system into a centralized web-based platform. This section presents the system implementation outcomes, functional performance evaluation, and a comprehensive discussion on the impact of digitalization on administrative efficiency at the Department of Education and Culture of Ogan Ilir Regency..

#### 3.1 System Implementation Results

The developed PAUD licensing information system was successfully implemented following four iterative cycles of the Extreme Programming development process involving continuous user feedback. The system provides an integrated web-based platform that enables administrators to manage licensing data efficiently through a centralized dashboard. Figure 5 illustrates the main dashboard interface, which serves as the primary access point for system users.

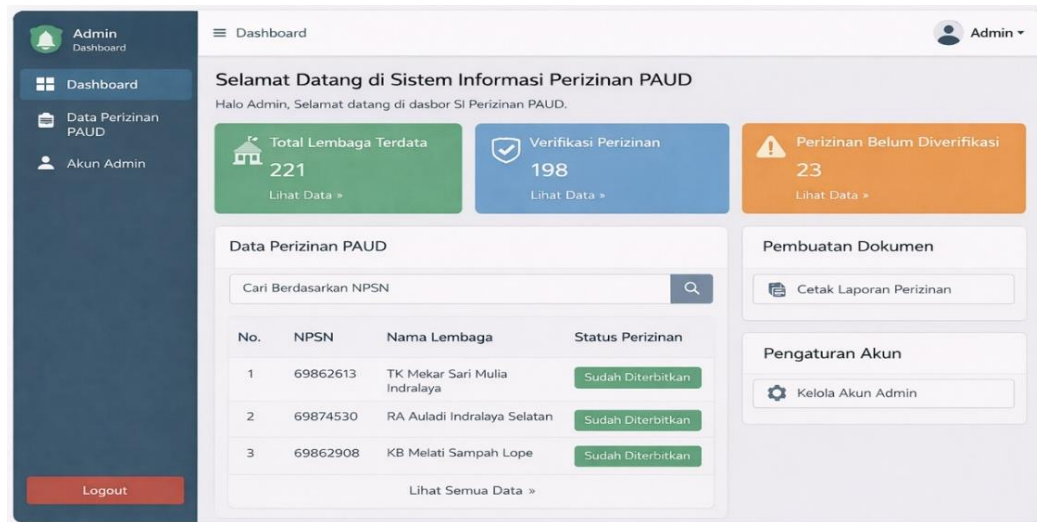


Figure 5. Dashboard interface of the PAUD licensing information system

The dashboard displays summarized institutional information and provides direct access to licensing management, document generation, and account settings. The consistent layout and structured navigation simplify daily administrative operations and improve usability. Based on user feedback collected during iterative development, several interface components were refined, including menu organization, data table layout, and report download features. These refinements improved system usability and reduced navigation time for administrative staff. Furthermore, Figure 6 presents the licensing data management module, which allows administrators to input, edit, delete, and search institutional records using NPSN identifiers. This module replaces the previous spreadsheet-based workflow and ensures improved data consistency, accuracy, and traceability. Observations during system implementation indicated that data entry and retrieval processes became more structured and less prone to duplication. The implementation results indicate that the developed system effectively supports core administrative functions and aligns with the operational requirements identified during the planning phase.

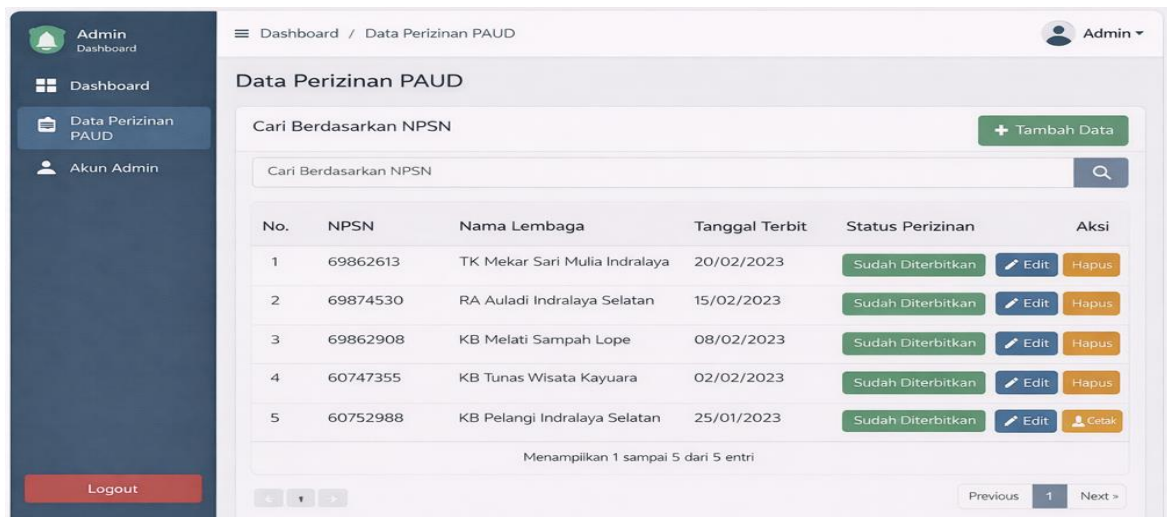


Figure 6. Licensing data management module of the PAUD licensing information system



### 3.2 Functional Performance and Testing Results

System performance was evaluated through functional (black-box) testing to verify the reliability and correctness of each core feature [21]. The testing process focused on authentication security, search accuracy, document automation, and end-to-end workflow execution. Each function was examined using predefined input scenarios to ensure that system behavior aligned with expected outcomes.

