



AI-Enabled Intelligent Agent for Maternal Health Tracking in Tribal Regions: A Conceptual Framework

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Abstract

Maternal health is a crucial component of policy making and execution as it is closely associated with human capital of the country which ultimately contributes towards development of the country. Though the Maternal Mortality Ratio (MMR) in India is declining gradually, it still has not reached the targeted Sustainable Development Goals (SDG) defined by the UN which targets at reducing MMR less than 70 per 1,00,000 live births by the year 2030. In remote tribal areas, women face challenges in accessing maternal health care services. Difficult terrains, lack of infrastructure, socio-economic factors such as illiteracy, poverty and migration limit accessibility of maternal care to potential beneficiaries. To address the issue and reach out to underserved beneficiaries, the GOI has initiated various health programmes. Within the Primary Health System, Accredited Social Health Activists (ASHAs) are identified as primary point of contact for delivering maternal health services to the potential beneficiaries, especially in rural tribal areas. To enhance coverage and performance of healthcare services, technological advancement has been increasingly integrated into healthcare delivery. Since most of the mHealth tools are manual and rule based, their ability to provide intelligent, track real-time location of beneficiaries and provide decision support is limited. It also hampers monitoring of Antenatal Care Visits and vaccination schedules of the migrated mother. In the light of inadequacy of existing tools to provide proactive and intelligent maternal health tracking support in tribal areas, present study focuses on the designing of an AI-based intelligent agent which will efficiently manage the task of record keeping, tracking and monitoring enrolled beneficiaries, early identification of high risk pregnancies along with tracking of location of the beneficiary. The present study is exploratory in nature and adopts interdisciplinary approach. It integrates health and artificial intelligence and suggests a conceptual framework and system design for an AI-powered decision-support agent. It will assist frontline health workers and public health systems, specifically in tribal regions for effective delivery of maternal care services. The proposed AI agent will enhance effective provision of maternal health services by the government to the last-mile maternal healthcare delivery.

Key words: *AI in Public Health, Maternal Health Tracking, ASHA Workers, Tribal Health, Intelligent Agent*



Introduction:

Maternal health is a crucial component of policy making and execution as it is closely associated with human capital of the country which ultimately contributes towards development of the country. Easily accessible, affordable, respectful and high quality maternity healthcare is the basic right of every woman. According to WHO, the term maternal health includes the period during pregnancy (antenatal care), childbirth and the after delivery (postnatal) period. (World Health Organization, 2023) Due to personal, family, cultural and socio economic reasons, many women are deprived of basic maternal care. Many developing countries experience a comparatively high maternal mortality rate (MMR) which often signifies flaws in the healthcare system of a country. India being a signatory to the United Nations (UN) adopted 17 Sustainable Development Goals (SDGs) to be achieved by 2030, of which SDG 3.1 speaks about reducing MMR less than 70 by 2030. (United Nations, 2024)) Maternal health in India has been a serious concern for government and policy makers. With rigorous policies and execution India has witnessed gradually falling MMR from 130 in 2014 further reaching to 93 in 2019-21 (Office of the Registrar General & Census Commissioner, India, 2023) The public as well as private sector plays a crucial role in the provision of health care in India. Rural and remote tribal areas are mainly dependent on a three tier public health system for health care. Despite continuous efforts to address the challenges of maternal health care, women in tribal areas are still deprived of maternal health services and facing challenges in accessing the same.

The government has adopted various maternal health programmes to serve the needy and underserved sections of the society. Accredited Social Health Activists (ASHA) workers, ANM play crucial role and act as frontline workers to ensure the continuum of maternal healthcare services in tribal and remote regions of India. They serve as the first point of contact among the community and the public health system. Right from identifying pregnant women through screening, registration and meticulously monitoring Antenatal Care (ANC) schedules are prominent responsibilities of them. As frontline worker they bear responsibilities such as conducting household visits, keeping track of ANC visits and vaccinations, tracking high-risk pregnancies and providing essential health education like nutrition counselling and danger-sign awareness. The role of ASHA is crucial in tribal belts marked with geographical isolation, transportation barriers, and socio-cultural factors which limit access to maternal care. They thus serve as the backbone of maternal health tracking, but their ability to deliver these services effectively is constrained by substantial operational challenges.

