
Original Research

MyOLC: An Intelligent Learning Ecosystem with Automated Multi-Role Tracking for Non-Formal Education in the Society 5.0 Era

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ABSTRACT

Technological developments have brought significant changes in various fields, including education. Optima Mataram Tutoring is one of the non-formal educational institutions that is required to adapt to technological developments to improve the quality of learning services. Optima Mataram Tutoring is an educational institution that provides learning assistance services for students at various levels of education. However, the learning management process is still carried out conventionally, such as manual attendance recording, delivery of materials via instant messaging, and the collection of assignments that are not yet integrated, causing various obstacles to the effectiveness and efficiency of the teaching and learning process at Optima Mataram Tutoring. This condition causes difficulties in monitoring student progress and managing academic data, as well as slow and inaccurate information delivery. Therefore, in this study, a Learning Management System application was developed at Optima Mataram Tutoring that is able to support an integrated and effective learning process that is easy to access. The method used in developing this LMS is the waterfall method. This LMS is expected to meet the needs of students in receiving learning materials, the needs of teachers in conducting assessments, and the needs of parents in monitoring their children's activities during the learning process at Optima Mataram Tutoring.

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1 INTRODUCTION

Currently, the development of information and communication technology has grown very rapidly, this development has given rise to progress in various important areas in people's lives [1]. Technological developments have brought significant changes in various fields including education. The development of increasingly sophisticated technology is able to provide various access to information quickly so that students can obtain learning materials very easily [2]. The use of LMS (Learning Management System) which is used to manage learning materials, exercises, assignments and one of the media used to communicate between teachers and students which is done in an integrated manner through a digital platform is one form of technology implementation in the field of education.

Tutoring is a non-formal educational institution that is required to adapt to technological developments to

improve the quality of its learning services. Optima Mataram Tutoring is an educational institution that provides learning assistance services for students at various levels of education. However, the learning management process is still carried out conventionally, such as manual attendance recording, delivery of materials via instant messaging, and collection of assignments that are not yet integrated, creating various obstacles to the effectiveness and efficiency of the teaching and learning process at Optima Mataram Tutoring. This condition causes difficulties in monitoring student progress and managing academic data, as well as slow and inaccurate information delivery.

Several previous studies have developed a Learning Management System to support technology-based learning processes. Research [3] who implemented the independent learning curriculum using a Learning Management System (LMS) with the results of the LMS implementation is closely related to the implementation of the independent learning curriculum. In addition, research conducted by Macharani Raschintaso and Herti Yani This study discusses the importance of a learning management system for use by teachers to increase interest in learning and provide convenience to users [4]. There are benefits from using an LMS also in accordance with research conducted [5] explaining that the use of a Learning Management System provides benefits in improving the quality of learning by innovating learning media and content that are in accordance with the needs of the business world and the industrial world in the era of society 5.0.

Previous studies discussing the benefits of LMS in supporting the learning process still have several limitations. Most of the systems developed focus on formal educational institutions such as schools and universities, so they have not fully accommodated the operational needs of tutoring institutions which have different characteristics [6,7]. In addition, several studies have not provided comprehensive student progress monitoring features, digital attendance integration, or the presentation of learning reports that can be accessed in real-time by tutors and parents [2,8].

Previous studies have identified a research gap in the lack of a Learning Management System specifically designed to support learning management needs in tutoring institutions, particularly Optima Mataram Tutoring. Currently, the management of learning materials, student assignments, student attendance, and learning evaluations at Optima Mataram Tutoring is still carried out through various separate media, resulting in data duplication, difficulties in information management, and suboptimal student progress monitoring. Therefore, a system is needed that can integrate all learning activities into one centralized platform.

The development of a responsive, easy-to-use LMS that can be accessed through various devices is one of the developments in modern web technology and application development frameworks that is much needed today. LMS is an application used to carry out the process of managing, tracking, documenting and delivering educational plans and this application can also be used to assist teaching and learning activities [9]. In addition, the concept of Learning Management System is able to provide a flexible, structured and easily monitored learning experience for all parties involved in the educational process and makes it easier for students and teachers [6].

