
IMPLEMENTATION OF WEB-BASED AND MACHINE LEARNING DECISION SUPPORT SYSTEM "BUNDA DINI" FOR MATERNAL HEALTH RISK DETECTION

Pramono^{1*}, Rovica Probawati², Arif Setiawan³

Faculty of Computer Science, Informatics Engineering Study Program Universitas Duta Bangsa
Surakarta¹, Faculty of Health Sciences, Nursing Study Program Universitas Duta Bangsa Surakarta²,
Faculty of Computer Science, Informatics Engineering Study Program, Universitas Duta Bangsa
Surakarta³

*Correspondence Email: pramono@udb.ac.id

ABSTRACT

Maternal Mortality Ratio (MMR) remains a strategic issue in Indonesia's national health system. Efforts to reduce MMR are often hindered by the slow early detection of high-risk pregnant women at primary healthcare facilities. To bridge this gap, this study developed "Bunda Dini", a web-based Decision Support System (DSS) integrating a predictive machine learning model. The application was built using the framework Laravel and MySQL database management system. The system architecture was designed with a multi-tenant approach, enabling secure data isolation between various clinics or hospitals, as well as structured access permissions for Midwives, Obstetricians, Clinic Admins, and Super Admins (Developers). The system's inference engine is powered by an optimized Extreme Gradient Boosting (XGBoost) algorithm, which has been proven capable of classifying pregnancy risk levels based on six vital parameters with an accuracy rate of 84.24% and a high-risk class Recall reaching 96.36%. Key features of the application include an intelligent anamnesis form, risk level visualization real-time, as well as a comprehensive reporting module supporting patient data recapitulation in both PDF and Excel formats. Test results show that the system interface is highly responsive, easy for medical staff to use, and guarantees the confidentiality of medical records across clinics. The implementation of the "Bunda Dini" web platform has high potential to become a reliable medical triage instrument, accelerating emergency obstetric care responses, and directly contributing to efforts to reduce maternal mortality.

KEYWORDS

Bunda Dini; Decision Support System; Laravel; Maternal Health; Machine Learning



This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International

INTRODUCTION

Maternal health is an essential pillar in public health development. The Maternal Mortality Ratio (MMR) in Indonesia, despite showing a declining trend over recent decades, remains relatively high compared to neighboring countries in the Southeast Asian region (Group, 2020), (Salim et al., 2024), (Straw et al., n.d.). Maternal deaths are frequently triggered by obstetric complications such as preeclampsia, postpartum hemorrhage, and infections, which actually exhibit clinical manifestations and can be detected as early as the pregnancy phase (antenatal) (Pambudi & Srirahayu, 2020) (Tan et al., 2023) (Mosca et al., 2025). The main field constraint, particularly in primary healthcare facilities (FKTP) such as maternity clinics and Community Health Centers (Puskesmas), is the high workload of healthcare professionals and the lack of standardization in holistic medical record analysis (Hamidah, 2024) (Derksen et al., 2025). Consequently, pregnant women with hidden risk factors are often missed from intensive observation and experience delays in receiving medical referrals.

The rapid development of Artificial Intelligence (AI) and Machine Learning technology has offered computational solutions capable of automatically mapping complex medical risk patterns (Jajang Jaya Purnama, Nina Kurnia Hikmawati, 2024) (Mondal et al., 2023) (Chen et al., 2024). Predictive classification models, particularly gradient boosting-based algorithms like XGBoost, have proven effective in processing tabular clinical data to identify abnormality probabilities (Murtiningsih et al., 2025) (Villar et al., 2024) (Chevalier & Côté, 2025). However, the existence of sophisticated machine learning models on paper or within research laboratory environments (Jupyter Notebook) will not deliver real-world impact to society unless implemented in the form of end-user applications easily accessible to medical personnel (Du et al., 2023) (Niu et al., 2024) (Cockburn et al., 2024) (Vemulapalli et al., 2024).

