



CRADLE - A Digi Assistant Pregnancy Support

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Abstract: Pregnant women in developing regions lack access to reliable health guidance, real-time medical support, and mental wellness tools in a single platform. This paper proposes a Maternal Health and Gamification Platform — a full-stack web application built using Django REST Framework, Django Channels, and Next.js. The system integrates an AI chatbot powered by Retrieval-Augmented Generation (RAG) with FAISS vector search and a local Large Language Model for accurate, privacy-preserving maternal health responses. Real-time patient–doctor communication is enabled through Web Sockets, while gamification features including week-unlock journeys, nutrition games, and recipe discovery promote consistent engagement and reduce pregnancy-related anxiety.

Index Terms - Maternal Health, Gamification, Retrieval-Augmented Generation, Large Language Model, Web Sockets, Pregnancy Care System.

1. INTRODUCTION

Pregnancy is one of the most transformative and medically significant periods in a woman's life, demanding consistent access to health information, professional medical guidance, and emotional support across all three trimesters. According to the World Health Organization (WHO), complications during pregnancy and childbirth remain among the leading causes of death and disability for women of reproductive age, particularly in low- and middle-income countries. Despite the global proliferation of smartphones and internet connectivity, a significant portion of expectant mothers still lack access to integrated, easy-to-use digital tools that address their medical, nutritional, and psychological needs simultaneously. Existing maternal health applications available on the market primarily focus on a single dimension of care either offering static week-by-week baby development content, basic appointment reminders, or generic nutrition advice. Very few platforms combine real-time doctor–patient interaction, AI-powered health guidance, and engagement-driven features into a unified experience. Most AI chatbot solutions deployed in healthcare rely on cloud-based Large Language Model (LLM) APIs, raising serious concerns about data privacy, response latency, and accessibility in regions with limited internet infrastructure. These gaps highlight the need for a comprehensive, locally intelligent, and engagement-first maternal health platform.

Mental wellness during pregnancy is equally critical yet consistently overlooked by existing systems. Research indicates that approximately 10–15% of pregnant women experience prenatal depression or anxiety, conditions that directly impact both maternal and fetal health outcomes.

2. EXISTING SYSTEM

Several maternal health applications and research systems have been developed to support pregnant women digitally, yet each falls short of providing a holistic, integrated solution. Ovia Pregnancy & Baby Tracker, one of the most widely used consumer apps, offers week-by-week baby development information, symptom tracking, and appointment reminders. However, it relies entirely on static pre-written content with no real-time doctor interaction, AI-driven health Q&A, or gamification. What to Expect provides pregnancy content and community forums, but interactions are peer-to-peer without verified medical professional involvement — no AI chatbot, no doctor messaging, and no mental wellness component. Similarly, BabyCenter functions purely as a content delivery platform with due-date calculators and community groups, lacking intelligent question-answering, personalized health tracking, or direct medical consultation.

In the domain of AI-powered healthcare chatbots, cloud-based solutions such as Ada Health and Babylon Health employ NLP models to answer health-related queries. While effective, these systems depend entirely on third-party cloud APIs,

raising serious data privacy and response latency concerns. They are also generalist tools not tailored to maternal health workflows, trimester-specific guidance, or pregnancy nutrition. Research by Lewis et al. (2020) introduced Retrieval-Augmented Generation (RAG), combining dense retrieval with sequence-to-sequence generation to deliver superior factual accuracy over purely generative models. Subsequent works applied RAG to medical Q&A with domain-specific corpora, showing significant improvements in response grounding. However, these remain research prototypes without integration into production-ready healthcare platforms.

| System | Limitation |
|----------------------------------|--|
| Ovia, BabyCenter, What to Expect | Static content only; no AI, no real-time doctor chat |
| Ada Health, Babylon | Cloud-dependent; not maternal-specific; privacy risks |
| RAG-based medical bots | Research prototypes; not integrated into full platforms |
| Telemedicine platforms | Episodic consultation; no gamification or daily engagement |
| General health apps | No trimester-aware personalization or support groups |

TABLE 1: EXISTING SYSTEM LIMITATIONS ANALYSIS

The analysis of existing systems clearly establishes the need for a unified platform that combines AI-powered maternal Q&A grounded in verified local health guidelines, real-time doctor–patient communication, structured community support groups, and gamification-driven engagement — all within a single, privacy-preserving, locally hosted application. The proposed system addresses each of these identified limitations.

3. PROPOSED SYSTEM

The proposed Maternal Health and Gamification Platform is a full-stack web application serving as an all-in-one digital companion for pregnant women, integrating intelligent health assistance, real-time communication, and gamification-driven engagement into a single cohesive platform.