Though digital recording is introduced, reliance on manually prepared paper-based records is evident. The limitations such as poor internet connectivity, low digital literacy, and device limitations further leads to weaken digital reporting. This highlight the need for an AI supported intelligent and user friendly digital support system for maternal care domain which is essential to overcome gaps in manual and conventional tools used by ASHA workers in tribal areas. With the AI supported agent, maintaining records such as ANC, delivery, PNC and vaccination will become easier. It will further provide assistance to health system particularly ASHA in providing decision support for high-risk pregnancies and function steadfastly in low-connectivity zones with the help of accurate data entry. At all levels of health system, the data can be accessed by integrating information across PHCs and district will ensure faster coordination and timely maternal care.

The present paper focuses on proposing framework of AI-powered intelligent agent which aim at strengthening maternal health continuum tracking in tribal regions. The study seeks to address long-standing operational challenges faced by ASHA workers such as paper-based documentation, missed follow-ups, and connectivity barrier by proposing a context-sensitive digital solution tailored to the realities of remote and underserved areas.

Problem Statement

Previous studies and the available information regarding the use of technology in maternal health care highlights the inadequacy of existing tools to provide proactive and intelligent maternal health tracking support specifically in tribal areas. When pregnant women migrate to another state or district, most of the time ASHA workers or any concerned health personnel are not informed formally. Moreover, when they migrate as labourers, they do not have any fixed settlements that can be traced by ASHAs with which the pregnant lady is registered. It poses difficulties to the health system to track the ANC and vaccination and checkups of the registered beneficiaries. Moreover, these migrant families keep on moving as and when they get employment opportunities. Due to this they may not get enough nutritious intake, vaccinations and rest which is required

during pregnancy. These factors collectively contribute to delayed intervention, poor pregnancy outcomes, and preventable maternal morbidity in tribal regions. Existing digital health tools fail to provide real-time, location-aware monitoring for such mobile populations and most of the time results in delayed interventions and increased risk of maternal complications. It underscores a critical need for an AI-powered intelligent agent capable of providing automated tracking, proactive alerts, and unremitting continuity of care, irrespective of geographic mobility. Such system will significantly result in strengthening of maternal health surveillance and improve outcomes for vulnerable tribal populations.

Review of Literature:

Choudhury, Asan, and Choudhury, (2021) in the study observed increasing use of mHealth applications in maternal health tracking in India. These apps aim to support frontline health workers such as ASHAs for rendering enhanced maternal care services. Interventions such as “Mobile for Mothers” (MfM) showed that mHealth tools markedly improved awareness and behaviors regarding maternal health particularly among tribal women. Chaudhary and Chaudhary, (2022) in the quasi-controlled study operated in Jharkhand involving ASHAs using the MfM app during home visits, showed improved awareness outcomes among pregnant women in tribal communities. Modi D. et.al, (2019) denotes that the ImTeCHO mHealth intervention in tribal areas of Gujarat which involved use of mobile phone-based job aids for ASHAs to track, schedule and monitor maternal and child health services led to higher coverage of key maternal and child health services compared with conventional practices. These observations underscore the role of digital tools as productive assistance for frontline workers ultimately enhancing supervision and real-time tracking of care delivery across the maternal health continuum. Further Khan M. (2022) in the study underscores on the increasing scope and need of digital decision support systems with artificial intelligence (AI) to strengthen maternal care services in low-resource settings. Mustafa M. et al (2025) in the study highlighted increasing research into voice-enabled AI systems which demonstrate the usefulness of multilingual automatic speech recognition and large-language models to generate structured electronic medical records ultimately raising flag clinical risks in low-resource environments. The research advocates adaptableness of AI powered framework to support maternal health workers and clinical decision-making.

The recent initiatives government of India also reveal shift toward AI-enhanced maternal health monitoring. The studies highlight the feasibility of digital mHealth platforms where ASHAs can find the tools as helpful for in improving maternal health consultations in rural communities. These interventions indicate the potential for mobile and digital systems to augment maternal health tracking in underserved regions, although systematic nationwide tracking systems remain limited in scope and coverage. Despite it, very few study speak about AI powered framework with embedded GPS for tracking of migrated beneficiaries to bring them under maternal care services for uninterrupted services.

