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Design And Development Of An Early Childhood Development Monitoring And Reporting Information System Using The Web Development Life Cycle (WDLC)Method At Paud Kb Kenanga

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ABSTRACT

Continuous monitoring of early childhood development is essential to ensure that children's cognitive, motor, language, social, religious, emotional, and artistic development progresses according to established developmental milestones. However, the monitoring and reporting process at PAUD KB Kenanga, Raman Fajar Village, is still conducted manually using conventional notebooks, resulting in inefficient data management, difficulties in retrieving historical records, delayed information delivery, and limited parental access to children's developmental progress. Therefore, this study aims to design, develop, and evaluate a web-based Early Childhood Development Monitoring and Reporting Information System using the Web Development Life Cycle (WDLC) method. The study employed the WDLC approach consisting of planning, analysis, design and development, testing, implementation, and maintenance. Data were collected through observation, interviews, and documentation, while system functionality was evaluated using Black Box Testing involving Administrator, Teacher, and Parent access levels. The results demonstrate that the developed system effectively supports administrators in managing developmental data, enables teachers to record and report children's developmental progress digitally, and allows parents to monitor their children's development in real time through an online portal. All 32 Black Box Testing scenarios produced valid results (100%), indicating that the system functions as expected. The implementation of the proposed system improves the effectiveness, accuracy, continuity, and accessibility of developmental monitoring while strengthening communication between PAUD KB Kenanga and parents through an integrated web-based platform.

INTRODUCTION

Early childhood education (PAUD) plays a foundational role in shaping children's cognitive, motor, language, social, religious-moral, and emotional development during the most critical stage of human growth (Hasniati et al., 2025). To ensure that

developmental milestones are achieved appropriately, early childhood education institutions are required to conduct continuous and structured monitoring and reporting of each child's developmental progress. Developmental monitoring refers to the continuous and systematic process of observing, recording, and assessing children's progress across cognitive, motor, language, social-emotional, religious-moral, and artistic domains based on predetermined developmental indicators (Stratigos & Fenech, 2021).

Effective developmental monitoring requires periodic and structured data collection so that developmental delays can be identified promptly and followed by appropriate interventions from teachers and parents (Sheel et al., 2024). Consequently, the outcomes of developmental monitoring serve as essential information for educational institutions and parents in understanding children's learning achievements and constitute an inseparable component of quality PAUD service delivery (Avari et al., 2023).

In practice, however, many PAUD institutions continue to conduct developmental monitoring and reporting manually. This condition is also found at PAUD KB Kenanga in Raman Fajar Village, where children's developmental records covering cognitive, motor, language, social, artistic, religious, and emotional domains are still documented using conventional notebooks. Developmental reports are generally provided only during report-card distribution, preventing parents from monitoring their children's progress continuously. This manual process results in several operational problems, including time-consuming data retrieval, frequent recording errors, risks of document loss or damage, and limited parental access to developmental information (Prasetyo & Ikrimach, 2025; Putra F et al., 2024).

These limitations reduce the effectiveness of communication between schools and parents and may delay appropriate interventions when children experience developmental difficulties. Considering that parental involvement is an important factor supporting children's development outside the classroom, improving the monitoring and reporting process has become increasingly important (Asmawati, 2021; Prahasti et al., 2025). One potential solution to these challenges is the implementation of a web-based information system. A web-based information system enables educational institutions to perform data input, processing, storage, and reporting digitally through internet-based applications without dependency on a single physical device or location (Farhan et al., 2025).

Such systems have been widely implemented to improve administrative efficiency, academic monitoring, and communication between educational institutions and stakeholders because of their flexibility, scalability, and accessibility (Timotheou et al., 2023). Furthermore, integrated web-based information systems improve the speed and accuracy of educational data processing while providing stakeholders with timely access to information (Ferdiansyah et al., 2024). Within the context of early childhood education, these characteristics enable parents to obtain real-time developmental information and strengthen collaboration between schools and families (Chen & Rivera-Vernazza, 2023).

