An Explainable AI-Powered Conversational Mobile Health System for Early Detection and Personalized Recovery Support of Postpartum Depression Among Sri Lankan Mothers

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1. Introduction

Postpartum Depression (PPD) is a common mental health condition that affects mothers after the childbirth and it can negatively impact both mothers and infants. However, routine maternal mental health screening remains limited in Sri Lanka, resulting in many mothers not getting adequate support. Even though Artificial Intelligence (AI), Machine Learning (ML), Conversational AI, and Mobile Health (mHealth) technologies have been successfully explored in mental healthcare, integrated solutions for postpartum depression are still lacking. Therefore, this study proposes an Explainable AI integrated conversational mobile health systems for early postpartum prediction, personalized recovery support, and continuous monitoring among Sri Lankan Mothers.

1.1. Summary of literature

Previous studies have used AI and ML techniques to predict PPD using clinical, demographic, psychological, and behavioral data. Several studies stated successful predicting performance using algorithms such as Random Forest, Support Vector Machines, XGBoost, and Neural Networks for early PPD risk identification. [1] [2] [3] [4]

Some research has also explored mobile health (mHealth) technologies, digital phenotyping [5], and conversational AI to improve mental healthcare in postpartum mothers. Mobile-based monitoring systems and passive sensing approaches [6] have shown potential for continuous tracking behavioral indicators associated with depressive symptoms. Additionally, conversational agents and AI chatbots have improved accessibility, engagement, and emotional support for mothers who are experiencing mental health challenges. [7] [8] [9]. However, many of these systems primarily target symptom screening and general mental health rather than personalized postpartum recovery support.

To address the issues related to transparency in healthcare AI, some studies have used Explainable Artificial Intelligence (XAI) techniques such as SHAP and interpretable machine learning models have been increasingly adopted to explain prediction outcomes and improve user trust [10] [11]. These approaches enhance model interpretability, but most studies focus only on explaining prediction results, they do not integrate personalized interventions or continuous monitoring capabilities.

In the Sri Lankan context, few studies have investigated the prevalence and risk factors associated with postpartum depression and demonstrated the potential of machine learning for local PPD prediction [2] [12]. However routine maternal mental health monitoring is limited, and technology-integrated support systems specifically designed for Sri Lankan postpartum mothers are largely absent.

Research Gap

The reviewed literature shows that current studies mainly address individual aspects of postpartum mental healthcare. Even though machine learning models have shown potential performance for PPD prediction [1] [3] [4], they mainly focus on risk identification and providing limited support for ongoing recovery. Conversational AI and chatbot-based systems have improved accessibility and user engagement [8] yet they often deliver general mental health support without integrating predictive analytics or personalized recovery recommendations. Similarly, XAI-based studies have improved transparency and trust in prediction models [10] [11] but the explainability to provide continuous support mechanisms are very little.

Additionally, studies on digital phenotyping and mobile health interventions have shown the value of continuous monitoring [5] [6], but these approaches are typically implemented independently and do not support explainable prediction models and conversational support systems. So existing research lacks a unified platform that combines Explainable AI, conversational AI, personalized recovery support, and continuous monitoring within a single mobile health platform.

Additionally, most existing solutions have been developed and evaluated in Western or high-resource healthcare settings. They do relate to the context of Sri Lanka and have limited consideration of the cultural, social, and healthcare challenges faced by Sri Lankan postpartum mothers [2] [12]. Therefore, a significant research gap exists in developing an integrated, Explainable AI-powered conversational mobile health system that supports early PPD prediction, transparent risk explanations, personalized recovery guidance, and continuous monitoring inside the Sri Lankan context. Unlike existing studies that only focus on prediction, explainability, chatbot support, or monitoring separately, this research proposes a unified mobile health platform that integrates XAI, conversational AI, personalized recovery support, and continuous monitoring specifically for Sri Lankan postpartum mothers. This integration represents the novelty and contribution of the proposed research.