Research Gap

Existing maternal health tracking systems in India lacks real-time monitoring and cannot proactively identify missed Antenatal Care Visits (ANC), delivery or PNC services status in tribal regions. Government is focusing on coming up with apps that can work efficiently. Current digital and mHealth tools do not track unnotified migration, leading to frequent loss to follow-up among tribal pregnant women. AI-based maternal health solutions exist globally, but evidence and application in low-resource tribal settings remain minimal. In urbanised areas of India such tools may function flawlessly but tribal areas are characterised by bottlenecks in infrastructure and health personnel. Use of WhatsApp group and shared google sheets are prominently used by ANM and ASHA for filling up the information of beneficiaries for further actions. No such system integrates risk prediction, migration detection, and intelligent alerts into one framework tailored for tribal communities. Therefore, a conceptual AI-enabled intelligent agent specifically designed for tribal maternal health tracking is missing in the existing literature

Objectives of the study:

- 1) To analyse the existing operational challenges in maternal health tracking in tribal regions.
- 2) To design an AI-powered intelligent agent for improving maternal health monitoring across ANC–delivery–PNC continuum.
- 3) To conceptually evaluate the feasibility and functional relevance of the proposed model within resource-limited settings.

Scope and Significance



Present study focuses on conceptualizing an AI-enabled intelligent agent designed to ensure continuous maternal health tracking among tribal women who frequently migrate across districts and states. It covers the entire maternal care continuum including ANC, child birth and postnatal by integrating ASHA/ ANM based data entry, device-generated location updates, and automated AI-driven alerts.

The significance of the proposed study lies in addressing a critical gap in maternal health service delivery in tribal regions of the country where migration interrupts continuity of care. By proposing an AI powered intelligent agent which is tailored for low-resource, high-mobility contexts, present study contributes to strengthening health system responsiveness and reducing preventable maternal risks. The proposed framework has potential policy relevance for integrating AI solutions with national health platforms and guiding future empirical research and technological innovation in maternal health surveillance.

Since the study is conceptual, it does not include testing of the proposed system, or evaluation of its real-world performance. The framework is based on existing literature and may not capture region-specific operational challenges. The study assumes the availability of basic digital infrastructure, which may vary across tribal settings. It does not include implementation or testing of the frame work in real-world settings.

Methodology

This study adopts a conceptual and exploratory research design aiming at developing a conceptual frame work of AI enabled intelligent agent for maternal health tracking in tribal communities. It synthesizes existing evidences of currently used maternal health tracking system, identifies the system gaps, and propose a framework.

Primary and secondary data is used for the study. The framework is an outcome of through interactions with frontline health workers operating in tribal regions such as ASHA, ANM and LHV. The secondary sources including government reports on maternal health, digital health guidelines, NFHS datasets, National Health Mission documents, research articles, and published studies on mHealth and AI-based interventions were refereed for framing the study. WHO digital health frameworks, peer-reviewed journals, and credible news reports were also refereed for secondary data.

Proposed AI-Powered Intelligent Agent

In order to address the challenges confronted by frontline health system workers an AI powered intelligent agent can assist. The proposed agent can compile the data fed in the system and based on it can generate various alerts and suggest pattern based remedial measures. The ASHA workers, THO and DHO can make use of the agent for maintaining paperless records of beneficiaries which will be a click away and can be accessed anywhere. The system will include an inbuilt tracking mechanism to monitor the location of beneficiaries and identify cases where contact has been lost. In the event of any missed visits or delays, the agent will automatically flag the case and notify the concerned health worker. The beneficiaries also will get notifications and reminders, alerts about their scheduled ANC and vaccinations.

