

IOT In Maternity Care Based on Smart Environment Monitoring (Sem) Technology

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ABSTRACT

Maternal healthcare requires timely observation, reliable communication, and coordinated responses across antenatal, intrapartum, and postnatal care. Internet of Things (IoT) systems can connect physiological sensors, environmental devices, mobile applications, and clinical dashboards to support this continuity. This article proposes a conceptual IoT-enabled maternity-care framework using Smart Environment Monitoring (SEM), interpreted here as continuous sensing of relevant environmental conditions in maternity spaces and integration with maternal monitoring workflows. The framework combines environmental sensing (temperature, humidity, air quality and room conditions) with approved maternal and fetal monitoring devices, secure connectivity, alert management, and clinician oversight. A narrative review of relevant digital-health guidance and research on maternal wearable sensors informs the proposed architecture. Potential benefits include improved visibility of environmental risks, more structured documentation, and faster escalation when configured thresholds are crossed. However, IoT alerts are not diagnoses, consumer devices may be inaccurate, and technology cannot replace skilled assessment or emergency obstetric services. Privacy, cybersecurity, connectivity, staff workload, equity, and clinical validation are central implementation requirements. The article concludes with a phased evaluation plan and measurable outcomes for future pilot studies. No new clinical data are reported; the framework is a research proposal requiring validation.

Keywords: Internet of Things; maternity care; Smart Environment Monitoring; maternal health; wearable sensors; remote monitoring; digital health

1. INTRODUCTION

Quality maternity care depends on recognizing changing maternal and fetal conditions, maintaining a safe care environment, and ensuring that information reaches the right professional at the right time. Conventional care relies on scheduled observations, clinical equipment, paper or electronic records, and direct communication among staff. These processes remain essential, but information may be fragmented across locations and time points,

particularly when a pregnant woman receives some care at home and some at a health facility.

The Internet of Things (IoT) refers to connected physical devices that collect and exchange data through networks. In maternity services, IoT may link approved vital-sign monitors, environmental sensors, mobile applications, and clinical information systems. Smart Environment Monitoring (SEM), as used in this article, refers to monitoring conditions in maternity wards, labour rooms, recovery areas,

and selected home-care settings. It is not a universally standardized clinical acronym; the proposed use is therefore explicitly defined for this conceptual study.

Research on wearable sensors identifies potential applications in monitoring maternal physiology, fetal heart activity, movement, and physical activity, while also noting that many systems have been tested under controlled conditions and require further real-world evaluation [1]. The World Health Organization (WHO) emphasizes that digital interventions should be assessed for benefits, harms, feasibility, resource use, acceptability, and equity, and should not be treated as substitutes for functioning health systems [2].

2. Aim and Objectives

The aim is to propose a safe, practical architecture for integrating IoT and SEM into maternity-care workflows. The objectives are to: (i) identify appropriate sensing and connectivity layers; (ii) describe how data may support clinical review and environmental safety; (iii) identify ethical, technical, and operational risks; and (iv) propose an evaluation plan for a future pilot implementation.

3. Review Approach

This article uses a focused narrative review and conceptual systems-design approach. It draws on a peer-reviewed systematic review of

maternal wearable sensors and WHO guidance on digital health interventions. The purpose is to synthesize design considerations rather than claim a comprehensive systematic search. No participants were recruited, no patient data were collected, and no intervention outcomes were measured. Accordingly, the architecture and expected benefits presented below are proposals, not experimentally demonstrated findings.

4. Proposed IoT–SEM Framework for Maternity Care

4.1 Sensing layer

The sensing layer can include: (a) environmental sensors for room temperature, relative humidity, ventilation-related indicators or carbon dioxide as a ventilation proxy, and selected air-quality parameters; (b) facility-approved maternal devices for blood pressure, pulse, oxygen saturation, and temperature where clinically indicated; and (c) fetal monitoring equipment prescribed and interpreted by qualified staff. Device selection must follow clinical guidance, intended use, calibration requirements, and local regulation. Consumer wearables should not be assumed to provide clinically reliable maternal or fetal measurements.

4.2 Connectivity and edge processing

Sensors may communicate through Bluetooth Low Energy, Wi-Fi, or other locally approved protocols to a gateway or secure mobile device. Edge processing can check device status, timestamps, missing readings, and basic plausibility before transmitting data. A local buffer is important where internet access is intermittent. The system should clearly distinguish a missing signal, a technical fault, and a measurement that crosses a clinical threshold.

4.3 Data platform and clinical dashboard

A secure platform can organize observations by patient identifier, time, device, and care episode. The dashboard should present trends, measurement provenance, device status, and acknowledgement of alerts rather than simply displaying large volumes of raw data. Integration with electronic health records should use standardized interfaces where available and avoid unnecessary duplicate entry. Role-based access should ensure that staff see only information needed for their duties.

4.4 Alert and response workflow

Alerts should be designed with maternity clinicians and mapped to local protocols. An alert may prompt a midwife or clinician to verify a reading, assess symptoms, repeat a measurement, or escalate according to an

approved pathway. The system must not autonomously diagnose an obstetric emergency or delay direct clinical contact. High-priority alerts need clear ownership, acknowledgement, escalation after non-response, and a downtime procedure.

4.5 SEM environmental monitoring

Environmental readings can help facilities identify uncomfortable or potentially unsuitable conditions and document whether corrective action was taken. For example, a temperature or ventilation-related threshold may trigger a facilities-management notification. Environmental measurements are contextual indicators, not direct proof of infection risk or clinical harm. Thresholds should be set by qualified facility teams according to applicable standards and local conditions.