3.1 System Overview

The platform follows a three-tier client-server architecture: a Next.js TypeScript frontend for the user interface, a Django REST Framework backend handling authentication, data management, and APIs, and a Fast API AI Microservice independently managing RAG-based retrieval and LLM inference. All three services communicate via HTTP REST and WebSocket protocols, ensuring separation of concerns and independent scalability.

3.2 Key Modules

1. User Management and Role-Based Access Control The system supports three roles — Patient, Doctor, and Administrator — each with distinct permissions. Accounts are managed via a custom Django User model with UUID primary keys and JWT authentication. Patient profiles store trimester stage and pregnancy week, while doctor profiles include specialization and experience.

2. AI-Powered Maternal Health Chatbot The chatbot uses a priority-layered response pipeline. First, every query is scanned for emergency keywords (bleeding, severe pain, no fetal movement) — if detected, the user is immediately directed to seek hospital care. Otherwise, the system checks for greetings, then performs direct lookup against embedded food and recipe datasets for instant dietary responses. For complex health queries, a FAISS vector index built using the all-MiniLM-L6-v2 Sentence Transformer retrieves the top-3 relevant QA pairs from verified maternal health guidelines. These are passed to a locally hosted LLM via Ollama (qwen2.5:3b) to generate a context-grounded response, with graceful fallback to retrieved answers if generation fails. This ensures safety-first, privacy-preserving, and low-latency responses.

3. Real-Time Communication Module WebSocket-based messaging via Django Channels supports direct patient–doctor consultation and five category-based support groups: Trimester Journey, Mental Wellness, Nutrition & Health, Postpartum Prep, and General Support — with file sharing, emoji support, and message moderation.

4. Gamification Module is to promote mental well-being and reduce stress, the platform features a dedicated wellness suite consisting of three interactive games: Memory Match, Healthy Match-3, and a relaxation Puzzle. These games are designed to provide cognitive engagement and emotional relief and a Recipe Finder linked to a 1.6 MB recipe dataset.

5. Doctor Discovery and Admin Panel Patients can browse verified doctors by specialization. Administrators manage user verification, account blocking, and platform oversight through Django's admin dashboard.

| Feature | Existing Systems | Proposed System |
|-----------------------|----------------------|--|
| Real-time Doctor Chat | Separate platforms | Integrated WebSocket |
| Gamification | None / Basic streaks | Interactive wellness & stress-relief games |
| Emergency Detection | None | Keyword-triggered safety layer |
| Role-based Access | None | Patient / Doctor / Admin |
| Nutrition Guidance | Static articles | Interactive AI + Recipe DB |
| Support Groups | Generic forums | Categorized pregnancy groups |

TABLE 2: COMPARISON BETWEEN EXISTING AND PROPOSED SYSTEM

4. METHODOLOGY / IMPLEMENTATION

The system utilizes a modular, service-oriented architecture consisting of a Django backend, a Fast API AI microservice, and a Next.js frontend. The Django backend facilitates authentication via JWT and manages role-based access for patients, doctors, and administrators. Real-time communication is powered by Django Channels and Daphne, using Web Sockets for seamless messaging, file sharing, and group moderation within specialized support communities categorized by trimester and wellness needs.

A dedicated Fast API microservice independently manages the AI layer through a Retrieval-Augmented Generation (RAG) pipeline. It employs a FAISS vector index created with the all-MiniLM-L6-v2 transformer to index and search verified maternal health guidelines. Upon user query, the service retrieves relevant context and utilizes a local LLM (Ollama qwen2.5:3b) to generate grounded, privacy-preserving responses. A critical safety layer integrated into the Django bot scans all incoming queries for emergency keywords, providing immediate hospital referrals before AI inference. For common dietary information, the system performs zero-latency lookups against embedded Python datasets for food and recipes.

The frontend is implemented with Next.js and TypeScript, featuring a nurturing pastel design system to mitigate maternal anxiety. It leverages Framer Motion and GSAP for fluid UI animations, while Three.js powers 3D gamification elements like nutrition puzzles and an interactive 41-week pregnancy journey timeline. Zustand manages global state, while Axios and native Web Sockets facilitate robust communication between the client and backend services. This modular architecture ensures a responsive, emotionally supportive, and clinically reliable digital companion for maternal health.

