

# Nyano Kakh (Baby Monitoring Blanket): An IoT-Based Infant Care System

## Minimum Viable Product

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**Abstract** – Neonatal care is a critical component of infant health, particularly in developing regions where access to medical technology is limited. "Nyano Kakh" (meaning "Warm Blanket" in Nepali) is an IoT-based baby monitoring system designed to monitor vital environmental conditions surrounding a newborn, such as temperature, humidity, and movement. This smart blanket system utilizes a network of low-cost sensors integrated into a comfortable and child-safe textile to ensure the well-being of infants, especially in rural or low-resource settings.

This system gathers real-time data and transmits it via Wi-Fi or Bluetooth to caregivers' or medical personnel's smartphones. Alerts are triggered if values go beyond safe thresholds, helping to prevent hypothermia, overheating, or prolonged immobility. Nyano Kakh aims to serve as an affordable, practical solution for baby monitoring in both domestic and clinical environments.

**Keywords:** IoT, Baby Monitoring, Embedded Systems, Smart Blanket, Arduino, Infant Safety, Real-Time Alerts, Nyano Kakh

## I. Introduction

### A. The Need for Infant Health Monitoring

Globally, neonatal hypothermia and lack of adequate monitoring systems contribute significantly to infant morbidity and mortality, especially in low-income countries. According to the World Health Organization, many infant deaths could be prevented with timely detection and appropriate responses. In Nepal, where access to neonatal ICUs is limited, there is an urgent need for alternative monitoring solutions that are affordable and accessible to all.

The first few weeks of an infant's life are critical, as newborns are particularly vulnerable to environmental changes. Their immature thermoregulatory systems make them susceptible to hypothermia, while their inability to communicate distress makes continuous monitoring essential. Traditional monitoring methods often require expensive equipment and trained personnel, making them inaccessible in many developing regions.

## **B. Problem Statement**

Infants, particularly newborns, are highly vulnerable to temperature fluctuations, improper sleep postures, and unnoticed health risks. Traditional baby monitors are either too expensive or lack essential features such as temperature control and real-time notifications. There is no affordable system that combines temperature, humidity, and motion sensing in a safe, textile-based solution.

The current challenges in infant monitoring include:

- High cost of commercial baby monitors: Most advanced monitoring systems are prohibitively expensive for low-income families
- Limited accessibility in rural areas: Lack of reliable internet connectivity and technical support
- Complexity of existing systems: Many monitors require technical expertise to operate effectively
- Safety concerns: Some monitors use materials or components that may not be safe for direct infant contact
- Limited functionality: Basic monitors often lack comprehensive environmental monitoring

## **C. Introducing Nyano Kakh – Baby Monitoring Blanket**

Addressing the challenges faced in neonatal care especially in rural and under-resourced regions Nyano Kakh is an IoT-based smart baby monitoring blanket designed to improve infant safety through real-time environmental monitoring. This project aims to provide a cost-effective, portable, and non-invasive solution that continuously observes vital factors around the baby, such as temperature, humidity, and movement, helping caregivers take timely actions before conditions become dangerous.

Nyano Kakh is built with smart sensors integrated into a soft, baby-safe textile, allowing it to function both as a comfortable blanket and a smart health monitoring device. The system detects abnormal conditions like hypothermia, overheating, or prolonged immobility and instantly alerts caregivers via mobile notifications or local buzzers.

### **Core Functionalities**

Nyano Kakh currently features two core functionalities:

1. Real-Time Environmental Monitoring: The smart blanket continuously collects temperature, humidity, and motion data using DHT sensors and motion detectors. These readings are processed through a microcontroller (e.g., ESP8266 or ESP32) and transmitted to a mobile application or cloud dashboard. If any readings fall outside the safe threshold, an immediate alert is triggered to ensure rapid intervention.
2. Caregiver Notification and Alerts System: The system can send alerts via mobile app and optionally through email or SMS if internet connectivity is available. These alerts include personalized messages such as:
  - "The temperature around the baby is too low!"
  - "No movement detected for 20 minutes!"
3. This two-way notification mechanism not only helps prevent health risks but also builds trust and reliability in the system by ensuring that caregivers are always informed.