1.1. Problem definition

Due to social stigma, limited awareness and insufficient routine mental health assessments, many Sri Lankan postpartum mothers silently experience depressive symptoms without adequate recognition or support. Most current healthcare services often rely on mothers seeking professional help voluntarily. This could leave many vulnerable people unidentified. Also, existing AI-based prediction systems often lack transparency, fail to provide personalized recovery and do not offer continuous emotional monitoring after identifying the risk leading to limiting their practical usability in real-world settings.

1.2. Research Questions

RQ1: How can Explainable Artificial Intelligence (XAI) be used to accurately predict postpartum depression risk among Sri Lankan mothers while providing transparent and interpretable explanations?

RQ2: How can conversational AI and mobile health technologies support continuous symptom monitoring and engagement among postpartum mothers?

RQ3: How can personalized recovery recommendations be generated based on postpartum depression risk levels and ongoing emotional assessments?

RQ4: How effective is the proposed integrated mobile health system in terms of prediction performance, explainability, usability, usability, user trust, and user engagement?

2. Goal of the project

The goal of this project is to design, develop, and evaluate an Explainable AI (XAI) integrated conversational mobile health system that can support early detection and management of postpartum depression among Sri Lankan mothers. This proposed solution will address the gap mentioned earlier by integrating four core components into a single mobile application:

1. Explainable AI integrated PPD Prediction
2. Conversational AI for interactive screening
3. Personalized recovery guidance
4. Continuous mental well-being monitoring

The scope is limited to the development and evaluation of a mobile health solution based on software. This system will function as a supportive tool for identifying at-risk mothers, providing clear prediction insights, engaging users through conversation, and facilitating recovery through personalized and culturally relevant advice.

3. Aims and objectives

To develop and evaluate XAI- integrated conversational mobile health solution that implements early detection, personalized recovery and continuous monitoring of postpartum depression among Sri Lankan Mothers.

- To develop a machine learning model to predict the risks of postpartum depression using maternal, demographic, and psychological factors.
- To implement XAI, techniques to provide transparent, interpretable prediction explanations.
- To develop a conversational AI chatbot for symptom assessment, emotional check-ins, and user engagement.
- To generate personalized recovery recommendations based on risk levels and user interactions.
- To implement continuous monitoring of user's emotional well-being.
- To evaluate the prediction performance, explainability, usability, user trust, engagement, and overall system effectiveness.

4. Expected Outcomes

- An integrated mobile health application combining PPD prediction, XAI explanations, conversational support, personalized recovery guidance, and continuous monitoring.
- An Explainable AI-based prediction model with measurable performance.
- Transparent prediction explanations generated using SHAP.
- A conversational AI chatbot for symptom tracking and emotional support.

- A personalized recommendation mechanism based on user risk profiles and emotional trends.
- Evaluation results demonstrating the system's prediction performance, explainability, usability, usability, user trust, engagement, and effectiveness.

5. Proposed methodology

Data Collection and Preprocessing

- Use a publicly available postpartum depression dataset from Kaggle containing 1,503 records collected through a hospital-administered questionnaire. (https://www.kaggle.com/datasets/parvezalmuqtadir2348/postpartum-depression?resource=download)
- Features include Age, Feeling Sad/Tearful, Irritability Towards Baby and Partner, Sleep Disturbances, Concentration Difficulties, Appetite Changes, Anxiety, Feelings of Guilt, and Bonding Difficulties with Baby.
- Incorporate relevant publicly available Sri Lankan postpartum mental health datasets and research findings, subject to feature compatibility.
- Perform data preprocessing, including missing value handling, feature encoding, scaling, and class balancing.
- Validate locally relevant factors through existing Sri Lankan literature and healthcare guidelines.

Risk Prediction Model Development

- Train and compare Logistic Regression, Random Forest, SVM, XGBoost, and LightGBM models.
- Select the best model using Accuracy, Precision, Recall, F1-Score, and ROC-AUC.