5. SOFTWARE DESCRIPTION

| Category | Technology Stack |
|-----------------|--|
| Frontend | Next.js (App Router), TypeScript, Tailwind CSS |
| Animation & 3D | Three.js (R3F), GSAP, Framer Motion |
| Backend | Django REST Framework (DRF), Python 3.11 |
| Real-time | Django Channels, WebSockets, Daphne ASGI |
| AI Microservice | FastAPI, Uvicorn |
| AI / RAG | FAISS (Vector DB), Sentence-Transformers |
| LLM Engine | Ollama (qwen2.5:3b, llama3.2) |
| State & Auth | Zustand, JWT (SimpleJWT) |
| Database | SQLite (Dev), PostgreSQL (Prod) |

TABLE 3: TECHNOLOGY STACK USED IN CRADLE PLATFORM

6. RESULTS AND DISCUSSION

FIGURE 1: HOME DASHBOARD INTERFACE OF CRADLE PLATFORM

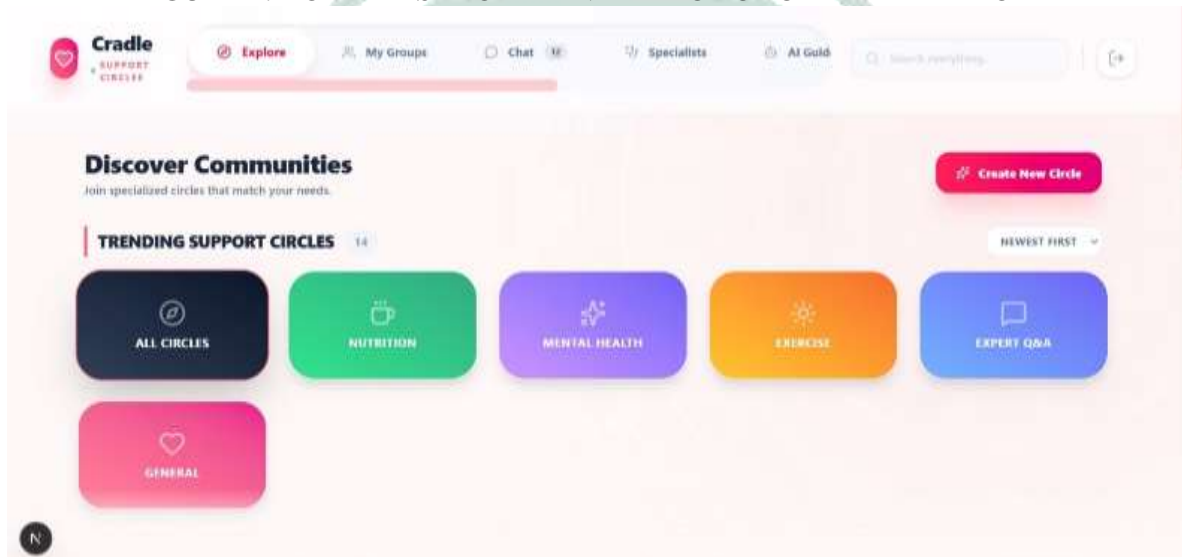


FIGURE 2: REAL-TIME PATIENT-DOCTOR CHAT INTERFACE