By focusing on affordability, usability, and safety, Nyano Kakh stands as a reliable alternative to expensive neonatal monitoring devices, aiming to bring essential baby care technology to every household regardless of financial or geographical barriers.

## **II. Objectives**

The primary objectives of this project are:

- To design and develop a cost-effective, sensor-embedded smart blanket for infant monitoring that can be manufactured and distributed at scale in developing regions
- To implement real-time data monitoring and alert mechanisms using IoT technologies that provide immediate notifications to caregivers
- To enhance neonatal care at home and in rural clinics by providing reliable, continuous monitoring that doesn't require constant human supervision
- To ensure the comfort and safety of infants through a textile-safe and flexible product that meets international safety standards for infant products
- To create a scalable solution that can be adapted for different environments and extended with additional monitoring capabilities
- To validate the system's effectiveness through comprehensive testing and user feedback collection

## **III. Literature Review**

### **A. Background Research on IoT in Baby Care**

Many babies, especially newborns, are at risk of getting sick due to cold temperatures, poor sleep posture, or being left unattended for too long. Research shows that using IoT (Internet of Things) technology can help keep babies safe by constantly checking their environment. Smart devices with sensors can watch things like temperature, humidity, and movement, and alert parents if anything is wrong.

The integration of IoT in healthcare has shown significant promise in improving patient outcomes through continuous monitoring and early intervention. In neonatal care, IoT applications have been primarily focused on hospital settings, where complex monitoring equipment is used to track vital signs and environmental conditions. However, the application of IoT technology in home-based infant care, particularly through textile-integrated solutions, represents a relatively new and growing field.

IoT is already being used in hospitals and homes to help monitor patients, but using it in baby blankets is still a new and growing idea. The concept of "smart textiles" or "e-textiles" has gained traction in recent years, with researchers exploring ways to embed sensors and electronics into fabric materials without compromising comfort or safety.

### **B. Current Trends**

Today, some baby monitors use wearables like socks or belts to track a baby's health. These are smart but usually very expensive and not suitable for rural or low-income areas. More recently, developers are using mobile apps, Wi-Fi modules (like ESP32), and cloud platforms like firebase to build simple baby care systems that alert parents instantly.

Current market trends include:

- Wearable baby monitors: Devices like smart socks and chest bands that monitor heart rate and breathing
- Video monitoring systems: Advanced cameras with AI-powered analysis for sleep pattern recognition
- Environmental monitors: Standalone devices that track room temperature, humidity, and air quality
- Smartphone integration: Apps that consolidate data from multiple sensors and provide analytics

Soft, safe materials with built-in sensors are becoming popular because they don't disturb the baby's comfort. The focus on user experience has led to the development of more intuitive interfaces and simplified setup processes.

## C. Future Trends

In the future, baby monitoring systems like Nyano Kakh could include more advanced features. AI with IoT can help detect unusual patterns and give early warnings. Wireless charging and better mobile apps will make the system more user-friendly. Making the blanket washable with detachable sensors can also improve hygiene and safety.

## D. Research Gap

Most baby monitors today are too costly, focus only on audio or video, and are not suitable for rural areas with poor internet. Nyano Kakh fills this gap by offering a low-cost, easy-to-use device that monitors temperature, humidity, and motion. However, more research is needed to make the sensors more durable, wireless, and washable for long-term use.

## E. Critical Evaluation

Nyano Kakh is a smart and simple tool to improve baby care in low-resource areas. Still, it needs a longer battery life, offline functionality, user training, and better data privacy to be fully reliable and safe.