Many prior studies have focused solely on evaluating algorithm metrics without offering a functional software prototype (Virginia Khoirunnisa, 2023) (Rahagiyanto et al., 2025) (Sari & Pramono, 2024). Therefore, this study aims to bridge this gap by designing and implementing a web-based Decision Support System (DSS) named "Bunda Dini". This system is specifically designed to integrate the predictive XGBoost model into an interactive, multi-user, and secure web interface. By using the Bunda Dini web platform, Midwives and Doctors can directly input vital patient parameters and receive health risk level recommendations in real-time. Furthermore, the system is equipped with multi-tenant management capabilities to ensure patient medical record data is securely isolated based on the clinic or hospital where the medical staff operates.

RESEARCH METHOD

This research utilizes a structured software development methodology to convert *machine learning* models into a functional web application. The development process adopts the *Software Development Life Cycle* (SDLC) model with an *Agile* approach, allowing dynamic feature iterations. The sequence of research steps, from dataset collection to full web application launch, is depicted in the flowchart (Figure 1) below:

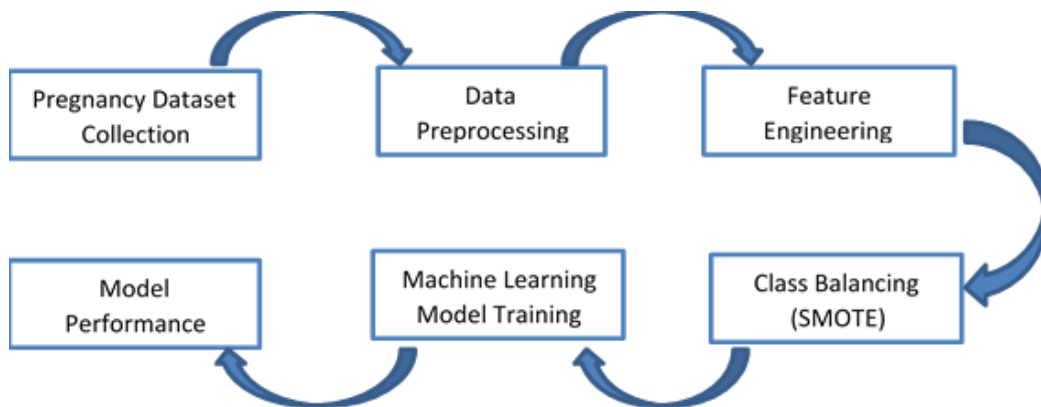


Figure 1. Research Methodology Flowchart

The diagram above outlines six essential phases in this research. The first phase focuses on collecting pregnancy medical record datasets. Next, data preprocessing is applied to handle anomalies, followed by feature engineering to enrich predictors. Given that medical data is frequently imbalanced, the class balancing phase is conducted using the SMOTE technique. Once the data is prepared, comparative *machine learning* algorithm models are trained and evaluated for performance. The final phase is integrating the optimized model into a functional web application ready for testing.

System Architecture

The "Bunda Dini" web application was built using the *Model-View-Controller* (MVC) architecture leveraging the PHP-based *framework* Laravel 11 configured to work with a relational MySQL database. The core prediction logic is integrated such that user input data from the *browser* is forwarded by the *Controller* to the classification service (containing rules derived from XGBoost), which then returns a prediction value categorized as: "Low Risk", "Medium Risk", or "High Risk".

Multi-Tenant Design and Authorization

A crucial factor in health information systems is the confidentiality of patient medical records. Therefore, the system was built with a *multi-tenant* concept to isolate databases (*database*) between health institutions. The system strictly regulates three levels of access rights (*Role-Based Access Control*):

- Level 1 Access (Midwives & Obstetricians): This entity acts as the frontliner of medical services (*frontliner*). They are granted specific authorization to access the predictive diagnosis *form* and input vital parameters (blood pressure, blood glucose, etc.) of patients in person. Midwives and Doctors can only view, add, or print medical record histories of patients receiving care at the clinic or hospital to which they are assigned.
- Level 2 Access (Clinic/Facility Admin): This entity acts as a facility-level manager. Clinic Admins do not perform prediction inputs; instead, they monitor all diagnostic records conducted by midwives and doctors within their facility. They possess the authority to export comprehensive reports in PDF or Spreadsheet formats for submission to clinic management or the District Health Office. The system guarantees that Clinic Admin "A" will never be able to access patient data from Clinic "B".
- Level 3 Access (Super Admin / Developer): The apex entity holding technical control over the system. The Super Admin is responsible for reviewing *machine learning* performance metrics and summarizing cross-clinic data traffic. They can view

aggregated data from all registered *tenants* for system auditing and advanced research development purposes.