Explainable AI Integration

- Implement SHAP as the primary XAI framework.
- Provide risk-factor explanations for mothers and detailed feature-importance visualizations for healthcare professionals and researchers.

Conversational AI and Recovery Support

- The system will use Google Dialogflow CX as the main conversational AI to handle structured flows such as emotional check-ins, symptom assessment, and user interactions, using intent detection and context management for guided conversations.
- Personalized recommendations will be generated using a hybrid approach. User mood, symptom scores, and interaction history are analyzed to understand the user's condition. A rule-based system applies clinical thresholds for safe guidance, while an AI-driven component personalizes suggestions based on emotional context and past behavior.

Mobile Application Development

- Develop the mobile application using Flutter and Supabase.
- Integrate AI Prediction services, chatbot function, and monitoring features.

Evaluation

- Evaluate prediction performance using Accuracy, Precision, Recall, F1-Score, and ROC-AUC.
- Assess usability using System Usability Scale (SUS).
- Evaluate explainability, user satisfaction, and engagement by using user feedback surveys.

The proposed methodology is preliminary and may be updated as the project develops further.
The detailed system architecture diagram is provided in Appendix A (Figure 1).

6. Resource requirements

Frontend	Flutter
Backend Services	Supabase
AI/ML/XAI Development	Python, Scokit-learn, TensorFlow, SHAP
Database	Supabase, PostgreSQL
APIs	Conversational AI API, Supabase API Services

These resources requirements are the initial requirements and may change with the further development of the project.

7. Ethics and AI Compliance (if applicable)

For the initial phases of development, a publicly available dataset will be used with no human participants. Therefore, informed consent is not required. The data will be processed under ethical guidelines for secondary data use, ensuring privacy and confidentiality.

For the later phases of the project, including system testing and validation, real postpartum mothers will be recruited as participants. Prior to involving human participants, ethical clearance will be obtained from the relevant ethics review committee. Informed consent will be obtained from all participants, and the study will be conducted in accordance with established ethical guidelines to ensure participant privacy, confidentiality, and voluntary participation

8. Risk Assessment (If applicable)

- **Data Risk**: Limited availability of high-quality postpartum depression datasets.
  Mitigation: Use publicly available datasets (e.g., Kaggle), apply appropriate preprocessing techniques, and supplement with survey data after obtaining ethical clearance.
- **Model Risk:** Some machine learning models may not achieve the desired predictive performance or may overfit the training data.
  Mitigation: Train and compare Logistic Regression, Random Forest, Support Vector Machine (SVM), XGBoost, and LightGBM using Accuracy, Precision, Recall, F1-Score, and ROC-AUC, and select the best-performing model through cross-validation and hyperparameter tuning.
- **Integration Risk:** Challenges in integrating the trained AI model, explainability module (SHAP), and conversational chatbot into the mobile application.
  Mitigation: Adopt an incremental development approach with modular integration and continuous testing throughout the development process.
- **Project Risk:** Development delays due to technical challenges, limited resources, or time constraints.
  Mitigation: Follow a structured project timeline, conduct regular progress reviews with supervisors, and maintain contingency time for unforeseen issues.

9. Time plan

The detailed project schedule is provided in Appendix B (Figure 2).

10. Conclusion

This research proposes an Explainable AI integrated mobile health system for Sri Lankan's mothers to support early detection, personalized recovery guidance and continuous monitoring of postpartum depression. By combining Explainable AI, conversational AI, and mobile health technologies, the system aims to improve access to maternal mental health support and address the research gaps in previous studies.