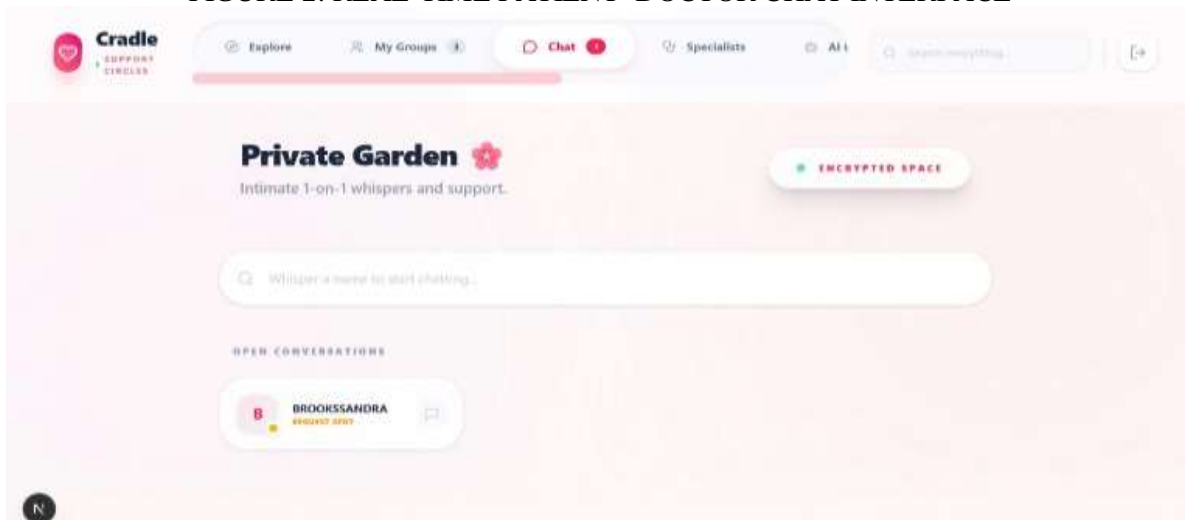


FIGURE 3: COMMUNITY SUPPORT GROUPS INTERFACE

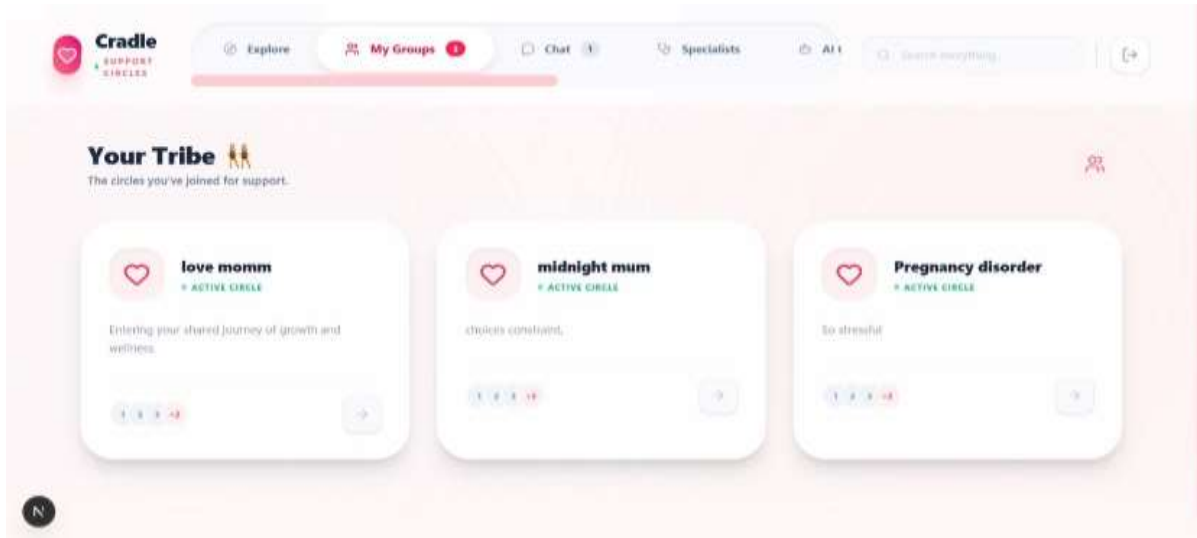


FIGURE 4: DOCTOR DISCOVERY AND APPOINTMENT INTERFACE

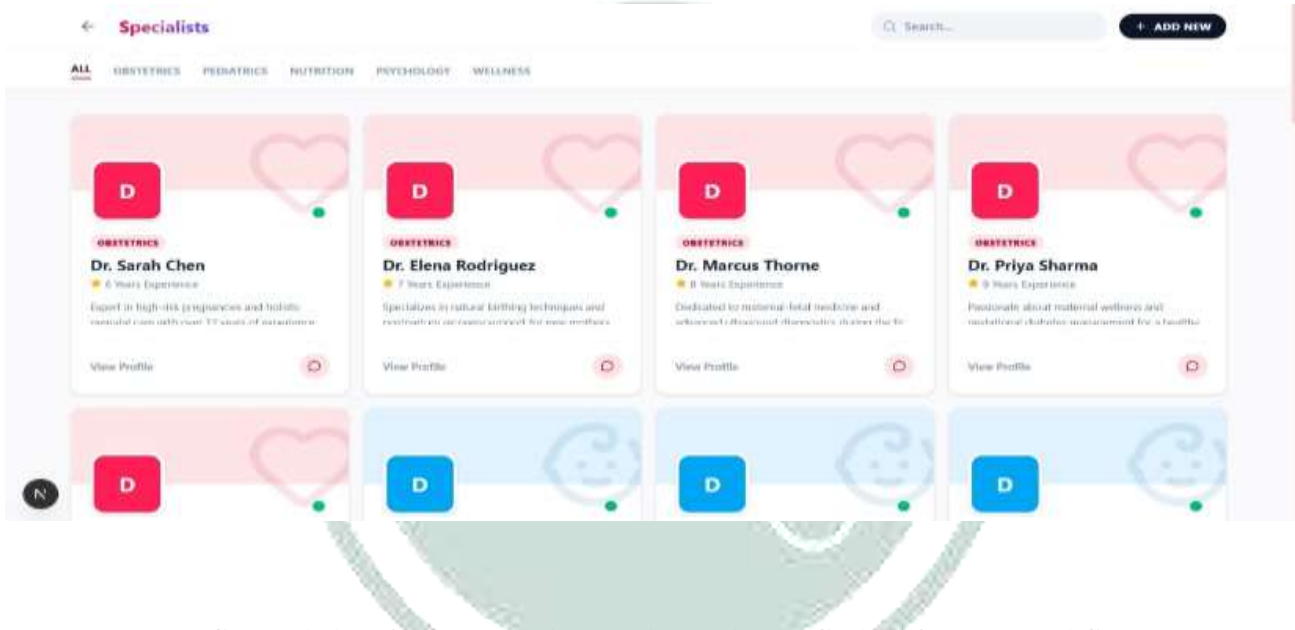
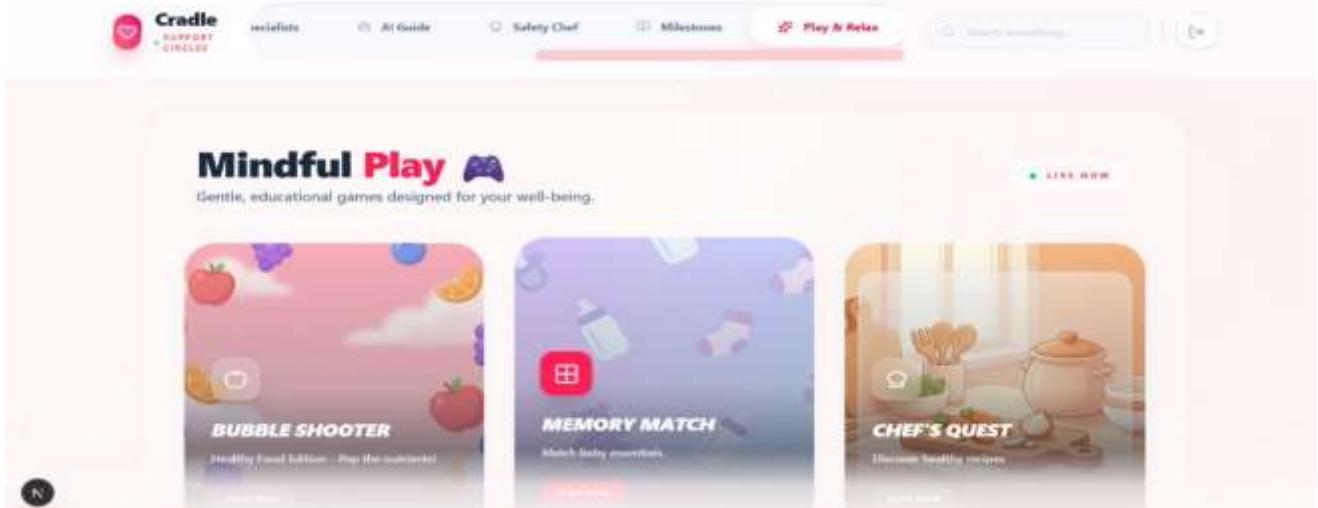


FIGURE 5: AI-POWERED MATERNAL HEALTH CHATBOT INTERFACE



FIGURE 6: GAMIFICATION AND WELLNESS ACTIVITIES INTERFACE



7. CONCLUSION

The Maternal Health and Gamification Platform successfully bridges the gap between clinical maternal care and patient engagement by unifying AI-driven assistance, real-time communication, and wellness-focused gamification into a single digital companion. By utilizing a local RAG-based AI microservice and WebSocket-enabled support groups, the platform ensures secure, high-speed access to medical guidance while maintaining strict user privacy. The integration of 3D game elements and an interactive 41-week timeline effectively mitigates maternal anxiety and promotes consistent platform adherence. This research demonstrates that a service-oriented approach, combining Django, FastAPI, and Next.js, provides a robust, emotionally supportive, and clinically reliable framework for improving maternal health outcomes.

8. FUTURE SCOPE

Multilingual Support: Expanding the AI knowledge base to include regional languages and voice-activated assistance.
Predictive Analytics: Implementing machine learning models to identify potential high-risk pregnancy indicators based on symptom tracking data.

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