The difference between previous research and the current research lies in the design and development of a Learning Management System (LMS) application tailored to the operational needs of Optima Mataram Tutoring. The proposed system integrates features for learning material management, user management, assignment submission, digital attendance, learning outcome evaluation, and student progress reports in a single, integrated platform. Therefore, this application is expected to simplify the academic monitoring process, increase the efficiency of learning management, and improve the quality of educational services provided to Optima Mataram Tutoring students.

Based on the background outlined in the previous paragraph, the purpose of this study is to design and build a Learning Management System application at Optima Mataram Tutoring Center that is capable of supporting an integrated, effective, and easily accessible learning process. The results of this study are expected to be used as a solution in managing teaching and learning activities at Optima Mataram Tutoring Center and can contribute to the development of technology-based educational information systems.

2 RESEARCH METHODS

The research method used in developing the Optima Mataram tutoring LMS involves a series of systematic steps. This study employed Research and Development (R&D) with a software development approach using the Waterfall model [10–14]. The Waterfall model was chosen because it has structured and systematic stages, making it suitable for developing Learning Management System (LMS) applications that require clear needs

analysis before implementation.

Prior to the development stages, data collection techniques were conducted to ensure the system meets the actual needs of the institution. The techniques include: (1) Observation, to directly observe the conventional learning management processes at Optima Mataram Tutoring; (2) Interviews, to gather in-depth requirements and pain points from administrators, tutors, students, and parents; and (3) Literature study, to support the theoretical foundation and system design using relevant previous research.

The research stages carried out consist of:

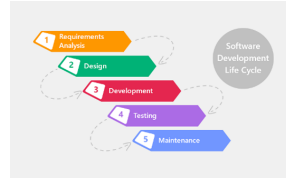


Figure 1. Waterfall model stages

The Waterfall model is a structured software development model. Software development is carried out in stages. In this model, the next stage can only be started once the previous one has been completed.

2.1 Analysis Stage

At the analysis stage, the software development team collects all the requirements needed by the user and complies with the specifications required by the software based on the data obtained from observations and interviews. The requirements are categorized into functional and non-functional requirements to ensure a comprehensive system scope.

2.2 Design Stage

In the design phase, the activities carried out in the waterfall model continue the previous phase, namely the analysis phase, and the results of the analysis are processed into a system design that is ready for implementation. At this stage, the software development team created the entire program architecture design, database structure, and user interface design. The system modeling is conducted using the Unified Modeling Language (UML), which includes Use Case Diagrams to map user interactions and Activity Diagrams to detail the system's workflow. Additionally, an Entity Relationship Diagram (ERD) is designed to structure the database schema, while the User Interface (UI) is prototyped to ensure a user-friendly experience.

2.3 Implementation Stage

In the implementation phase, the activities carried out in this waterfall model include implementing the design created in the previous phase. The software development team writes the program code and prepares the environment for operating the tutoring application software at Optima Mataram. The system is developed using PHP with the Laravel framework for the backend, Flutter for the mobile user interface, and MySQL as the database management system. This technology stack was selected for its reliability, scalability, and suitability for building responsive educational platforms.

2.4 Testing Phase

In the testing phase, the activities carried out are testing the application that has been created in the implementation phase to ensure that the application that has been built can be used and functions properly according to user needs. The system is tested using several test scenarios that include user login, data management, uploading materials, collecting assignments, attendance, assessments, and report generation to ensure all functions run well according to the needs of Optima Mataram Tutoring. System testing is carried out using two approaches: (a) Black Box Testing to test the functionality of each system feature based on the defined requirements specifications, without looking at the internal program code; and (b) User Acceptance Testing (UAT) to measure the level of user acceptance and satisfaction with the system developed. The UAT utilizes a questionnaire based on a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The UAT participants consist of 28 respondents, comprising 3 administrators, 5 teachers, and 20 students of Optima Mataram Tutoring.

