



# Smart Guards



## Design and development of vital sign monitoring wearable device that alerts possible complications to health care providers

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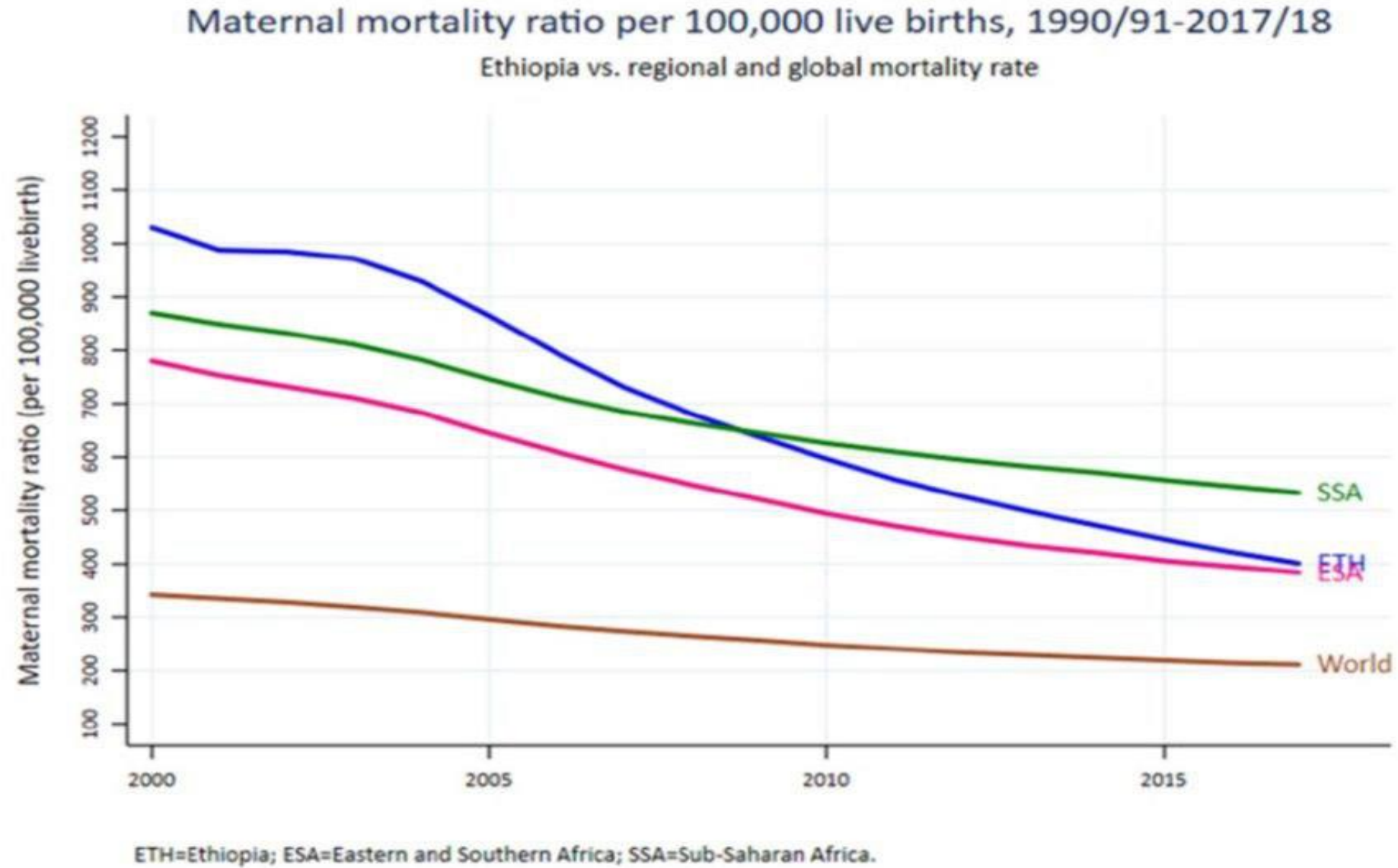
HARAMAYA, ETHIOPIA

JUNE 10, 2024

# Introduction

- Maternal mortality remains a pressing global health challenge particularly in low-resource settings.
- Ethiopia had one of the highest maternal mortality rates in the world.
- According to data from the World Bank, as of 2017, the maternal mortality ratio in Ethiopia was 401 deaths per 100,000 live births.