Various studies have investigated information systems for monitoring and reporting within educational environments. Prasetyo & Ikrimach, (2025) developed a web- and Android-based academic information system for a kindergarten covering attendance, savings, and assessment records; however, the assessment component

was not structured around the comprehensive developmental indicators required in early childhood education. Puspitasari et al., (2021) developed digital portfolio media and a learning assessment application for early childhood institutions, but both function primarily as assessment documentation tools rather than integrated multi-user systems that provide parents with continuous access. Rahmayanti & Alda, (2026) designed a mobile-based child monitoring system, but its focus remained limited to physical growth indicators such as weight and height. Faizah et al., (2022); Putra F et al., (2024) developed digital report cards for kindergarten institutions, which improved reporting efficiency but were confined to periodic report generation rather than continuous daily monitoring. Meanwhile, Nawar et al., (2026) applied a decision-support approach to assessing the developmental attainment of Toh et al., (2025) validated a digital developmental screening instrument; both, however, address episodic assessment rather than structured developmental assessment embedded in daily institutional reporting practice.

In relation to system development methodology, the Web Development Life Cycle (WDLC) offers an iterative framework consisting of planning, analysis, design and development, testing, implementation, and maintenance, making it more suitable for dynamic web application development than the conventional sequential Waterfall approach (Yudianto & Sulistyo, 2022; Yuzefa & Eviyanti, 2024). During the design phase, Unified Modeling Language (UML) facilitates the visualization of system requirements and architecture through use case, activity, and class diagrams (Febriyani & Hadiprakoso, 2021), while Black Box Testing provides functional validation by evaluating whether system features operate according to expected outputs from the end-user perspective (Amalia et al., 2021; Raihan & Voutama, 2023).

Although previous studies have demonstrated the benefits of digital monitoring systems, several research gaps remain. Existing studies have generally focused on academic monitoring, physical growth assessment, or reporting applications without comprehensively integrating indicator-based developmental assessment across all six PAUD developmental domains. In addition, most previous systems relied on conventional Waterfall-based development approaches that provide limited flexibility for iterative refinement during web application development. Furthermore, existing studies have not simultaneously integrated a three-tier user access model consisting of administrators, teachers, and parents to facilitate continuous real-time communication regarding children's developmental progress.

Based on these gaps, this study offers several novel contributions. First, it integrates structured developmental assessment covering the six standardized PAUD developmental domains into a single web-based information system. Second, the study applies the Web Development Life Cycle (WDLC), which is specifically designed for iterative web application development and therefore provides greater adaptability than conventional development models (Rahmi et al., 2023). Third, the developed system implements a three-tier access mechanism involving administrators, teachers, and parents, enabling continuous real-time monitoring and improving communication between educational institutions and families. These innovations distinguish the proposed system from previous studies while addressing practical challenges encountered at PAUD KB Kenanga.

The urgency of this research lies in the increasing need for effective, accurate, and accessible developmental monitoring systems capable of supporting early identification of developmental issues and strengthening parental involvement in

children's education. Without an integrated digital monitoring system, educational institutions remain vulnerable to inefficient data management, delayed interventions, and limited dissemination of developmental information to parents. Therefore, developing a web-based monitoring and reporting information system is expected to improve the effectiveness, continuity, and transparency of developmental monitoring within PAUD institutions.

Accordingly, this study aims to design, develop, and empirically evaluate a web-based Early Childhood Development Monitoring and Reporting Information System at PAUD KB Kenanga using the Web Development Life Cycle (WDLC) method. The expected outcome is a system capable of improving the effectiveness, accuracy, and continuity of developmental monitoring and reporting while strengthening communication between teachers, administrators, and parents.

RESEARCH METHOD

This study employed the Web Development Life Cycle (WDLC) methodology to design and develop a web-based Early Childhood Development Monitoring and Reporting Information System. The research was conducted at PAUD KB Kenanga, Raman Fajar Village. Data were collected through direct observation of the existing manual monitoring and reporting process, semi-structured interviews with the head of the institution and classroom teachers to identify functional requirements, and documentation of developmental record books and reporting formats currently used by the institution.

The development process followed the six iterative stages of the Web Development Life Cycle (WDLC), namely planning, analysis, design and development, testing, implementation, and maintenance (Putra F et al., 2024; Yudianto & Sulistyo, 2022). During the planning stage, the research objectives, development scope, and required resources were identified, including the determination of the three primary user roles consisting of Administrator, Teacher, and Parent. The analysis stage focused on identifying functional requirements, including multi-domain developmental indicator recording, periodic report generation, and real-time parental access, together with non-functional requirements such as role-based access control and data security.