11. References

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12. Appendices

- Appendix A: The complete system Architecture of the project

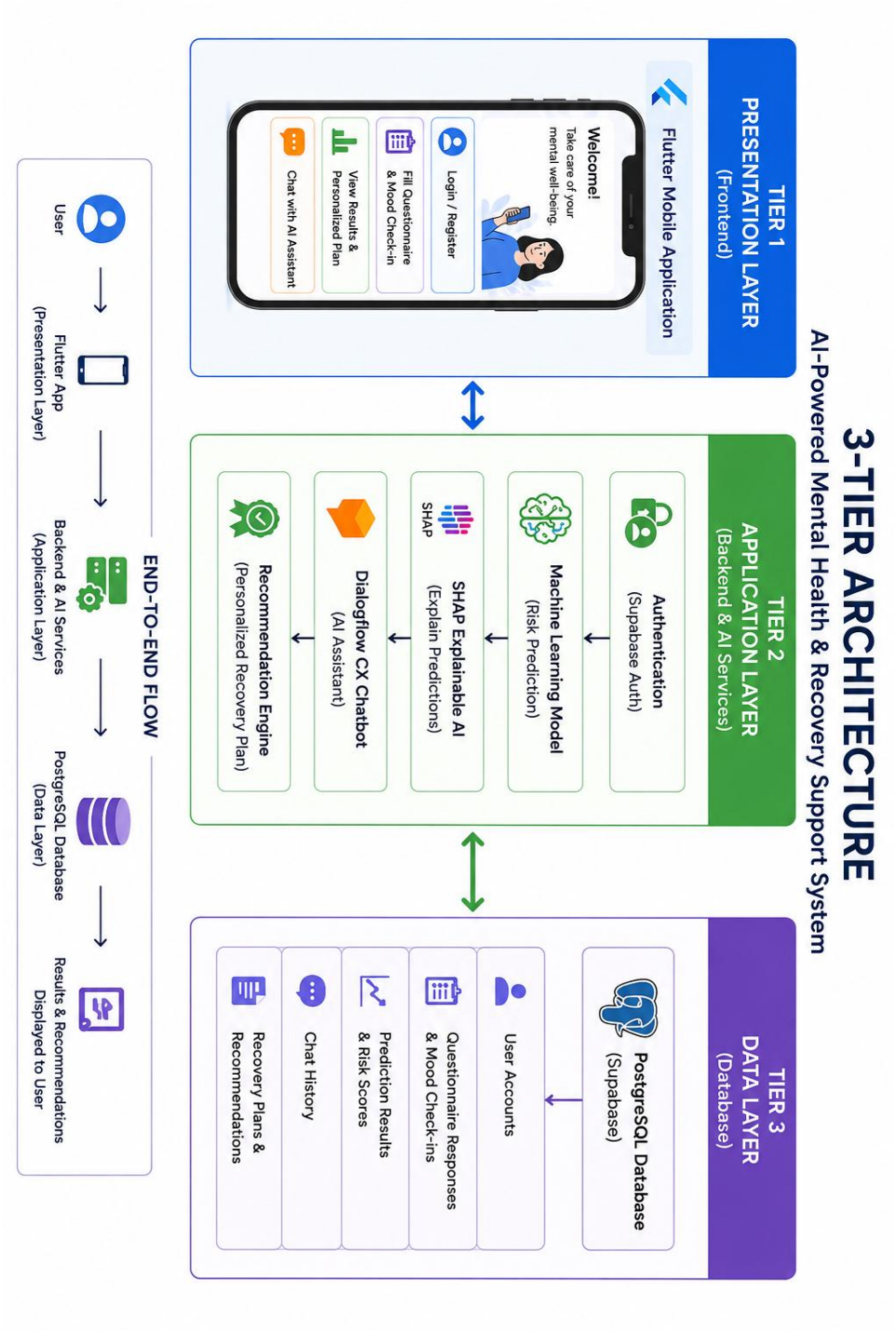

Figure 1

- Appendix B: The detailed time plan of the project.

