CHILD AND MATERNAL MORTALITY RISK FACTOR ANALYSIS USING MACHINE LEARNING

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Abstract: *Maternal and child mortality remain significant public health challenges, particularly in low- and middle-income countries where early risk identification and continuous healthcare monitoring are often limited. Previous studies have shown that machine learning techniques can effectively predict mortality risk using clinical indicators, with models such as Random Forest achieving very high accuracy after addressing class imbalance through over-sampling and under-sampling methods. However, most existing approaches function mainly as analytical models and lack integration into real-time, end-toend healthcare decision-support systems. The proposed system aims to overcome these limitations by developing a comprehensive early-warning and decision support platform for maternal and child health management. The system analyzes a*

wide range of health-related risk factors, including demographic details, nutritional status, medical history, pregnancy-related complications, vaccination records, and socio-economic conditions, to classify cases into low-, moderate-, or high-risk categories. Beyond prenatal prediction, the system also evaluates post-delivery health conditions of both the mother and newborn by monitoring postpartum complications, neonatal vital signs, infection risks, and early growth indicators.Machine learning models such as Logistic Regression, Support Vector Machine (SVM), Neural Networks, and Random Forest are trained using historical healthcare datasets to identify critical patterns, generate accurate risk predictions, and determine key contributing factors. By providing timely risk assessment and actionable insights, the proposed system supports healthcare professionals in early intervention and improved decision-making, ultimately contributing to the reduction of maternal and child mortality rates.

I. INTRODUCTION

Maternal and child health is a key indicator of a nation's healthcare quality and socio-economic development. Despite advancements in medical science, maternal and neonatal mortality rates remain high in many developing regions due to late risk identification, lack of timely intervention, and limited access to predictive healthcare technologies. Many complications during pregnancy, childbirth, and the postnatal period can be prevented if high-risk cases are detected early and monitored continuously.

Traditional healthcare systems primarily rely on manual evaluation methods such as clinical observations, paper-based records, and basic statistical analysis. These approaches are often reactive and

depend heavily on the experience of healthcare providers. As a result, the early warning signs of complications may go unnoticed, and large volumes of healthcare data remain underutilized. With the rapid growth of digital medical records and data collection, there is an opportunity to leverage advanced technologies to improve risk prediction and decision-making in maternal and child healthcare. This project proposes a machine learning–based system for analyzing maternal and child mortality risk factors. The system utilizes historical and real-time health data—including maternal age, medical history, pregnancy conditions, nutritional status, socio-economic factors, delivery details, and neonatal health indicators—to predict risk levels. By applying machine learning algorithms such as Logistic Regression, Support Vector Machine (SVM), Random Forest, and Neural Networks, the system classifies cases into low, moderate, or high-risk categories.

In addition to prenatal risk assessment, the system extends its analysis to the post-delivery stage, monitoring the health of both the mother and the newborn. Postnatal indicators such as birth weight, Apgar score, maternal recovery, and neonatal complications are analyzed to provide early warnings and recommendations.

The proposed solution aims to transform healthcare from a reactive approach to a proactive and predictive model, enabling healthcare professionals to make data-driven decisions, improve resource planning, and ultimately reduce preventable maternal and child deaths.

II. LITERATURE SURVEY

Recent research highlights the growing role of machine learning in predicting maternal and child mortality by analyzing complex healthcare data.

Sharma et al. (2025) [1] proposed a machine learning–based risk prediction model for maternal and neonatal mortality using clinical and demographic features. Their study demonstrated that ensemble models significantly improve

prediction accuracy and help identify high-risk cases at early stages.

Alhassan and Adeyemi (2025) [2] introduced an explainable AI framework for maternal health risk assessment, emphasizing model transparency and interpretability to support clinical decision-making. Their work addressed the limitation of black-box models by enabling healthcare professionals to understand the contributing risk factors. Li et al. (2025) [3] focused on deep learning models for prenatal and postnatal health monitoring, showing that neural networks can effectively learn complex temporal patterns from maternal and neonatal data. Their approach improved early detection of complications during both pregnancy and post-delivery phases. Verma and Singh (2025) [4] conducted a comparative analysis of various machine learning algorithms for child mortality prediction and concluded that Random Forest and Support Vector Machine models outperform traditional classifiers in terms of accuracy and robustness. However, their study primarily focused on prediction performance rather than real-time implementation. Mensah et al. (2025) [5] further emphasized the role of socioeconomic determinants such as income level, education, and access to healthcare services in improving the accuracy of mortality risk prediction models. Their research demonstrated that combining medical and socio-economic data significantly enhances model performance.

Sheakh et al. (2024) [6] analyzed child and maternal mortality risk factors using machine learning approaches and highlighted the importance of combining medical and socio-economic indicators for accurate risk classification. Their findings confirmed that multifactor analysis significantly enhances prediction reliability.

Ahmed and Rahman (2023) [7] applied supervised learning techniques for child mortality prediction and showed that datadriven models can significantly improve early risk detection. Wang et al. (2023) [8] used deep learning approaches to predict neonatal health risks and demonstrated improved accuracy compared to traditional statistical methods.

Singh and Verma (2023) [9] conducted a comparative study of machine learning algorithms for pregnancy risk assessment, identifying ensemble methods as highly effective for healthcare prediction tasks.