The system was subsequently designed and developed using Unified Modeling Language (UML), including Use Case Diagrams to model actor interactions, Activity Diagrams to represent the developmental recording workflow, and Class Diagrams combined with an Entity Relationship Diagram (ERD) to define the database structure. System implementation was carried out using the PHP programming language with the Laravel framework, Bootstrap for the user interface, and MySQL as the relational database management system. The database architecture consisted of ten core tables, namely User, Teacher, Parent, Class, Child, Daily Activity, Developmental Indicator, Child Development Record, and Report. This relational structure ensured that every developmental record entered by teachers was linked accurately to the corresponding child, class, and developmental indicator, thereby enabling reliable historical tracking of children's developmental progress.

Because the system was designed to accommodate three categories of users, each role was assigned different access rights according to its operational responsibilities. The Administrator was responsible for managing master data, developmental indicators, institutional reports, and user accounts. Teachers were authorized to

record daily learning activities, input developmental indicator scores, monitor classroom progress, and generate periodic developmental reports. Parents were provided with access to their children's biodata, real-time developmental monitoring, and downloadable developmental reports. The distribution of user access rights is presented in Table 1.

Table 1. User Roles and Access Rights in the System

User Role	Access Rights
Administrator	Manage master data (teachers, children, classes), manage developmental indicators, generate institutional reports, and manage user accounts.
Teacher	Record daily activities, input child developmental data based on indicators, monitor classroom developmental progress, and generate periodic developmental reports.
Parent	View child biodata, monitor developmental progress in real time, and view or download periodic developmental reports.

System validation was performed during the testing stage using the Black Box Testing method, Frayudha et al., 2024; Ridwan et al., (2024), which evaluated all system functions from the perspectives of Administrator, Teacher, and Parent. The testing covered login authentication, data management, developmental recording, monitoring features, and report generation to ensure that each function operated according to the expected outcomes. Following successful validation, the system entered the implementation stage through trial deployment involving administrators, teachers, and selected parents at PAUD KB Kenanga. Finally, the maintenance stage established procedures for periodic system updates, bug fixes, and continuous improvements following implementation.

The developmental monitoring component was structured according to the six standardized domains of national PAUD developmental standards, namely (1) religious and moral values, (2) physical-motor, (3) cognitive, (4) language, (5) social-emotional, and (6) art. Each domain consisted of several measurable indicators that were assessed periodically on weekly and monthly bases using four achievement categories: Not Yet Developed, Beginning to Develop, Developing as Expected, and Developing Very Well. These standardized indicators formed the basis for the automated developmental reports generated by the system.

RESULT AND DISCUSSION

System Design Results

Based on the requirements analysis, the use case diagram identifies three primary actors Administrator, Teacher, and Parent each interacting with distinct system functions according to their authorization level, as summarized in Table 1. The activity diagram for the developmental-recording process maps the workflow from daily activity input by the Teacher, automated aggregation of indicator scores by the system, to real-time availability of the monitoring data on the Parent's dashboard. This digital workflow design directly replaces the manual notebook-based recording process previously used at PAUD KB Kenanga and is consistent with the web-based monitoring model proposed by Prasetyo & Ikrimach, (2025), while extending it with a multi-

domain, indicator-based assessment structure specifically tailored to PAUD developmental standards.

Database Implementation

The system's database was implemented based on the Entity Relationship Diagram (ERD) described in the Research Method section, consisting of the User, Admin, Guru, Orang Tua, Kelas, Anak, Kegiatan Harian, Indikator, Perkembangan Anak, and Laporan tables. This relational structure ensures referential integrity between a child's developmental records and the corresponding indicators and class information, supporting the centralized, auditable digital archive emphasized by Farhan et al., (2025) as a key advantage of database-based educational record management over manual notebook-based systems.

Functional Testing Results

Black Box Testing was conducted on 32 test scenarios distributed across three access levels: Administrator, Teacher, and Parent. Testing included login authentication, master data management, daily activity input, progress indicator recording, real-time monitoring displays, and periodic report generation. Table 2 presents a summary of 6 of the 32 representative Black Box Test scenarios and their results.

Table 2. Summary of Black Box Testing Results (6 of 32 Scenarios Shown)

Access Level	Tested Feature	Expected Result	Status
Administrator	Login Authentication	Access granted to Admin Dashboard	Valid
Administrator	Add Teacher / Child / Class Data	Data saved successfully in the database	Valid
Teacher	Input Daily Developmental Data	Indicator score recorded and linked to the child's record	Valid
Teacher	Generate Monthly Development Report	PDF report generated and downloadable	Valid
Parent	View Child Monitoring Dashboard	Real-time developmental progress displayed	Valid
Parent	Download Developmental Report	Report file downloaded successfully	Valid

This summary shows that all scenarios (100%) produced results consistent with the expected output, indicating that the system functions at all three access levels operated validly without critical errors. This result is in line with the findings of Ridwan et al., (2024), who reported a comparable full-validity rate when applying Black Box

Testing with the equivalence partitioning technique to a web-based information system, reinforcing the reliability of this testing technique for institutional and educational web applications.