## III. MINIMUM VIABLE PRODUCT (MVP)

### A. Significance of Minimum Viable Product (MVP) for *Nyano Kakh*

Developing a Minimum Viable Product (MVP) for *Nyano Kakh* means creating a basic, working version of the baby monitoring system that includes only the core features needed for early testing and feedback. This approach brings several key advantages:

- Focuses on the main goal : Ensures the device can monitor a baby's safety through key sensors like temperature, humidity, and motion.

- Speeds up testing : Allows the team to quickly share the product with real users (such as caregivers and health workers) to gather valuable feedback.
- Supports step-by-step improvement : Based on real-world use, the product can be improved gradually to better meet user needs.
- Reduces cost and risk : Prevents wasting time and money on features that may not be necessary or useful in early stages.
- Improves understanding of user behavior : Helps the team learn how caregivers interact with the device and mobile app, leading to better design and usability.

## B. MVP Canvas

NYANO KAKH[Smart baby monitoring Blanket]					
Problem	Solution	Channels	Cost Structure	Customer Segment	
<ul style="list-style-type: none"> <li>Parents anxious about their baby's health and safety while sleeping.</li> <li>There's limited access to affordable and non-intrusive baby monitoring tools in Nepal.</li> <li>Tracking vital signs like heart rate and temperature usually requires hospital-grade equipment.</li> </ul>	<ul style="list-style-type: none"> <li>Smart blanket prototype with sensors for temperature and heart rate</li> <li>Basic mobile app to show real-time baby health info</li> <li>Pilot launch with 10–20 families for testing and feedback</li> </ul>	<ul style="list-style-type: none"> <li>Instagram and TikTok parenting content</li> <li>Word-of-mouth via pediatricians</li> <li>Facebook parenting groups and online communities</li> </ul>	<ul style="list-style-type: none"> <li>Blanket prototyping and manufacturing</li> <li>App development (basic version)</li> <li>Marketing (social media, pediatrician outreach)</li> </ul>	<ul style="list-style-type: none"> <li>New parents and caregivers in urban areas</li> <li>Gift-buyers (grandparents, relatives)</li> <li>Health-conscious, tech-savvy parents</li> </ul>	
Key Metrics		Unique Value Proposition		Revenue Stream (for MVP stage)	Early Adopters
<ul style="list-style-type: none"> <li>Number of blankets sold or pre-ordered</li> <li>App engagement (daily active users, alert response rate)</li> <li>User satisfaction and testimonials</li> <li>Rate of repeat or referral customers</li> </ul>		<ul style="list-style-type: none"> <li>A cozy baby blanket that quietly monitors your baby's vital signs while they sleep</li> <li>Mobile alerts give parents peace of mind</li> </ul>		<ul style="list-style-type: none"> <li>Direct blanket sales (bundle with app)</li> <li>Future upgrades for app features (e.g., insights, export reports)</li> </ul>	<ul style="list-style-type: none"> <li>Parents in Kathmandu with newborns</li> <li>Members of parenting groups on Facebook/Instagram</li> <li>Parents already using baby gadgets (e.g., bottle warmers, cameras)</li> </ul>