2.5 Maintenance Stage

In the maintenance stage in the waterfall model, the activities carried out are that the application that has been tested and implemented in the previous stage is used and maintained periodically to ensure that the tutoring application that has been built can run well after being implemented at the Optima Mataram tutoring

center. This stage also includes bug fixing, performance optimization, and potential feature updates based on continuous user feedback.

3 RESULTS AND DISCUSSION

This section describes the system design implemented in the Optima Mataram tutoring application. This tutoring application is called myOLC. MyOLC is a modern, app-based tutoring platform specifically designed to meet the needs of students, teachers, and guardians. The myOLC application provides an interactive, practical, and comprehensive digital learning ecosystem [15].

3.1 Implementation of Core LMS Features

a Initial View of the myOLC Application

The initial display of the Optima Mataram tutoring application is the onboarding screen. The onboarding screen is the first screen that appears when a new user installs the myOLC application.

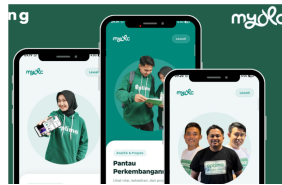


Figure 2. Onboarding Screen page of the myOLC application

b Free Trial Feature

This free trial feature is for users who haven't registered as Optima students. By utilizing this free trial, students who haven't registered can experience the excitement of learning using the myOLC app and can register immediately to become students at the Optima Mataram tutoring center.

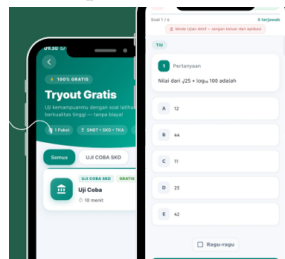


Figure 3. Free trial feature

c Login Page

Figure 4 shows the login page form of the myOLC application. There is a login for students, parents, and tutors from the Optima Mataram tutoring center.

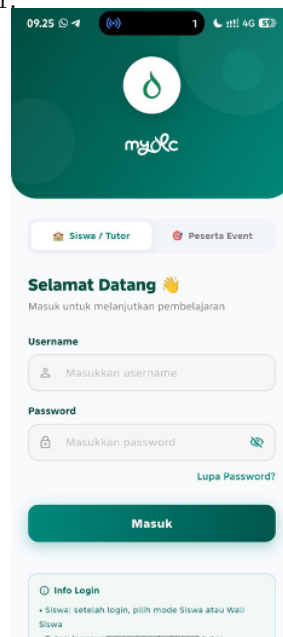


Figure 4. Login Page

d Student Dashboard Page

In this dashboard section, users can see various information that appears on the main page, such as the nearest study schedule, information on student attendance percentage, tryout scores, number of tryouts taken, and student rankings.

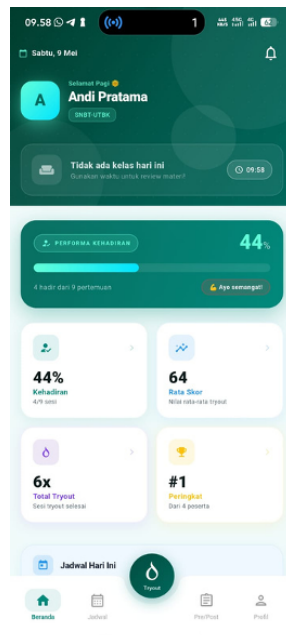


Figure 5. Student Dashboard page

e Tutor Dashboard Page

The Bimbel Optima Mataram tutor dashboard displays information for tutors, such as the current teaching schedule and quick actions for several app features. Additionally, there's a presence feature for tutors that can analyze student attendance.

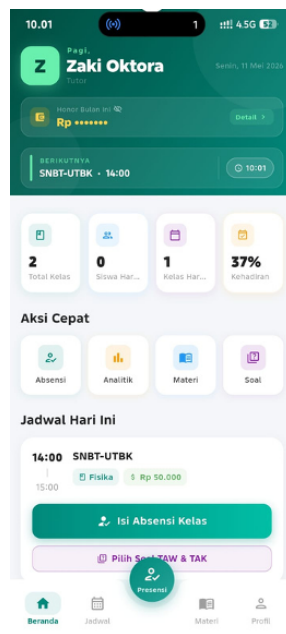


Figure 6. Tutor dashboard page

f Dashboard Page for Parents

On the dashboard page for parents, several pieces of information are displayed about students who are studying at Optima Mataram, such as student attendance percentage, tutoring information, rankings and other information about students.