Conceptual Framework for the Proposed AI System

Tribal regions are mostly located in difficult terrains with low infrastructure. People from these regions mostly live in scattered settlements and have unstable source of livelihood which increases comparatively higher dependence on seasonal employment opportunities. In order to earn bread and butter these families migrate to nearby talukas, districts and even states. This leads to missed ANC visits and vaccinations of pregnant women. Most of such migrations are not notified to concerned PHCs which leaves them out of the tracking of health workers especially ASHA and AWW. Frequently occurring migrations one of the crucial factors that disrupt continuous maternal care. Such unreported movement to health workers, cause gaps in ANC, PNC, and referral follow-up. For follow ups and reporting purpose present health system in the country highly depend on frontline workers such as ASHA, AWW, ANM.

Proposed AI agent will assist these frontline health service providers in tribal areas. The framework assumes that ASHAs can collect basic data and women can receive simple reminders through mobile phones. Technologically, it assumes only basic mobile access, not full internet availability. The core requirement is to track ANC, delivery, and PNC milestones without missing any woman.

Proposed AI agent will identify high-risk conditions based on the symptoms, status of the maternal care acquired or previous complications, if any. It will also detect changes in location that indicate migration or movement. AI decision logic includes



generating alerts for missed services or danger signs. It will predict risk levels and trigger follow-up or referral actions when migration or complications are likely.

Home visits and screening is the core function of ASHA workers. Through this they gather data of conceived pregnancies and get the potential beneficiary registered with health system and track their further pregnancy for bringing them in maternal care services provided by government. The proposed framework proposes to use the information collected by ASHA workers in a more organized way to ensure pregnant women in tribal areas receive timely care. Through this basic inputs by ASHAs such as status of ANC visits, symptoms, and movement patterns will be recorded in the system and will be processed for further use. By giving early warnings about missed services, possible risks, or unreported migration AI agent will reduce manual tracking. By combining these elements, the framework aims to improve continuity of care and reduce delays in identifying complications, especially in communities where mobility and distance often interrupt regular maternal services.

Components of the Framework

The proposed framework will have following components.

A) Community Interface (ASHA, ANM)

Beginning with the community level where ASHA workers, ANMs, and pregnant women interact, ASHAs collect routine information during home visits and ANMs provide clinical support. This interface forms the foundation of the system.

B) Data Acquisition Layer

While interacting with potential beneficiaries ASHA workers will gather information such as missed periods, ANC status, nutrition intake, symptoms, and basic location changes which is required for further processing will be recorded through a simple mobile interface. At this level the focus is in collecting essential details already part of routine maternal health work. ASHA with their routine visits can gather and feed the information, hence additional skills or technical knowledge are not required.

C) AI Processing Layer

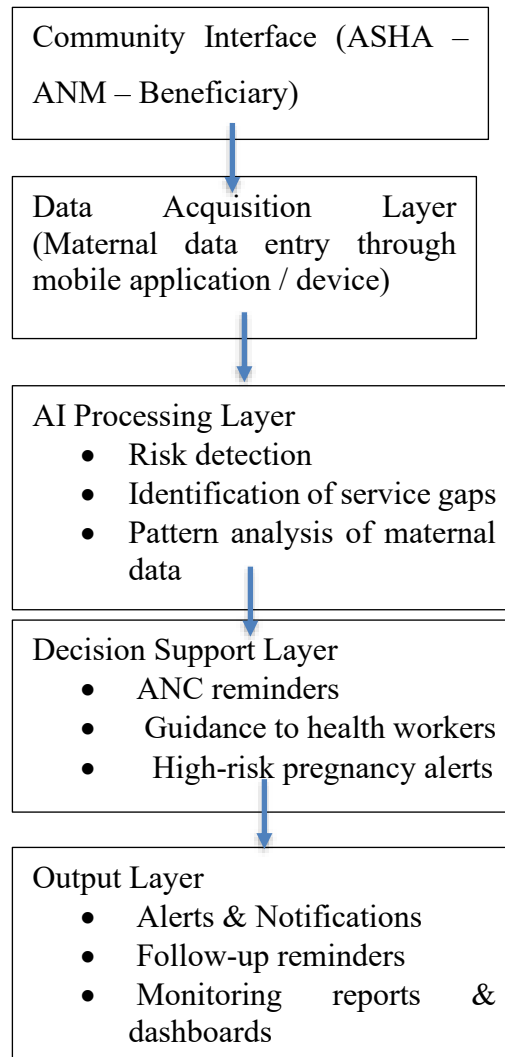
Based on the data entry, the system will review it to identify the gaps or potential risks involved in the cases. It will check for missed ANC visits, delayed PNC, warning signs, or unusual movement patterns. The AI component will analyse and interpret the information and identify areas that may need attention.