Fig1: MVP Canvas

## **C. Hardware and Software Required**

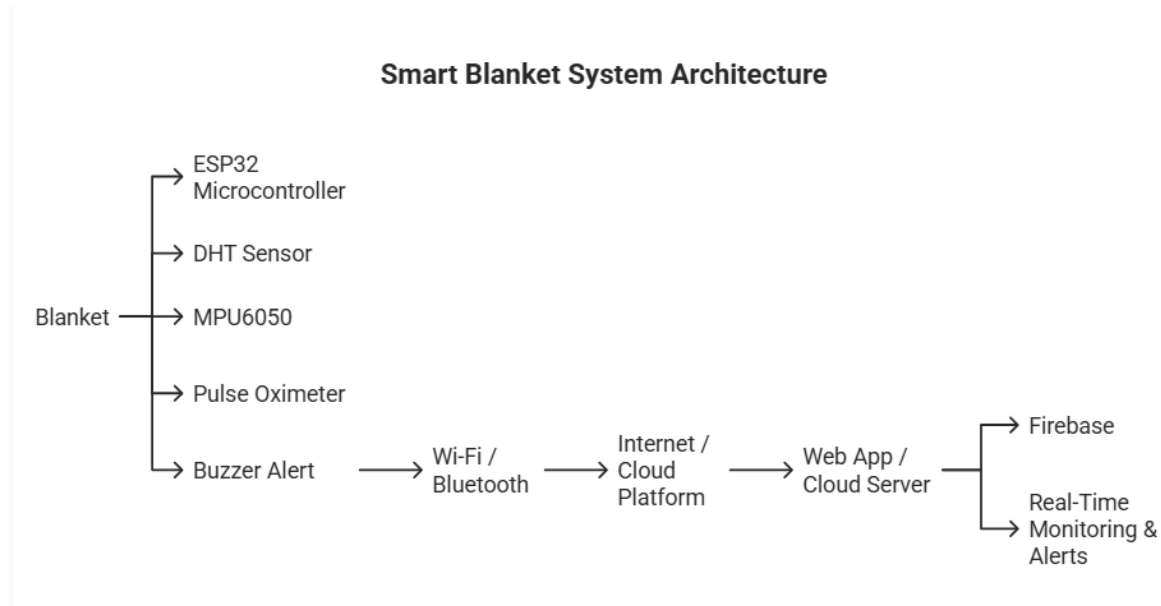
### **1) Hardware Required**

- ESP32 Microcontroller: A small, Wi-Fi and Bluetooth-enabled board that collects data from sensors and sends it to the mobile app or cloud.
- DHT11/DHT22 Sensor: Measures the temperature and humidity around the baby.
- Pulse Oximeter Sensor: Measures the baby's oxygen level ( $SpO_2$ ) and heart rate to ensure safe breathing and health.
- Buzzer: Sounds an alert if something is wrong, like unsafe temperature, low oxygen, or no movement.
- Battery Pack: Powers the whole system so it can work without needing to be plugged in.
- Soft Blanket Material: Safe and comfortable fabric where the sensors are carefully placed.

### **2) Software Required**

- Arduino IDE: A software tool used to write and upload the code into the ESP32 microcontroller.
- Firebase: Online platforms that store sensor data and send alerts to the web app.
- HTTP Protocol: Used by the ESP32 to send data to the internet or cloud platform.

## **IV. CLIENT-SERVER ARCHITECTURE**



*Fig2: Client-Server architecture illustration*

#### **Client (Sensor Side):**

The smart baby blanket is equipped with an ESP32 microcontroller connected to sensors like temperature, motion, and humidity. These sensors continuously monitor the baby's environment and activity.

#### **Server (Cloud Side):**

The ESP32 sends sensor data over Wi-Fi to a cloud platform such as Firebase or Blynk. The server receives and processes this data to detect any abnormal conditions .

#### **User Interface ( App):**

Caregivers access real-time data through a web app connected to the cloud. If any values go beyond the safe range, the app immediately sends alerts. A local buzzer attached to the blanket also provides instant warnings, ensuring safety even during internet outages.

## **V. PRODUCT PROTOTYPE**

The first version of Nyano Kakh was built using an ESP32 microcontroller, a DHT11 temperature and humidity sensor, Pulse Oximeter Sensor, and a soft fabric base to make it baby-friendly. This prototype helped us test real-time temperature and we were able to send notifications to the caregiver's phone using the web app through Firebase. The blanket was also tested for comfort and usability to ensure it is safe and suitable for babies.