Key Feature Implementation

Below is the visualization of the "Bunda Dini" application interface supporting medical operations:

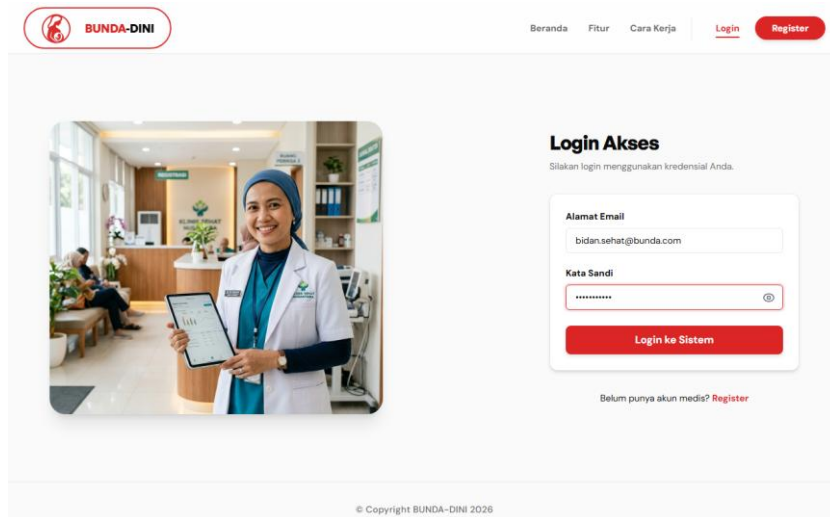


Figure 2. Bunda Dini Application Login Page Interface

- a. Intelligent Diagnosis Interface: *form* An interactively and ergonomically designed form to accelerate the input of 6 essential parameters (Age, Systolic, Diastolic, Blood Glucose, Body Temperature, and Heart Rate).

Figure 3. Clinical Parameter Input Form

- b. Result Visualization: The system instantly translates classification results into an intuitive color palette (Green for safe, Yellow for caution, Red for high risk) along with specific medical follow-up recommendations.

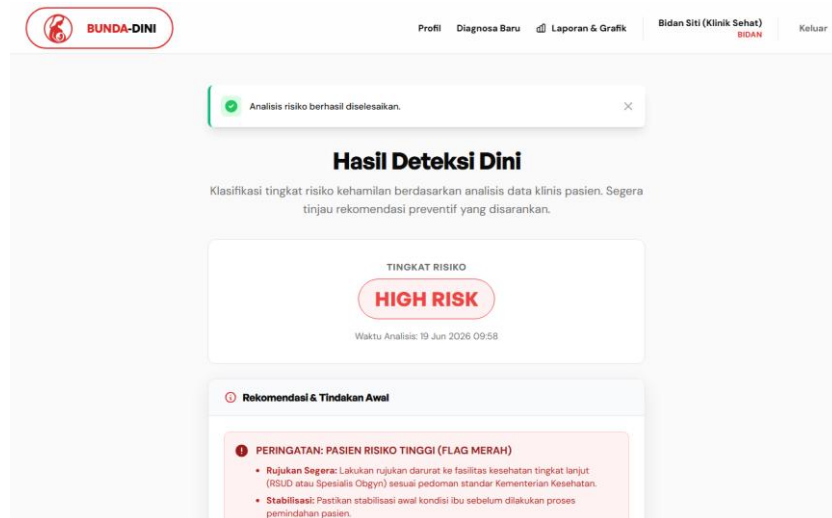


Figure 4. Risk Prediction Analysis Result Interface

- c. Executive Reporting System: Diagnostic summary data export feature in PDF document and Excel spreadsheet formats for auditing purposes or referrals to higher-level hospitals.