5. Example Use Cases

- Antenatal follow-up: scheduled home readings from approved devices are transmitted to a care team for review, with reminders and clear instructions about symptoms requiring urgent care.
- Labour and delivery: clinical monitoring remains under direct professional supervision; IoT may support equipment-status checks, timestamped documentation, and controlled transmission of readings.

- Postnatal observation: selected maternal observations and follow-up reminders may support continuity after discharge, provided there is a staffed process to review incoming information.
- Maternity-unit environment: temperature, humidity, and selected ventilation or air-quality indicators are trended to support maintenance and environmental quality management.
- Equipment and workflow: connected devices may report battery, connectivity, calibration-due, or maintenance status to reduce unnoticed equipment downtime.

6. Benefits and Limitations

Potential benefits include more continuous visibility of selected observations, earlier recognition of data requiring review, better documentation, improved coordination between home and facility, and evidence to support environmental maintenance. Remote monitoring may also reduce avoidable travel for some routine follow-up, although suitability depends on clinical risk, access, and local service capacity.

Important limitations remain. Sensor readings may be affected by movement, placement, device quality, or connectivity. False alarms can create alert fatigue, while missed or delayed data can create false reassurance. Environmental monitoring does not replace cleaning, infection-

prevention practices, ventilation engineering, or clinical assessment. A digital system may widen inequity if women lack smartphones, reliable networks, language-appropriate interfaces, digital literacy, or private space. Evidence of technical feasibility should not be confused with evidence that a system improves maternal or neonatal outcomes.

7. Safety, Privacy, and Implementation Requirements

The system should follow data minimization, encryption in transit and at rest, strong authentication, role-based access, audit logging, secure updates, and a documented incident-response process. Consent and clear information about data use are important, particularly for home monitoring. Data retention, access by family members, cross-border transfer, and secondary use should be governed by applicable law and institutional policy. Identifiable maternal health information should not be sent through unsecured messaging channels.

Clinical governance should define who reviews each data stream, during which hours, how quickly alerts are handled, and what happens when a reading is missing. Staff training, maintenance, device validation, accessibility, language support, and procurement planning should be included from the beginning. The service must have a safe non-digital fallback. WHO guidance supports digital interventions

only with attention to implementation context, privacy, workforce roles, and the health system's capacity to respond [2].

8. Proposed Evaluation Plan

A pilot should begin with usability and technical testing in a limited setting before any expansion.

The evaluation should be approved by an appropriate ethics committee when research involving people or identifiable data is planned. A feasible evaluation framework is shown below.

Domain	Example indicator	Purpose
Technical reliability	Data transmission success; uptime; sensor failure rate	Assess operational performance
Alert performance	Alert acknowledgement time; false-alert rate; missed events identified in audit	Assess safety and workload
Clinical workflow	Time spent reviewing dashboard; completeness of documentation	Assess integration into care
User experience	Maternal and staff usability, trust, and acceptability	Identify barriers and design improvements
Equity and access	Participation and completion by connectivity, language, and access needs	Check for unequal reach
Resource use	Device, connectivity, training, and maintenance costs	Inform feasibility and sustainability

Before implementation, clinicians should define intended use, inclusion criteria, thresholds, escalation pathways, and stopping rules. The pilot should report adverse events and unintended consequences as well as usability and technical metrics. A later controlled evaluation would be needed to determine whether the system improves outcomes or service efficiency.

9. DISCUSSION

IoT and SEM can be considered complementary layers within maternity services: SEM provides contextual information about the care environment, while clinically approved monitoring devices provide patient-specific measurements. Their value depends less on the number of connected sensors than on data quality, interpretation, and a reliable response pathway. The most appropriate design is therefore a human-centred system that supports,

rather than replaces, midwives, obstetricians, nurses, and facility teams.

For resource-constrained settings, implementation should prioritize a small set of actionable measurements, offline capability, low-cost maintenance, and integration with existing maternal-health services. Technology selection should be guided by a locally defined problem and evidence of performance rather than novelty. The systematic review by Alim and Imtiaz highlights the need for testing wearable maternal monitoring beyond controlled environments [1]. A staged approach—co-design, bench testing, supervised pilot, safety review, and outcome evaluation—can reduce risk and help determine whether the approach is worth scaling.

10. CONCLUSION

This article proposes an IoT-enabled maternity-care framework that combines Smart Environment Monitoring with clinically governed maternal monitoring and secure data workflows. Potential applications include environmental quality tracking, structured observation transfer, equipment-status monitoring, and selected remote follow-up. These benefits remain conditional on device accuracy, clinical oversight, privacy protection, staff capacity, connectivity, and equitable access. The framework should be treated as a research proposal rather than a validated clinical solution. Future work should evaluate feasibility, safety, acceptability, cost, and patient-centred outcomes before wider adoption.

REFERENCES

- [1] Alim, A., & Imtiaz, M. H. (2023). Wearable Sensors for the Monitoring of Maternal Health—A Systematic Review. *Sensors*, 23(5), 2411. <https://doi.org/10.3390/s23052411>
- [2] World Health Organization. (2019). WHO guideline: Recommendations on digital interventions for health system strengthening. Geneva: WHO. <https://www.who.int/publications/i/item/9789241550505>
- [3] World Health Organization. (2019). WHO guideline: Recommendations on digital interventions for health system strengthening—Executive summary. <https://www.who.int/publications/i/item/WHO-RHR-19.8>
- [4] Stricker, K., et al. (2025). Continuous remote home monitoring solutions for mother and fetus: A scoping review. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. <https://pubmed.ncbi.nlm.nih.gov/39705987/>