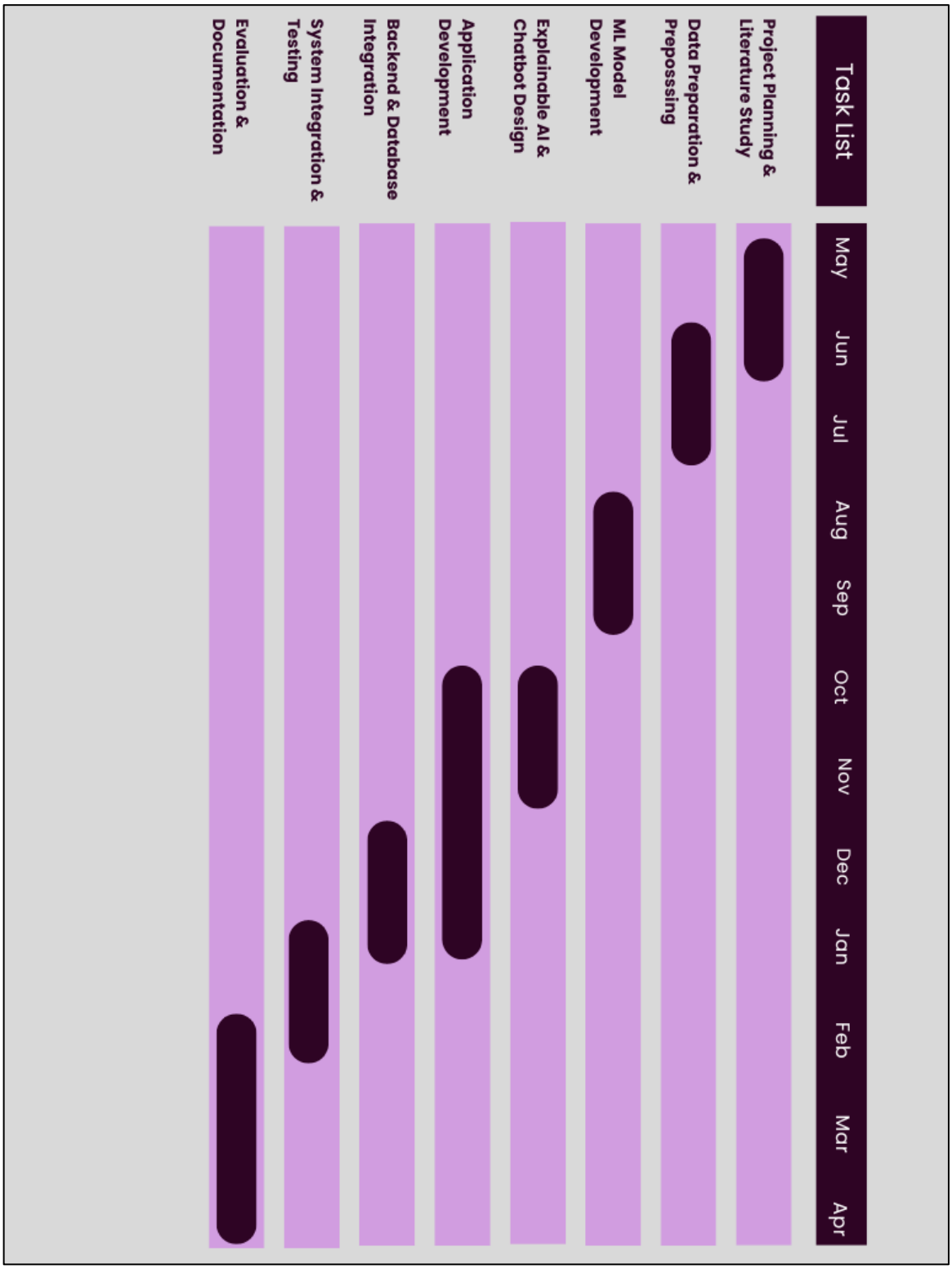

Figure 2