# Ethiopia's Maternal Mortality Ratio



# Cont...

- This project focuses on the design and development of vital signs monitoring wearable devices specifically tailored for pregnant women.
- These devices aim to continuously monitor key vital signs, including...
  - Heart rate, blood pressure,
  - Oxygen saturation, and
  - Body temperature.
- The data collected by these devices is transmitted to a central monitoring system, where it is analyzed in real-time.

# Current Clinical Environment and Pin Points...

- The absence of a vital sign monitoring wearable device that alerts healthcare providers of possible complications can present several challenges for hospitals.

## ☐ Overburdened Healthcare Systems

## ☐ High Patient Loads

- ☐ Hospitals and clinics often have a high patient-to-staff ratio, leading to insufficient monitoring of each patient.

## ☐ Nursing Shortage

- ☐ There is a widespread shortage of nurses and medical staff, further complicating patient monitoring and care.

# Current Clinical Environment and Pin Points...

## ❑ Manual Monitoring Challenges

- ❑ **Intermittent Monitoring:** Vital signs are typically checked at intervals, leading to potential gaps in patient data.
- ❑ **Human Error:** Manual recording of vital signs is prone to errors, including mis-recording or omission.

## ❑ Delayed Response to Complications

**Lack of Continuous Monitoring:** Intermittent checks can miss rapid changes in a patient's condition, delaying necessary interventions.

**Slow Alert Systems:** Traditional methods of detecting complications rely heavily on routine checks and manual reporting, which can be slow.



# Proposed Solution

- ❑ **Continuous Monitoring:** Develop wearable devices capable of continuously monitoring key vital signs such as heart rate, blood pressure, oxygen saturation, and body temperature in pregnant women.
- ❑ **Real-Time Data Transmission:** Ensure that the collected data is transmitted in real-time to a central monitoring system, facilitating immediate analysis and response.
- ❑ **Early Detection and Alerts:** Implement data analysis algorithms that can detect abnormalities and potential complications early, triggering instant alerts to healthcare providers.
- ❑ **Integration with Healthcare Systems:** Design the system to integrate seamlessly with existing healthcare infrastructure, allowing healthcare providers to access and monitor patient data remotely.

# Impact on Patient Care

- ❑ Early Detection of Complications
  - Continuous Monitoring
  - Timely Intervention
  - Reduced Emergency Admissions
- ❑ Enhanced Patient Safety:
  - 24/7 Monitoring
  - Reduced Human Error
- ❑ Improved Overall Care Quality
  - Personalized Care
  - Data-Driven Decisions
  - Patient Engagement



# Technical Feasibility

- ❑ **Technological Stack:** The project will leverage state-of-the-art sensor technology and IoT platforms to ensure accurate data collection and seamless device connectivity.
- ❑ **Resource Availability:** Adequate human and financial resources are allocated to support the research, development, and testing phases of the wearable device.
- ❑ **Infrastructural Support:** The hospital's existing IT infrastructure is capable of integrating with the new device for data analysis and storage.
- ❑ **Integration and Compatibility:** The device will be designed to be compatible with various hospital information systems and electronic health records for smooth integration.

## Cont...

- ❑ **Risk Assessment:** A comprehensive risk analysis will be conducted to identify and mitigate potential technical and operational risks associated with the device.
- ❑ **Security:** Advanced cybersecurity measures will be implemented to protect sensitive health data against unauthorized access and breaches.
- ❑ **Compliance:** The device will be developed in accordance with relevant healthcare regulations and standards to ensure compliance and certification for hospital use.

# System Design

## System Components

### Wearable Device sensor

- Heart Rate (HR)
- Blood Pressure (BP)
- Oxygen Saturation (SpO2)
- Body Temperature: Thermistors or infrared sensors
- Fetal Heart Rate (for pregnancy): Doppler ultrasound or ECG

### Others

- Smoke and fire detector sensors

## Cont...

- **Smartphones:** Connect to the system by going to the web browser and entering the IP of the registration server and logging in using ID and Password.
- **Home Gateway:** Central hub for processing data and managing communication.
- **Switches:** Network switches for device connectivity.