Hassan et al. (2023) [10] proposed an ensemble learning framework for early detection of high-risk pregnancies, emphasizing the importance of combining multiple models for better performance.

coordination among stakeholders but lacked mobile accessibility and chatbot assistance for real-time user engagement.

III. PROPOSED SYSTEM

The proposed system is an AI-based maternal health early warning and monitoring system designed to provide preventive healthcare support outside traditional clinical settings. The system collects essential health parameters such as age, blood pressure, blood sugar, body temperature, and heart rate, and processes them using a trained machine learning model to predict the maternal risk level as low, mid, or high. In addition to basic prediction, the system incorporates advanced features such as risk trend analysis, which compares current and previous records to determine whether the condition is improving or worsening, and future risk prediction, which estimates the likely progression of risk. To improve transparency and trust, the system includes explainable AI, highlighting the key factors responsible for the predicted risk. It also generates personalized recommendations based on individual health parameters and calculates a health score (0–100) for easy understanding of the patient's condition. Furthermore, an early warning mechanism alerts users if risk levels increase rapidly, enabling timely intervention. The system is designed to be accessible for home-based and rural healthcare environments, assisting non-expert users and health workers in making informed decisions. Additionally, an admin dashboard provides community-level analytics, helping monitor population health trends. Overall, the proposed system shifts maternal healthcare from a reactive approach to a proactive, predictive, and preventive model, supporting doctors rather than replacing them.

IV. PROPOSED SOLUTION

The proposed solution is to develop an intelligent machine learning– based prediction system that can analyze maternal and neonatal healthcare data and identify mortality risk at early stages. The system is designed to transform traditional manual healthcare assessment into a predictive and automated decision-support system that assists healthcare professionals in providing timely medical care.

The solution begins with the collection of historical healthcare datasets containing information related to maternal health, pregnancy conditions, delivery details, neonatal health indicators, and socio-economic factors. This data is then processed through a preprocessing stage where missing values are handled, noise is removed, and the data is normalized and transformed into a machine-readable format.

After preprocessing, the system performs feature selection and engineering to identify the most significant risk factors influencing maternal and child health outcomes. These features are used to train multiple machine learning models such as Logistic Regression, Support Vector Machine (SVM), Random Forest, and Neural Networks. The models learn patterns from historical data and generate predictions for new cases.

The trained model is integrated into a risk prediction engine that classifies each case into low, moderate, or high-risk categories. The system also highlights the key contributing factors behind each prediction, making the results interpretable and useful for healthcare professionals.

In addition, the solution includes a post-delivery monitoring component that evaluates the health of both the mother and the newborn after childbirth. This ensures continuous monitoring and early detection of complications such as infections, low birth weight, maternal hemorrhage, or delayed recovery.

Finally, the system provides alerts and preventive recommendations to healthcare workers, enabling early intervention and better healthcare planning. By combining predictive analytics, continuous monitoring, and decision support, the proposed solution aims to reduce preventable maternal and child mortality and improve overall healthcare efficiency.

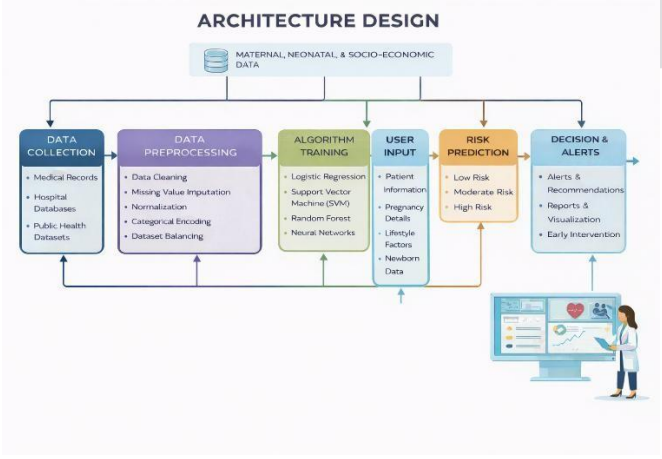
V.IMPLEMENTATION

The proposed system is implemented as a full-stack web application integrating machine learning with a user-friendly interface. The frontend is developed using HTML, CSS, Bootstrap, and JavaScript, providing responsive and interactive pages for user input, result visualization, and dashboards. The backend is built using the Flask framework in Python, which handles routing, user authentication, data processing, and communication with the machine learning model. The system uses a Random Forest classifier trained on maternal health datasets to predict risk levels. During model training, data preprocessing techniques such as feature scaling and encoding are applied to improve accuracy, and the trained model is saved as a serialized file (best_model.pkl) for deployment.

When a user enters medical parameters through the dashboard, the input data is preprocessed and passed to the trained model to generate predictions along with probability scores. The system then performs additional analysis, including risk trend comparison (previous vs current), future risk estimation, and explainable AI, which identifies key contributing factors such as high blood pressure or blood sugar. A health score (0–100) is also calculated for intuitive understanding, and personalized recommendations are generated based on input values. All prediction records are stored in an SQLite database, enabling history tracking and trend analysis over time.

The application also includes an admin module, which visualizes aggregated data using Chart.js, providing insights into risk distribution and population-level trends. The system is designed to be lightweight and deployable on cloud platforms such as Render, making it accessible for remote and rural healthcare environments. Overall, the implementation combines machine learning, web technologies, and data analytics to deliver a scalable and practical healthcare decision-support system.

VI . ARCHITECTURE DAIGRAM



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