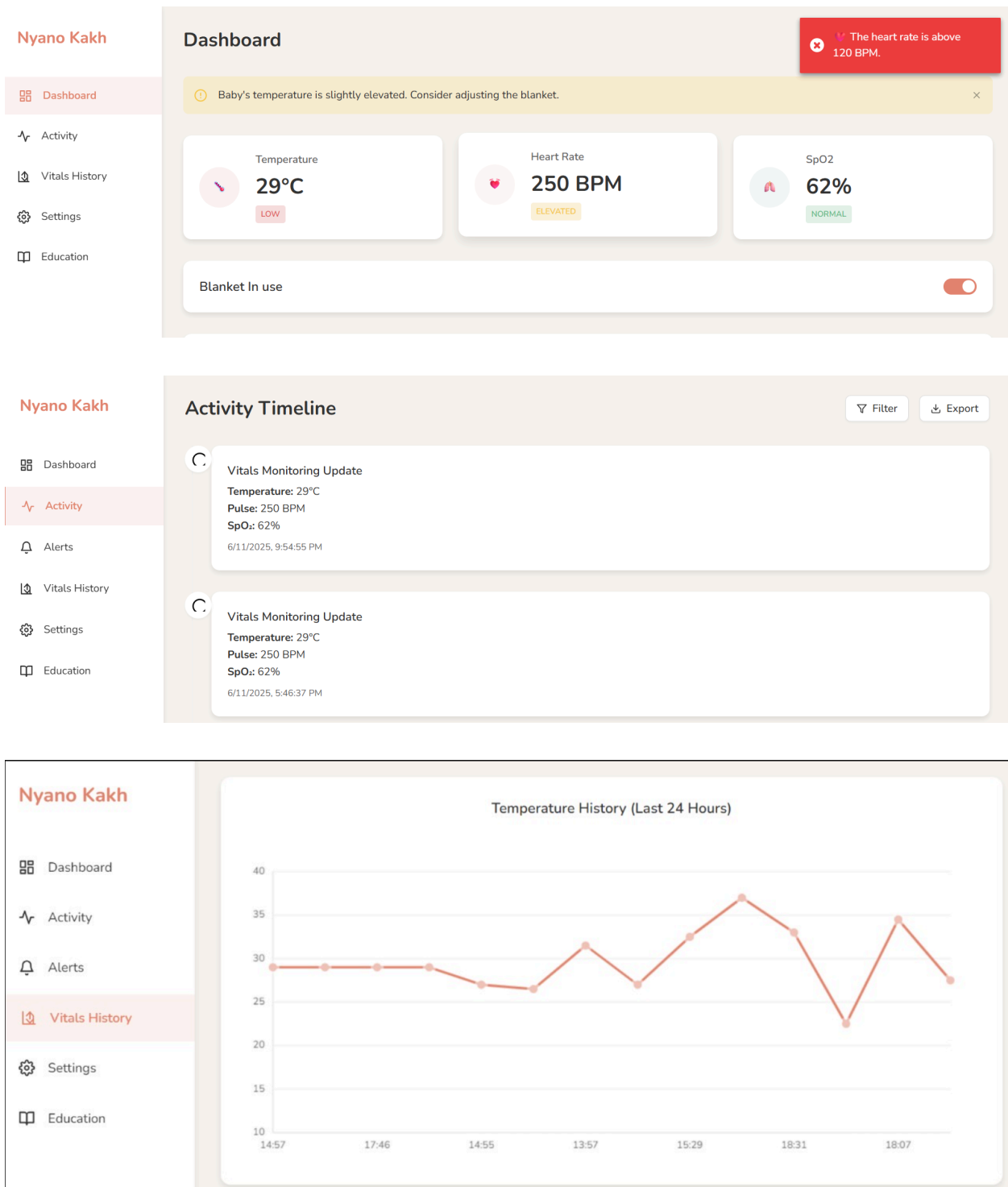
To support the prototype, we also created a Tinkercad simulation using virtual components like Arduino, DHT11, and motion sensors. This helped us test the circuit design and logic before building the real hardware setup.