# Overall System Architecture.

- **Detection Layer:** Comprises vital sign like Temperature , blood pressure , heart rate and smoke detectors placed in each hospital room.
- **Communication Layer:** Uses wired and wireless communication protocols to transmit data to the home gateway.
- **Control Layer:** The home gateway processes the data and manages the system's overall operation.
- **Response Layer:** displays the vital signs data on smart devices

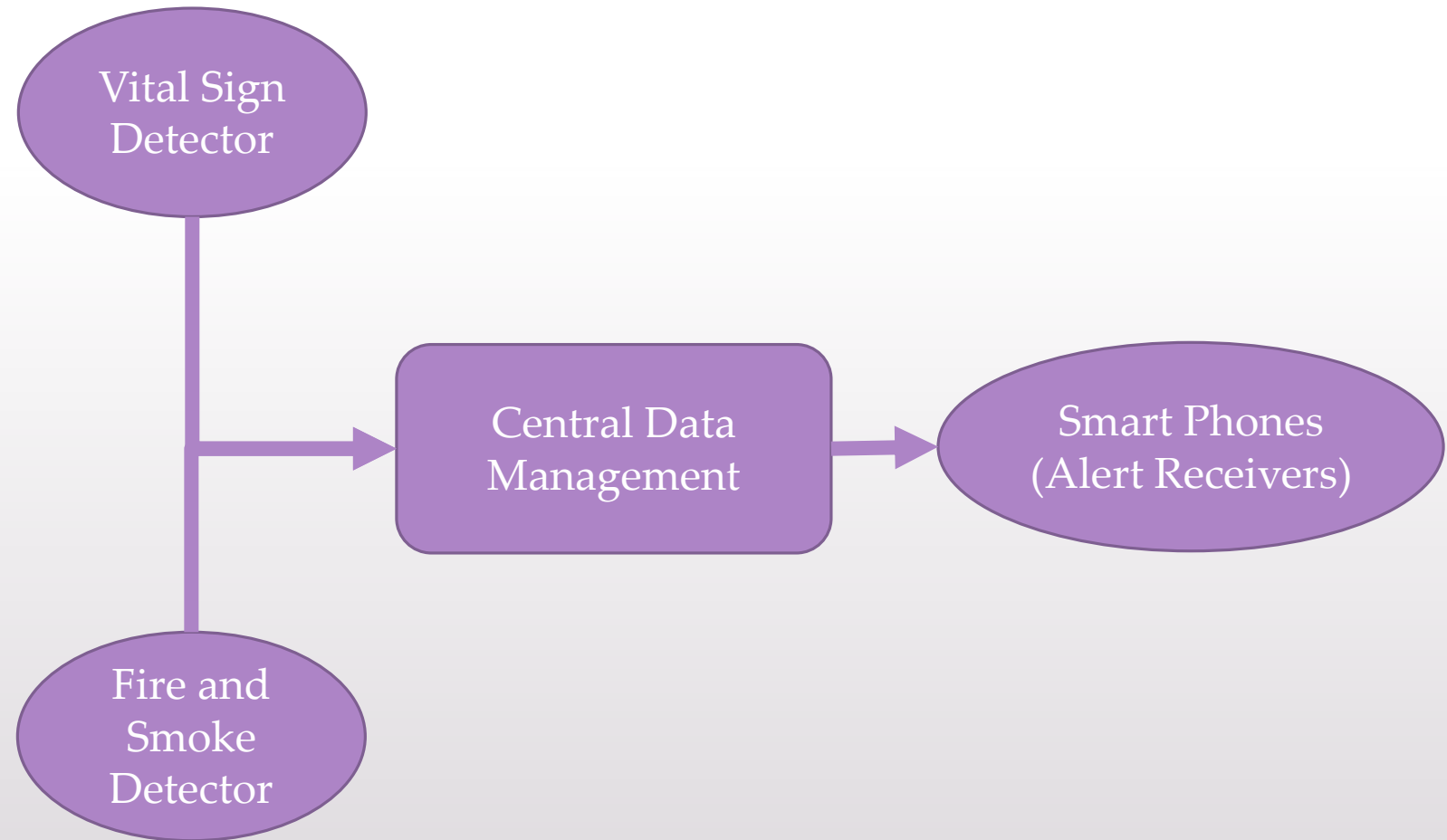
# Data Flow and Processing

Steps,

1,Vital sign and fire detector.