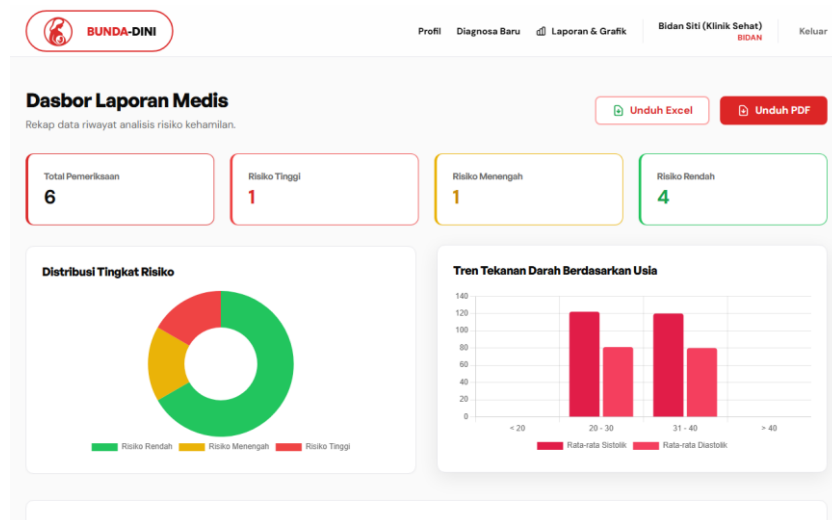


Figure 5. Data Recapitulation and Report Printing Page

RESULTS AND DISCUSSION

The "Bunda Dini" system has been successfully implemented and comprehensively tested, both in terms of interface functionality and authorization *routing* logic accuracy.

User Interface and Diagnosis Process

The User Interface (UI) is designed prioritizing clean aesthetic principles and User Experience (UX). The Login and Register pages are facilitated with credential validation and security features such as show/hide password (eye toggle feature). Once users (e.g., Doctors) log into the system, they are presented with the main page featuring the Intelligent Diagnosis Form. When clinical parameters are submitted, the "Analyze Now" button executes backend computations. The system's execution speed is highly optimal, displaying

risk category results (such as *High Risk*) instantaneously on screen, complete with emergency referral warnings if patient parameters exceed normal thresholds. This strongly supports the Standard Operating Procedure (SOP) for obstetric emergencies.

Successful Multi-Tenant Data Isolation

One of the major technical achievements in this web development is the validation of the *multi-tenant* feature. Testing was conducted using a scenario involving two different health facilities, for instance, "Bahagia Clinic" and "Bunda Hospital".

When a Midwife from Bahagia Clinic inputs data, the system automatically attaches the *clinicname identity "Bahagia Clinic" to that medical record entry. When an Admin from Bunda Hospital accesses the Reports & Charts panel, they will not see a single trace of data from Bahagia Clinic. This horizontal data isolation horizontal ensures compliance with medical confidentiality ethical codes. Meanwhile, accounts with the Super Admin role successfully bypass tenant boundaries to observe nationwide pregnancy risk distribution metrics.*

Reporting Functionality (PDF and Excel)

The system includes an interactive Report panel for Admins and Super Admins. Prediction history data is presented in historical tables. To support healthcare facility performance reporting to the District Health Office, the *Export* feature facilitates converting tables into *Portable Document Format* (PDF) or Microsoft Excel files. The generated reports are not mere data dumps, but neatly formatted reports containing essential metadata such as inspection dates, doctor STR/SIP license numbers, and individual patient vital sign details. The inclusion of professional titles (such as dr. Sp.OG or S.Tr.Keb) on exported outputs adds legitimacy for formal administrative purposes.

Black Box Testing

To guarantee application quality and reliability before full operation, software testing was conducted using the *Black Box Testing* method. This testing focused on fulfilling interface functionality (input/output), *routing* logic accuracy, and access control restriction in accordance with *multi-tenant* concepts. The test results are summarized in Table 1 below:

Table 1. Black Box Testing Results

No	Test Scenario	Input (User Action)	Expected Result	Actual Result	Status
1	Multi-Role Login Validation	Entering valid email and password with various access rights (Admin/Midwife)	The system routes the user to the dashboard page corresponding to their respective role.	User is routed to the correct path, navigation menu adapts.	Valid
2	Prediction Testing (Frontliner)	Midwife enters 6 clinical parameters and presses the 'Analyze' button	System processes data via XGBoost algorithm and displays pop-up / risk result page.	Result page appears in under 3 seconds with medical recommendations.	Valid
3	Query Scoping Testing (Tenant)	Clinic 'A' Admin attempts to view patient data report table	Report table only displays data generated by staff from Clinic 'A'.	Patient data from Clinic 'B' is not displayed horizontally.	Valid
4	Prediction Route Authorization	Clinic Admin forces manual access to `/prediction` URL route	System denies access and displays warning message that Admin is unauthorized.	Page is denied (Access Denied) and redirected back to dashboard.	Valid
5	Data Export Functionality	Pressing 'Print PDF' and 'Export Excel' buttons on recap page	.pdf or .xlsx file downloads with table data identical to web display.	File downloads successfully and column structure is aligned (midwife/doctor name included).	Valid

Overall, all test scenarios for functionality and *routing* logic were successfully met (Valid), proving that the role-based data protection mechanism functions properly and is ready for real-world deployment.

Discussion on Clinical Significance

The development of the Bunda Dini application demonstrates that even complex computational models can be translated into user-friendly web services. By combining the backend model's accuracy *backend* (boasting a high-risk Recall of 96.36%) with *frontend* accessibility across handheld devices at Community Health Centers, this system empowers field healthcare workers. Village midwives now possess a validation instrument based on massive historical data (second opinion) prior to making decision referrals for pregnant women to hospitals.

CONCLUSION

This research has yielded tangible outcomes in the form of the "Bunda Dini" web application, an integrated Decision Support System (DSS) innovation in midwifery care. The system successfully combines *machine learning* technology with modern web *framework* capabilities to deliver real-time maternal risk classification. The implementation of a *multi-tenant* architecture ensures that the web platform is scalable and can be used by hundreds of distinct clinics simultaneously without concerns regarding inter-institutional data leakage. Furthermore, flexible reporting features (PDF/Excel) address medical administrative requirements. Mass adoption of the Bunda Dini system across primary healthcare facilities is projected to boost early pregnancy risk detection percentages, streamline critical medical referral workflows, and progressively contribute to systemic maternal mortality reduction missions.

Acknowledgements

The authors express their deepest gratitude to the Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, LLDIKTI Region VI Central Java, and Universitas Duta Bangsa Surakarta for the support provided in the form of facilities, guidance, funding, and mentoring throughout this research and manuscript preparation process.

REFERENCES

- Chen, W., Yang, K., Yu, Z., Shi, Y., & Chen, C. L. P. (2024). *A survey on imbalanced learning : latest research , applications and future directions* (Vol. 123). Artificial Intelligence Review. <https://doi.org/10.1007/s10462-024-10759-6>
- Chevalier, D., & Côté, M. (2025). From point to probabilistic gradient boosting for claim frequency and severity prediction. *European Actuarial Journal*. <https://doi.org/10.1007/s13385-025-00428-5>
- Cockburn, N., Osborne, C., Withana, S., Elsmore, A., Nanjappa, R., South, M., Parry-smith, W., & Taylor, B. (2024). Articles Clinical decision support systems for maternity care : a systematic review and meta-analysis. *EClinicalMedicine*, 76, 102822. <https://doi.org/10.1016/j.eclinm.2024.102822>
- Derksen, C., Walter, F. M., Akbar, A. B., Parmar, A. V. E., Saunders, T. S., Round, T., Rubin, G., & Scott, S. E. (2025). The implementation challenge of computerised clinical decision support systems for the detection of disease in primary care : systematic review and recommendations. *Implementation Science*.