User Dashboard (Web App View)

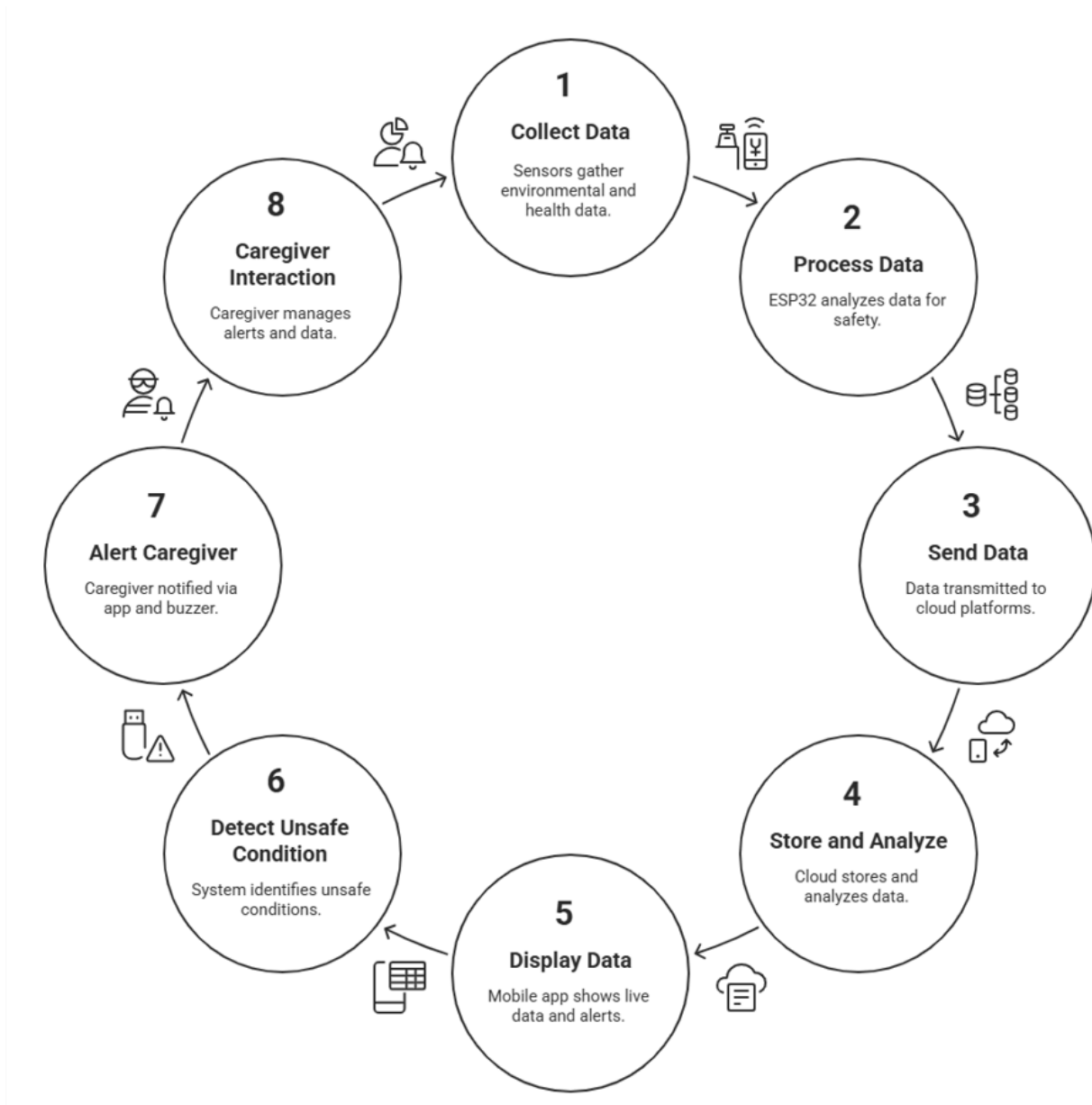
To make monitoring easy, the caregiver can access a web app dashboard that shows live data from the blanket, including current temperature and humidity, baby movement status, and alert indicators.



*Fig4: Dashboard Interface*

The dashboard provides a simple and user-friendly interface, allowing caregivers to stay informed and respond quickly if needed.