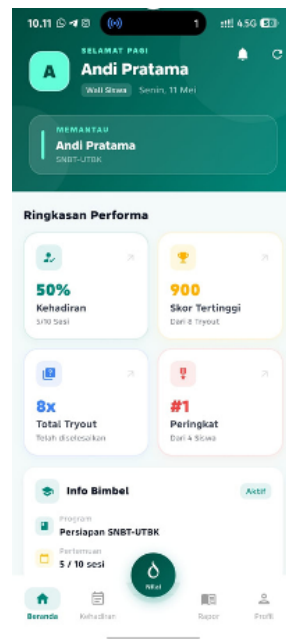


Figure 7. Parent Dashboard Page

3.2 System Testing and Evaluation

This section presents the results of the system testing, which aims to ensure that the MyOLC application functions correctly and meets the needs of its users. The testing phase consists of two approaches: Black Box Testing and User Acceptance Testing (UAT).

a Black Box Testing

Black Box Testing was conducted to evaluate the functionality of the system's features based on the specified requirements, without examining the internal code structure. The testing focused on input validation, process execution, and output generation. Table 1 presents a summary of the Black Box Testing scenarios and their results.

Table 1. Black Box Testing Results

No	Feature Tested	Test Scenario	Expected Result	Actual Result	Status
1	Authentication	Enter valid username and password	User redirected to respective dashboard	User redirected successfully	Valid
2	Authentication	Enter invalid credentials	Display error "Invalid credentials"	Error message displayed	Valid
3	Digital Attendance	Tutor marks student attendance	Attendance data saved to database	Data saved and synced to parent dash	Valid
4	Material Delivery	Tutor uploads PDF learning material	File uploaded and visible to students	File uploaded and accessible	Valid
5	Assignment Submission	Student uploads assignment file	Assignment submitted and timestamped	Assignment submitted with timestamp	Valid
6	Progress Monitoring	Parent views child's learning report	Display attendance percentage and grades	Data displayed accurately in real-time	Valid

Based on Table 1, all tested features functioned correctly and produced outputs according to the expected results, yielding a 100% success rate for the functional testing phase. This confirms that the system logic and database integrations are working properly.

b User Acceptance Testing (UAT)

User Acceptance Testing (UAT) was conducted to measure the level of user satisfaction and the system's suitability for real-world implementation at Optima Mataram Tutoring. The UAT involved 28 participants, consisting of 3 administrators, 5 tutors, and 20 students.

The evaluation utilized a 10-item questionnaire based on a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire assessed three main aspects: System Usability, Feature Completeness, and User Interface Design [16–20].

Calculation Method: To determine the overall user acceptance level, the quantitative data from the Likert scale was analyzed using descriptive statistics. The percentage of user acceptance (P) was calculated using the

following formula:

$$P = \left(\frac{\sum X}{\sum X_{\max}} \right) \times 100\% \quad (1)$$

Where P is the percentage of user acceptance, $\sum X$ is the total score obtained from all respondents, and $\sum X_{\max}$ is the maximum ideal score (Total respondents $\times$ Number of items $\times$ Maximum scale).

The calculated percentage was then interpreted using the criteria shown in Table 2.

Table 2. Likert Scale Interpretation Criteria

Percentage Range	Category
81% – 100%	Very Good / Highly Acceptable
61% – 80%	Good / Acceptable
41% – 60%	Fair / Moderately Acceptable
21% – 40%	Poor / Less Acceptable
0% – 20%	Very Poor / Unacceptable

UAT Results: Based on the distributed questionnaires, the scores obtained from each user group are summarized in Table 3.