D) Decision Support Layer

Based on the analysis, the system will formulate interpretation and practical suggestions for health workers. This will comprise reminders to conduct follow-up visits, flags for high-risk cases, or guidance on when referral may be necessary. This layer aims to support the judgement of ASHAs and ANMs by offering timely insights.

E) Output Layer

At this level alerts, reminders, notifications about missed services, location, possible migration, or symptoms that require attention and short summaries that can be used by ASHA workers, ANMs, and PHC staff will be generated. It will help to ensure that no woman is overlooked and necessary actions are taken promptly. In case of unnotified migration, with the help of GPS tracking the location of the pregnant lady will be traced and health system will reach out to her for further medical attention and maternal care.



System Architecture & Functional Design

Community Interface
↓
Data Acquisition Layer
↓
AI Processing Layer
↓
Decision Support Layer
↓
Output Layer

Module Descriptions:

The modules required for the proposed AI powered intelligent agent can be described as follows.

A) Registration & Profile Module:



This module will serve as the digital record of the beneficiaries. All details such as name of the mother, age, address / village, contact information, pregnancy details such as previous pregnancies, delivery, miscarriages, health history and other required information will be entered by ASHA/ ANM.

B) GPS-enabled Migration Tracker:

GPS tracking system will locate the location of migrating mothers so that nearest PHC/ sub center can reach out her and she will receive continuous care.

C) ANC, Delivery, PNC Milestone Tracker:

This module will track ANC, vaccination, delivery and PNC records of the registered mothers. It will ensure that neither of the important component of maternal care is missed by the beneficiary.

D) AI Risk Scoring Engine:

Based on entered data and history of the beneficiary, the AI will identify the risk factors and other health related alerts will be generated by it.

E) Notification & Alert System:

Automatic reminders and alerts will be sent to the beneficiaries about upcoming ANC, vaccinations, date of delivery. ASHA, ANM and THO will also receive consolidated notifications which will help them to track the progress of maternal care of the registered beneficiaries. They will also get weekly or monthly records of the mothers due for ANC, vaccination delivery etc.

F) Dashboard for Supervisors:

This module will provide real time monitoring of health administration. Details such as number of registered mothers, high-risk pregnancies, missed ANC visits, vaccinations and cases of migrations will be available to the supervisors such as Taluka Health Officer, District Health Officer which will help them to get umbrella view of the overall status of maternal health in the region.

Considerations for implementation:

Implementation of the proposed AI powered agent will be based on certain technical and functional considerations. Offline functionality, data syncing, privacy and security of data, integration with govt systems such as RCH Portal etc, along with resource requirements, training needs of personnel will have to be addressed. Alignment of the proposed framework at policy level such as JSY, JSSK, RMNCH+A will have to be fulfilled. Along with it for effective barriers to Implementation in Tribal Areas.

Conclusion

Based on the data fed by frontline health personnel, the proposed AI powered agent will function. Along with record keeping the agent will generate alerts, notification about ANC, vaccination, delivery dates. It will also process the information to find out patterns, risk factors and necessary alerts for health system. Moreover, with the help of embedded GPS the tracking of location of the mother will be facilitated. In case of consistently missing follow up of registered mother, the ASHA with ANM will inform such cases to THO, and THO further report to DHO. By tracing the location, the nearest PHC health personnel/ AWW/ ASHA will be informed about it and they will reach out to the mother for further maternal care.

Such initiative will be helpful in enhancing maternal health conditions in the country especially in tribal regions.

Since the proposed AI agent is a conceptual framework, based on it experts in AI can develop it further and can be tested for practical application. This framework can be helpful to policymakers and technology developers in designing innovative digital solutions to strengthen the procedure of maternal health tracking which ultimately will help in enhancing the effectiveness of prevailing maternal health programs such as Janani Suraksha Yojana and Janani Shishu Suraksha Karyakram.



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