## VII. WORKING MECHANISM



*Fig5: Workflow of Nyano Kakh*

Once the Nyano Kakh system is activated, its built-in sensors (DHT11, MPU6050, and Pulse Oximeter) continuously monitor the baby's temperature, humidity, movement, and heartbeat. This data is processed by the ESP32 microcontroller, which evaluates whether the readings fall within the defined safe ranges.

If any abnormal condition is detected such as low temperature or lack of motion the system immediately activates a buzzer on the blanket and sends the data wirelessly to the cloud platform.

The cloud then updates the connected mobile application in real time. The caregiver can view all live sensor data, receive alert notifications, and interact with the system through the web app.

This continuous monitoring process ensures the baby's safety until the system is manually stopped.

## **VIII. Backend Communication & Alerts Flow**

This section explains how the system handles data after it is collected by sensors. The ESP32 microcontroller continuously reads real-time data from the temperature-humidity sensor (DHT11) and pulse oximeter. It checks whether these values remain within safe thresholds. If any abnormal reading is detected such as low temperature or irregular pulse the ESP32 immediately triggers an on-board buzzer and sends the data to a cloud platform (Firebase) using Wi-Fi or Bluetooth.

The mobile application is linked to the cloud and receives updated data instantly. It displays live readings and alert notifications, allowing caregivers to monitor the baby remotely. The app also offers basic control functions, such as turning off the buzzer or resetting alerts. This seamless communication between the blanket and app ensures timely response in case of any danger, improving infant safety and caregiver awareness.

## **IX. CHALLENGES FACED**

During the development of *Nyano Kakh*, we faced issues with unstable Wi-Fi and Bluetooth connections, causing delays in data transfer. We improved this by optimizing network settings and data protocols. Integrating multiple sensors into a soft, low-power blanket was challenging, so we carefully selected components to maintain comfort and efficiency. To reduce false alerts, we adjusted sensor thresholds and used data smoothing. Ensuring real-time updates on the mobile app required reliable cloud communication, which we achieved using Firebase/Blynk. These challenges helped improve the product's accuracy and reliability.

<b>Problem</b>	<b>Description</b>	<b>Solution</b>
<b>Unreliable Connectivity</b>	Difficulty sending real-time baby data consistently to parents' devices	Improved wireless module and backup data storage
<b>Comfort &amp; Usability Issues</b>	Blanket may be uncomfortable or hard to use for babies and parents	Soft, hypoallergenic materials and user-friendly design
<b>Battery &amp; Power Limitations</b>	Frequent charging or short battery life interrupts monitoring	Low-power sensors and long-lasting rechargeable battery
<b>Alert Reliability</b>	False alarms or missed alerts cause stress or risk	Refined alert algorithms and customizable alert settings

*Fig6: Nyano Kakh Challenges*

## **X. FUTURE IMPLEMENTATION**

In the future, Nyano Kakh will include more advanced sensors like a heartbeat monitor to track the baby's health in greater detail. The mobile app will be upgraded to let caregivers customize alerts, review past data, and get personalized tips based on the baby's behavior and environment.

We also plan to add smart cloud analytics that predict possible health issues before they happen, giving caregivers more time to act. Voice control will be introduced so parents can check the baby's status or control alerts without using their hands. Additionally, the system can be converted into a mobile app for easier access and use anywhere, making monitoring more convenient for busy caregivers.

These improvements will make Nyano Kakh smarter, easier to use, and more reliable—helping caregivers protect their babies better than ever before.

## **XI. CONCLUSION**

Nyano Kakh offers an innovative and reliable solution for real-time baby monitoring, enhancing infant safety and caregiver peace of mind. By continuously tracking vital parameters such as temperature, humidity, and movement, and providing instant alerts through a connected mobile app, the system enables timely interventions in case of any abnormal conditions. Its user-friendly design and portable nature make it suitable for use at home, hospitals, or remote health centers. With ongoing improvements and integration of advanced features, Nyano Kakh aims to become an essential tool for modern childcare, promoting healthier and safer environments for babies worldwide.

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