Table 3. Summary of UAT Scores by User Group

User Group	Respondents (n)	Items (k)	Max Score ($n \times k \times 5$)	Total Score ($\sum X$)	Mean Score	Percentage (P)
Administrators	3	10	150	142	4.73	94.6%
Tutors	5	10	250	234	4.68	93.6%
Students	20	10	1000	910	4.55	91.0%
Overall	28	10	1400	1286	4.59	91.8%

As shown in Table 3, the overall percentage of user acceptance is 91.8%, with a mean score of 4.59. This result falls into the “Very Good / Highly Acceptable” category (81% – 100%). This indicates that the MyOLC application is highly suitable, user-friendly, and well-received by all user roles at Optima Mataram Tutoring [21].

3.3 Discussion

The development and evaluation of the MyOLC application demonstrate a significant transformation in the operational management of Optima Mataram Tutoring, transitioning from a fragmented, conventional approach to a centralized, digital ecosystem. The 100% success rate in Black Box Testing and the highly acceptable UAT score of 91.8% indicate that the system not only functions technically but also aligns perfectly with the users’ practical needs. This section delves deeper into the implications of these findings across three primary dimensions: operational efficiency, stakeholder engagement, and alignment with contemporary educational paradigms.

First, from an operational perspective, MyOLC effectively resolves the critical bottleneck of data duplication and information fragmentation. Previously, tutors relied on manual attendance sheets and distributed learning materials via instant messaging platforms, which often led to missed information, disorganized assignment collections, and difficulties in tracking student progress. By integrating digital attendance, material delivery, and assignment submission into a single platform, MyOLC significantly reduces the administrative burden on tutors. This allows educators to allocate more time to instructional quality rather than administrative tasks. This finding supports the assertion by Raschintasofi and Yani [4] that a well-designed LMS significantly enhances user convenience and operational efficiency in educational institutions.

Second, the implementation of the Parent Dashboard introduces a new level of transparency and parental involvement, which is particularly crucial in non-formal education (tutoring). Unlike formal schools that typically provide periodic report cards, MyOLC enables parents to monitor their children’s attendance percentages, try-out scores, and class rankings in real-time. This continuous feedback loop fosters greater trust between the institution and the parents, as they no longer need to rely on delayed or subjective reports from tutors via private chats. The high satisfaction rate among parents and students in the UAT underscores the importance of real-time monitoring features, directly addressing the research gap identified by previous studies [2, 8] that often overlooked comprehensive, real-time progress tracking tailored for non-formal institutions.

Third, the MyOLC application promotes the concept of Self-Directed Learning (SDL) among students. By providing easy access to learning materials, interactive tryouts, and immediate performance feedback through the Student Dashboard, the system encourages students to take greater responsibility for their learning journey. This aligns with the findings of Ismanto et al. [2], who emphasized that an LMS built with an SDL approach can significantly improve student independence and learning outcomes. Furthermore, the inclusion of features like student ranking and attendance percentages serves as a motivational tool, stimulating healthy competition

and engagement among students in a digital environment.

Moreover, the successful deployment of MyOLC reflects the adaptation of educational institutions to the demands of the Society 5.0 era. As highlighted by Harahap et al. [5], the integration of advanced digital platforms in education is essential to innovate learning media that meet modern societal needs. By moving away from paper-based and chat-based management, Optima Mataram Tutoring is not only improving its internal efficiency but also positioning itself as a forward-thinking institution that embraces digital transformation. The system's responsive design ensures that it remains accessible across various devices, catering to the mobile-centric habits of today's students and parents, which is a critical requirement for modern application development [9].

Despite these significant achievements, this study acknowledges certain limitations. Currently, MyOLC functions primarily as a management, delivery, and monitoring tool. The evaluation of student performance is still largely descriptive, relying on manual analysis by tutors to identify students who may need additional help or personalized attention. Therefore, future research should focus on integrating Artificial Intelligence (AI) and Learning Analytics into the MyOLC ecosystem. By implementing machine learning algorithms, the system could analyze student interaction data and assessment results to provide personalized learning recommendations, early warning systems for students at risk of falling behind, and adaptive learning paths. Such enhancements would elevate MyOLC from a conventional LMS to an Intelligent Tutoring System (ITS), further solidifying its contribution to the advancement of technology-based educational information systems.