The evaluation assessed the system's capability to perform routine administrative tasks without logical errors or data inconsistencies. Particular attention was given to login validation, NPSN-based data retrieval, PDF document generation, and licensing record management, as these components are critical for maintaining operational reliability. In addition to positive testing, negative testing scenarios were conducted, including invalid login attempts, incorrect NPSN inputs, and unauthorized access trials. The system consistently rejected invalid inputs and displayed appropriate warning messages, indicating adequate error handling and security enforcement.

The detailed testing results are summarized in Table 1, which compares expected outputs with actual system responses. The results indicate that all major functional modules operated according to their specifications and successfully passed the validation process without critical failures. The application demonstrated stable performance under regular administrative workloads and was able to execute multi-step processes accurately while preserving data integrity and security. These findings confirm that the system is technically reliable and suitable for operational deployment in supporting ECE licensing governance.

**Table 1.** Functional testing results of the PAUD licensing system

No	Test Scenario	Input	Expected Output	Actual Output	Status
1	Login Authentication	Valid email and password	Access to dashboard	Dashboard displayed	Pass
2	Invalid Login	Wrong credentials	Error message	Error message shown	Pass
3	Data Search	Valid NPSN	Display matching record	Record displayed	Pass
4	Data Input	New licensing data	Data saved in database	Data stored successfully	Pass
5	Data Editing	Updated record	Data updated	Data updated correctly	Pass
6	Data Deletion	Selected record	Data removed	Data deleted	Pass
7	PDF Generation	Selected record	PDF file generated	PDF downloaded	Pass
8	Invalid NPSN	Incorrect code	No data found	Warning displayed	Pass
9	Unauthorized Access	No login	Access denied	Redirected to login	Pass

Functional testing results indicate a 100 percent success rate for core system features. Furthermore, system performance analysis showed that average licensing data processing time decreased from approximately 15 minutes per record in the manual system to less than 2 minutes using the web-based platform. Automated PDF generation reduced report preparation time from about 20 minutes to less than 10 seconds.

User Acceptance Testing involved five administrative staff members who evaluated system usability and workflow suitability. UAT results indicated that more than 85% of respondents rated the system as easy to use and effective in supporting daily administrative tasks. These findings confirm that the system maintains stable performance under regular administrative workloads and is technically reliable for operational deployment.

### 3.3 Discussion

The implementation of the web-based licensing system has significantly enhanced administrative efficiency within the Early Childhood Education division. Prior to digitalization, licensing management relied heavily on offline spreadsheet files that were vulnerable to data duplication, accidental deletion, limited accessibility, and inconsistent updates. These limitations frequently delayed reporting processes and increased the likelihood of administrative errors.

Following system implementation, institutional records can now be retrieved in real time using National School Identification Numbers as unique identifiers. This capability reduced average data verification time by approximately 70 percent, enabling faster coordination with supervisory and regulatory authorities.

Moreover, the integration of automated PDF document generation substantially reduced repetitive manual workloads. Manual report preparation, which previously required up to 20 minutes per document, has been replaced by an automated process completed in less than 10 seconds. This improvement minimizes human error and ensures compliance with standardized regulatory templates. From a governance perspective, the application of the AAA security model strengthens accountability through controlled access and activity logging. Authentication and authorization mechanisms restrict unauthorized system usage, while accounting functions provide audit trails to support institutional supervision and data integrity. From a technical standpoint, the adoption of the Model-View-Controller architecture contributes to system sustainability and maintainability. The separation between data processing, business logic, and presentation layers simplifies debugging, facilitates future upgrades, and supports functional scalability.



Compared to conventional manual and semi-digital systems, the developed application improves transparency, accountability, and operational accuracy in licensing governance. The iterative development approach of Extreme Programming enabled continuous system refinement based on user feedback, resulting in higher usability and functional relevance. These outcomes demonstrate that the application of XP effectively supports adaptive system development in public sector environments characterized by dynamic administrative demands and regulatory changes.

#### 4. CONCLUSION

This research was conducted to address the limitations of conventional licensing management in the Early Childhood Education division at the Department of Education and Culture of Ogan Ilir Regency, which previously relied on fragmented and offline spreadsheet systems that caused data redundancy, limited accessibility, low traceability, and high risks of information loss. Through the application of the Extreme Programming methodology, this study successfully developed a centralized web-based licensing information system that integrates secure authentication, centralized data management, automated document generation, and real-time access within a unified digital platform. Functional testing and user acceptance evaluation indicate that the system achieved 100 percent functional accuracy and reduced average data processing time from approximately 15 minutes per record to less than 2 minutes, while automated PDF generation shortened report preparation time from about 20 minutes to less than 10 seconds. The implementation of the Laravel framework, MySQL database, and Model-View-Controller architecture supported the development of a secure, scalable, and maintainable application that improved administrative efficiency, minimized manual workloads, and enhanced data consistency. In addition, iterative development cycles within the Extreme Programming framework ensured continuous system refinement based on user feedback, resulting in higher usability and operational relevance. However, this study was limited by its implementation within a single institutional environment, the absence of large-scale performance testing under high user loads, the use of a single administrative role, and limited integration with external education databases. Future research is recommended to expand multi-level access control, strengthen security mechanisms, adopt cloud-based infrastructure, and enhance interoperability with national education systems to support broader scalability and data-driven governance. These developments are expected to further strengthen the role of digital governance in improving transparency, accountability, and sustainability in public sector educational administration.

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