- <https://doi.org/https://doi.org/10.1186/s13012-025-01445-4>
- Du, Y., Mcnestry, C., Wei, L., Markella, A., Mcauliffe, F. M., & Mooney, C. (2023). International Journal of Medical Informatics Machine learning-based clinical decision support systems for pregnancy care : A systematic review. *International Journal of Medical Informatics*, 173(July 2022), 105040. <https://doi.org/10.1016/j.ijmedinf.2023.105040>
- Group, W. B. (2020). *Trends in maternal mortality 2000 to 2020*.
- Hamidah, U. F. (2024). *Evaluasi Literatur Penggunaan Teknologi Blockchain dalam Sistem Terdistribusi untuk Pelayanan Kesehatan*. 574–578.
- Jajang Jaya Purnama, Nina Kurnia Hikmawati, S. R. (2024). Analisis Algoritma Klasifikasi Untuk Mengidentifikasi Potensi Risiko Kesehatan Ibu Hamil. *Jurnal ISAS*, 5(1), 120–127. <https://doi.org/https://doi.org/10.52158/jacost.v5i1.809>
- Mondal, S., Nag, A., Barman, A. K., & Karmakar, M. (2023). *Machine learning-based maternal health risk prediction model for IoMT framework*. 32, 145–159.
- Mosca, M., Mosca, R., & Braggio, M. (2025). ScienceDirect Big Data and AI for Smart Maintenance : Literature review on the impact on plants Resilience. *Procedia Computer Science*, 253, 1959–1971. <https://doi.org/10.1016/j.procs.2025.01.258>
- Murtiningsih, D. A., Sari, B. W., & Fajri, I. N. (2025). Comparison of Light Gradient Boosting Machine , eXtreme Gradient Boosting , and CatBoost with Balancing and Hyperparameter Tuning for Hypertension Risk Prediction on Clinical Dataset. *JAIC*, 9(5), 2753–2763. <https://doi.org/https://doi.org/10.30871/jaic.v9i5.10400>
- Niu, S., Yin, Q., Ma, J., Song, Y., Xu, Y., Bai, L., Pan, W., & Yang, X. (2024). Enhancing healthcare decision support through explainable AI models for risk prediction. *Decision Support Systems*, 181(April), 114228. <https://doi.org/10.1016/j.dss.2024.114228>
- Pambudi, A., & Srirahayu, A. (2020). Aplikasi kesehatan ibu hamil berbasis Android. *Infokes*, 10(2), 55–62. <https://doi.org/https://doi.org/10.47701/infokes.v10i2.1034>
- Rahagiyanto, A., Prakoso, B. H., Yunus, M., Vestine, V., Eko, G., Suyoso, J., & Deharja, A. (2025). *Perbandingan Kinerja Algoritma KNN-DT-RF-SVM untuk Deteksi Dini Risiko Kematian Ibu*. 6(2), 137–145. <https://doi.org/10.25047/j-remi.v6i2.5658>
- Salim, S., Mashrafi, A., & Tafakori, L. (2024). Predicting maternal risk level using machine learning models. *BMC Pregnancy and Childbirth*. <https://doi.org/10.1186/s12884-024-07030-9>
- Sari, A. A., & Pramono. (2024). Penerapan Algoritma Deep Belief Networks (DBNs) Untuk Prediksi Kanker Serviks. *Duta.Com*, 17, 50–57. <https://doi.org/https://doi.org/10.47701/dutacom.v17i1.3790>
- Straw, I., Brass, I., & Mkwashi, A. (n.d.). *Insights From a Clinically Orientated Workshop on Health Care Cybersecurity and Medical Technology : Observational Study and Thematic Analysis Corresponding Author* : 26, 1–11. <https://doi.org/10.2196/50505>
- Tan, Y., Liu, X., Yang, Y., & Li, B. (2023). *Metabolomics analysis reveals serum biomarkers in patients with diabetic sarcopenia*. March, 1–13. <https://doi.org/10.3389/fendo.2023.1119782>
- Vemulapalli, H. S., Iyengar, S. K., Ko, N. L. K., Iyengar, S., Saranathan, S., & Srivathsan, K. (2024). Navigating the diagnostic challenges of the accessory pathway : Participant or bystander? *Heart Rhythm Case Reports*, 10(5), 335–340. <https://doi.org/10.1016/j.hrcr.2024.02.011>
- Villar, A., Robledo, C., & Andrade, V. De. (2024). Supervised machine learning algorithms for predicting student dropout and academic success : a comparative study. *Discover Artificial Intelligence*. <https://doi.org/10.1007/s44163-023-00079-z>
- Virginia Khoirunnisa, S. L. (2023). Implementasi Klasifikasi Kehamilan Beresiko dengan

Metode Naive Bayes pada Puskermas Kelurahan Malaka Jaya. *Jurnal Manajemen Informatika Dan Komunikasi*, 4(3), 1680–1693.
<https://doi.org/https://doi.org/10.35870/jimik.v4i3.396>