4 CONCLUSION

This study successfully designed and developed MyOLC, a Learning Management System specifically tailored to address the operational and academic challenges at Optima Mataram Tutoring. By transitioning from a fragmented, conventional approach to a centralized digital ecosystem, MyOLC effectively resolves critical issues such as data duplication, delayed information delivery, and the lack of real-time progress monitoring. The system evaluation demonstrated both technical reliability and strong user acceptance. Black Box Testing confirmed a 100% functional success rate across all core features, ensuring that digital attendance, material delivery, and assignment submissions operate without critical errors. Furthermore, User Acceptance Testing (UAT) involving 28 participants, comprising administrators, tutors, and students, yielded an overall acceptance score of 91.8%. This "Highly Acceptable" rating validates that the system's interface and features perfectly align with the practical needs of the institution's stakeholders. Beyond technical functionality, MyOLC significantly enhances operational efficiency for tutors, promotes self-directed learning among students, and provides unprecedented transparency for parents through real-time monitoring dashboards. However, this study acknowledges certain limitations; currently, MyOLC functions primarily as a management and delivery tool without advanced analytical capabilities. Therefore, future research will focus on integrating Artificial Intelligence (AI) and Learning Analytics into the MyOLC ecosystem. By implementing machine learning algorithms, subsequent iterations aim to provide personalized learning recommendations, early warning systems for at-risk students, and adaptive learning paths, ultimately evolving MyOLC from a conventional LMS into an Intelligent Tutoring System (ITS).

DECLARATIONS

Author Contributions:

Zaeniah: Conceptualization, Methodology, Software, Data Curation, Supervision, Writing – Original Draft, Writing – Review & Editing.

Ahmad Subki: Validation, Visualization, Methodology, Writing – Review & Editing.

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Conflicts of Interest:

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Use Statement:

During the preparation of this work, the authors used Qwen AI in order to improve the language and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the final content of the published article.

Additional Information:

No additional information is available for this paper.