Monitoring Dashboard

The implemented system provides a centralized monitoring dashboard for parents that visualizes a child's developmental progress across the six developmental domains using a radar- style progress indicator, alongside a chronological timeline of recorded daily activities and a color-coded indicator for any developmental aspect that has not yet reached the expected achievement level. Figure 1 illustrates the conceptual layout of the parent monitoring dashboard.

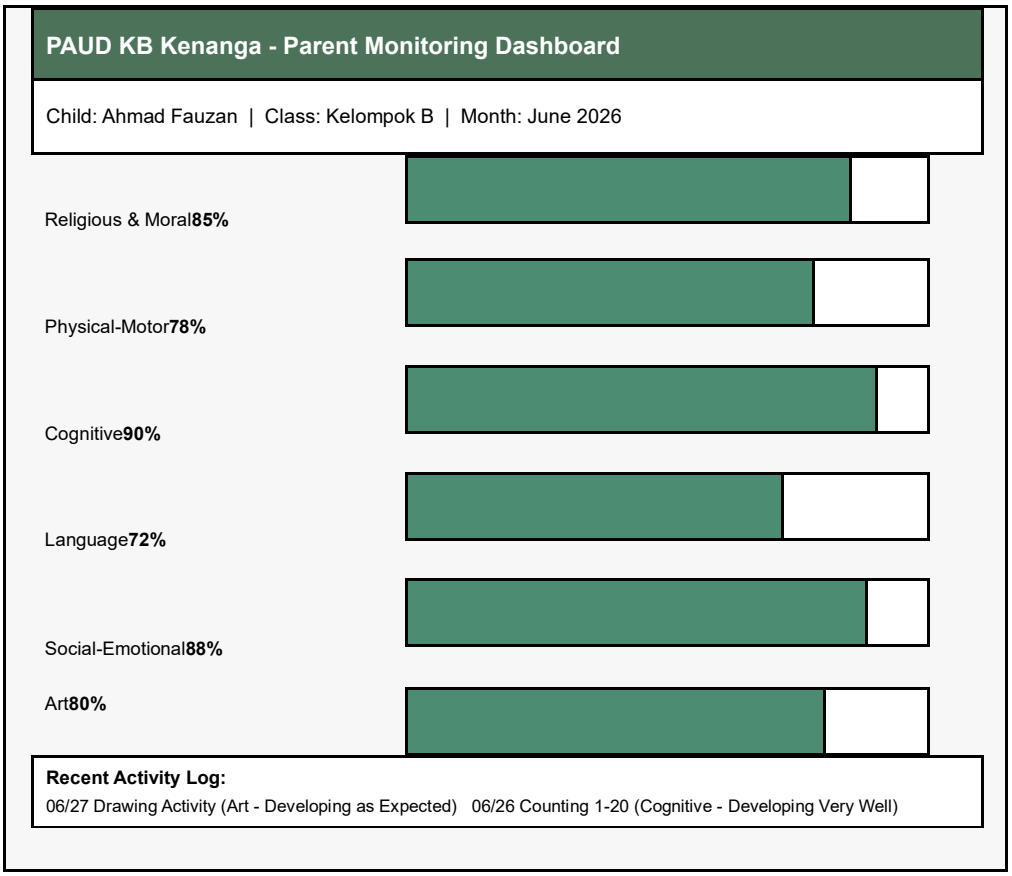

Figure 1. Conceptual Layout of the Parent Developmental Monitoring Dashboard

As shown in Figure 1, the dashboard aggregates a child's achievement across all six developmental domains into a single, easily interpretable view, allowing parents to immediately identify domains in which their child is excelling or may require additional support, without needing to wait for a scheduled report- card session. This finding supports the argument of Wilke et al., (2024) that real-time, accessible developmental dashboards substantially increase parental engagement in supporting a child's growth outside the classroom environment.

Comparison with the Manual Process

A comparison between the manual notebook-based process and the digital WDLC-developed system reveals a marked improvement in information accessibility and processing efficiency. Under the manual process, developmental information was only communicated to parents periodically typically once per semester during report distribution and retrieving historical developmental data for a specific child required manually searching through physical notebooks, a process that could take a considerable amount of time depending on the volume of records.