REFERENCES

- [1] K. G. Segara, M. Irwan, and P. Nasution, "Development of Information Technology in Indonesia: Challenges and Opportunities," *Unkn. J.*, vol. 3, no. 1, 2025.
- [2] E. Ismanto, P. B. Herlandy, and R. Rahmadani, "Development of Learning Management System (LMS) with Self Directed Learning (SDL) Approach for Vocational High Schools (SMK) in Pekanbaru City," *Unkn. J.*, vol. 14, no. 1, pp. 66–74, 2024.
- [3] M. Ngadiluwih, "Implementation of the Independent Learning Curriculum Using a Learning Management System (LMS)," *Allimna J. Educ. Islam. Stud.*, vol. 1, no. 2, pp. 65–79, 2022, doi: 10.30762/allimna.v1i2.694.
- [4] M. Raschintasofi and H. Yani, "UI UX Design for Mobile and Website-Based Learning Management System Applications Using the Design Thinking Method," *J. Technol. Manag. Inf. Syst.*, vol. 3, pp. 343–353, 2023.
- [5] S. Harahap, M. Simatupang, and L. Atika, "Strengthening the Learning Management System (LMS) to Improve the Quality of Learning in the Society 5.0 Era in Technology and Vocational Education Study Programs," *Unkn. J.*, pp. 1–10, 2023.
- [6] S. N. Rahmadanti, N. R. Wahyudanti, and N. Khimaya, "Integrating Learning Management System (LSM) with Artificial Intelligence to Facilitate Various Student Needs," *Unkn. J.*, vol. 3, no. 2, pp. 29–39, 2023.
- [7] A. Rochman, "Lecture Scheduling Using Constraints Programming and Simulated Annealing Methods," in *Seminar Nasional Aplikasi Teknologi Informasi (SNATI)*, 2012, pp. 15–16.
- [8] I. W. P. Pratomo and R. Wahanisa, "Utilization of Learning Management System (LMS) Technology at Unnes during the Covid-19 Pandemic," *Unkn. J.*, vol. 7, no. 2, 2021.
- [9] S. P. Saragih and M. Silalahi, "Development of a Web-based Learning Management System using the MOOC concept," *Unkn. J.*, pp. 15–21, 2024.
- [10] D. Rakhmad Hidayat and M. Alfian Rosid, "Implementasi Framework Codeigniter Dalam Pembuatan Sistem Informasi Pencatatan dan Pendataan Penduduk Desa Berbasis Web," *J. Tekno Kompak*, vol. 16, no. 1, p. 109, 2022, doi: 10.33365/jtk.v16i1.1453.
- [11] A. Fu'adi, R. N. Zubaidah, and B. J. M. Putra, "Sistem Informasi Monitoring Perkembangan Anak Usia Dini Berbasis Web," *J. Electr. Electron. Mech. Inform. Soc. Appl. Sci.*, vol. 1, no. 2, pp. 17–24, 2022, doi: 10.58991/eemisas.v1i2.14.
- [12] M. Multazam and E. Y. Saniyah, "Development and Implementation of Woven Bamboo Handicraft Online Shop in Loyok Village, Lombok, Indonesia," *J. Techno Nusa Mandiri*, vol. 17, no. 2, pp. 123–130, 2020, doi: 10.33480/techno.v17i2.1638.
- [13] M. I. Maulana and D. Wijayanto, "Aplikasi Kasir Berbasis Web Di Kedai Kopi Xyz Menggunakan Metode Waterfall," *J. Sains Komput. dan Teknol. Inf.*, vol. 5, no. 2, pp. 66–72, 2023, doi: 10.33084/jsakti.v5i2.5002.
- [14] M. R. Meta, A. Arman, R. Rajab, H. S. Yeni, and Z. Efendy, "Perancangan Sistem Informasi Pada Panti Asuhan Bundo Saiyo Berbasis Web," *IndraTech*, vol. 3, no. 1, pp. 13–24, 2022.
- [15] R. F. Sunartama, P. Sukmasetya, and M. Maimunah, "Implementasi Design Thinking pada UI/UX Bank Sampah Digital Banjarejo Berbasis Android," *JURIKOM (Jurnal Ris. Komputer)*, vol. 10, no. 2, p. 590, 2023, doi: 10.30865/jurikom.v10i2.6078.

- [16] L. Lun, D. Zetian, T. W. Hoe, X. Juan, D. Jiaxin, and W. Fulai, "Factors Influencing User Intentions on Interactive Websites: Insights From the Technology Acceptance Model," *IEEE Access*, vol. 12, pp. 122735–122756, 2024, doi: 10.1109/ACCESS.2024.3437418.
- [17] U. Ubaydillah et al., "Testing a Web-Based Sales Application Using Black Box Testing with Boundary Value Analysis Technique," *OKTAL*, vol. 2, no. 4, pp. 1119–1123, 2023.
- [18] S. Izzat and N. N. Saleem, "Software Testing Techniques and Tools: A Review," *J. Educ. Sci.*, vol. 32, no. 2, pp. 31–40, 2023, doi: 10.33899/edusj.2023.137480.1305.
- [19] M. A. Umar and C. Zhanfang, "A Comparative Study Of Dynamic Software Testing Techniques," *Int. J. Adv. Netw. Appl.*, vol. 12, no. 3, pp. 4575–4584, 2020, doi: 10.35444/ijana.2020.12301.
- [20] C. Fauziah, F. Sawitri, F. N. Azahara, and H. Permatasari, "Implementasi Pengujian Form Transaksi Laporan Penjualan Sistem Kasir Pos Codekop Cv Darut Taqwa Ujung Harapan Menggunakan Metode White Box Testing Dan Black Box Testing," in *Prosiding Seminar Nasional Teknologi Informasi dan Bisnis (SENATIB)*, 2023, pp. 456–464.
- [21] D. S. Taley, "Comprehensive Study of Software Testing Techniques and Strategies: A Review," *Int. J. Eng. Res. Technol.*, vol. 9, no. 8, pp. 817–822, 2020, doi: 10.17577/ijertv9is080373.