Following implementation of the web-based system, developmental information becomes available to parents in real time as soon as a teacher records the corresponding indicator, and historical records for any child can be retrieved within seconds through the system's search and filter functions. This finding is consistent with Ferdiansyah et al., (2024) assertion that integrated, database-supported information systems substantially improve both the speed and accuracy of educational data processing compared to manual methods.

Discussion

The results of this study demonstrate that applying the Web Development Life Cycle (WDLC) method to develop a multi-domain, indicator-based developmental monitoring system effectively resolves the core problems identified in the manual process at PAUD KB Kenanga: slow and inconsistent data recording, limited historical traceability, and restricted, infrequent access to developmental information for parents. Compared with the system developed by Prasetyo & Ikrimach, (2025), which followed a linear analysis–design–implementation–testing sequence for a kindergarten academic information system, the present study demonstrates that the WDLC method's iterative design-and-development stage allowed the research team to refine the developmental- indicator input interface directly based on feedback from teachers during the trial period, resulting in a more intuitive data-entry workflow tailored specifically to the six PAUD developmental domains. This iterative refinement capability is a key advantage of WDLC over the strictly sequential Waterfall model applied by Ferdiansyah et al., (2024), particularly for institutional systems whose requirements are clarified gradually through direct end-user interaction rather than fully specified at the outset.

Furthermore, while Rahmayanti & Alda, (2026) focused their mobile-based monitoring system exclusively on physical growth metrics such as weight and height, the system developed in this study incorporates a holistic, six-domain developmental framework that aligns with national PAUD developmental standards, thereby providing a more comprehensive picture of a child's overall development rather than a single

physical dimension. Similarly, in contrast to the messaging applications examined by Petrova, O., & Belyakova, (2024), which support teacher–parent communication but lack a structured, indicator-based assessment mechanism, the system in this study formalizes developmental assessment through a standardized four-level achievement scale for each indicator, enabling consistent and comparable reporting across teachers, classes, and reporting periods.

From a managerial perspective, the 100% Black Box Testing validity rate and the substantial improvement in information-access speed suggest that the system not only digitizes an existing manual process but fundamentally transforms the communication pattern between PAUD KB Kenanga and parents, shifting it from a periodic, one-way reporting model to a continuous, two-way accessible monitoring model. This shift is particularly significant for early childhood education, where timely identification of developmental concerns directly influences the effectiveness of early intervention (Sheel et al., 2024; Toh et al., 2025). However, the successful adoption of the system also depends on teachers' consistency in performing daily data entry; any delay or inconsistency in recording daily activities would directly reduce the completeness and reliability of the developmental data presented to parents, a dependency that should be anticipated through institutional policy and periodic monitoring of teacher data-entry compliance.

Several limitations of this study should be acknowledged. First, the current system does not yet provide a mobile-native application or push-notification mechanism, meaning that parents must actively access the web portal to view updates rather than receiving automatic alerts when new developmental data is recorded, a limitation that aligns with the security and accessibility considerations raised by Urbina et al., (2025) regarding digital school–family communication platforms.

Second, the Black Box Testing and trial implementation were conducted within a single institution with a relatively limited number of children and parent users, meaning that the findings may not be fully generalizable to PAUD institutions with substantially larger student populations or different organizational structures. Third, this study did not yet incorporate a quantitative usability evaluation instrument such as the System Usability Scale (SUS) to formally measure end-user satisfaction with the interface, relying instead on functional validity as the primary indicator of system readiness (Deshmukh & Chalmeta, 2024; Sarasmayana et al., 2024).

CONCLUSION

This study successfully designed and developed a web-based Early Childhood Development Monitoring and Reporting Information System for PAUD KB Kenanga using the Web Development Life Cycle (WDLC) method. The system digitizes developmental records across six standardized PAUD developmental domains and provides a three-tier access model for administrators, teachers, and parents, enabling continuous real-time monitoring and improving communication among stakeholders. Functional validation through Black Box Testing demonstrated that all 32 testing

scenarios produced valid results, confirming the system's operational reliability and readiness for implementation.

The findings indicate that the proposed system enhances the effectiveness, accuracy, continuity, and accessibility of developmental monitoring compared with the previous manual process. Despite these contributions, the system is currently limited by the absence of a mobile application, push-notification features, and formal usability evaluation. Future studies are recommended to incorporate mobile-based services, System Usability Scale (SUS) assessment, and broader implementation across multiple PAUD institutions to strengthen the generalizability and practical applicability of the system.

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