2)central data management.

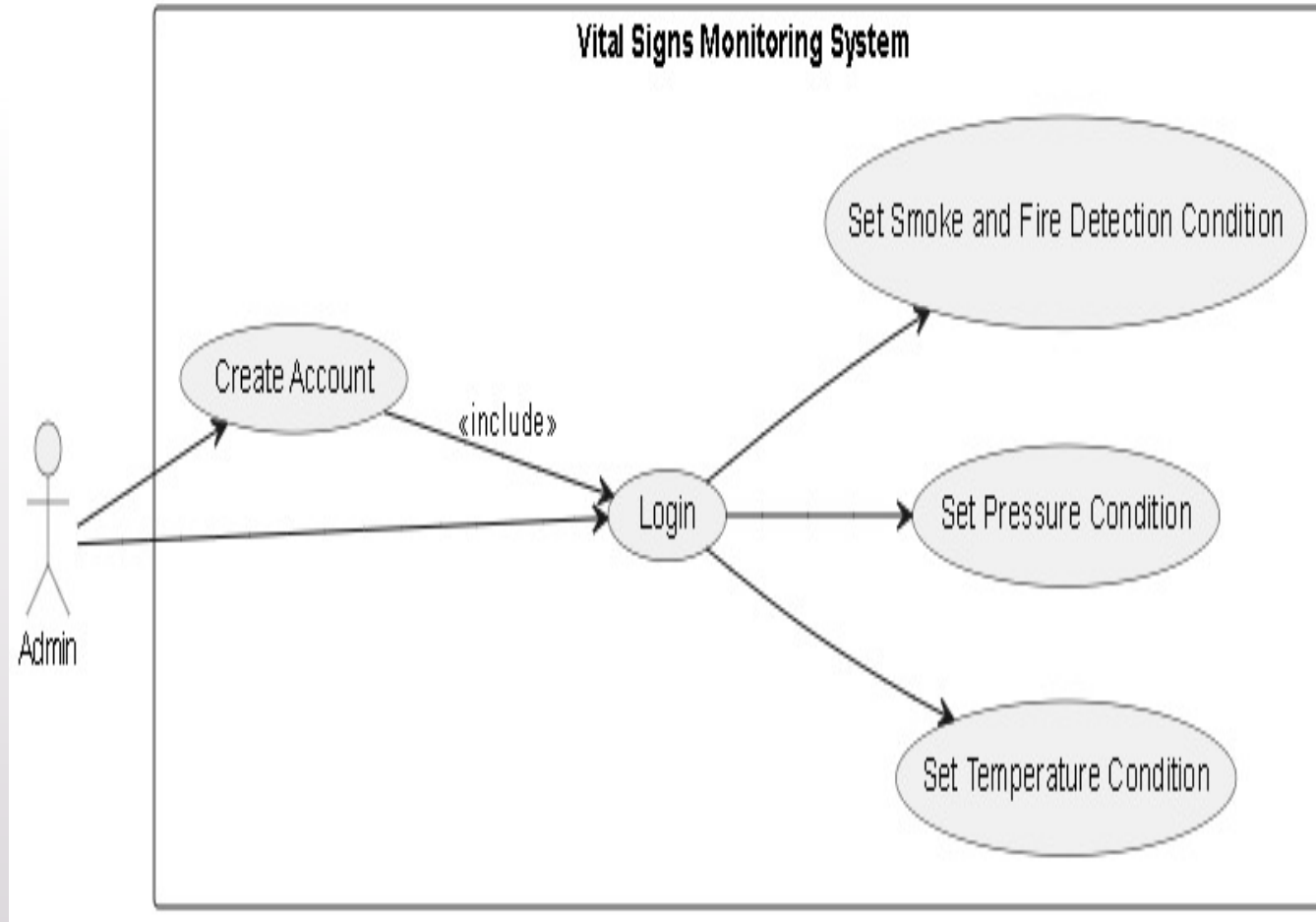
3)Smart phone(Alerted).





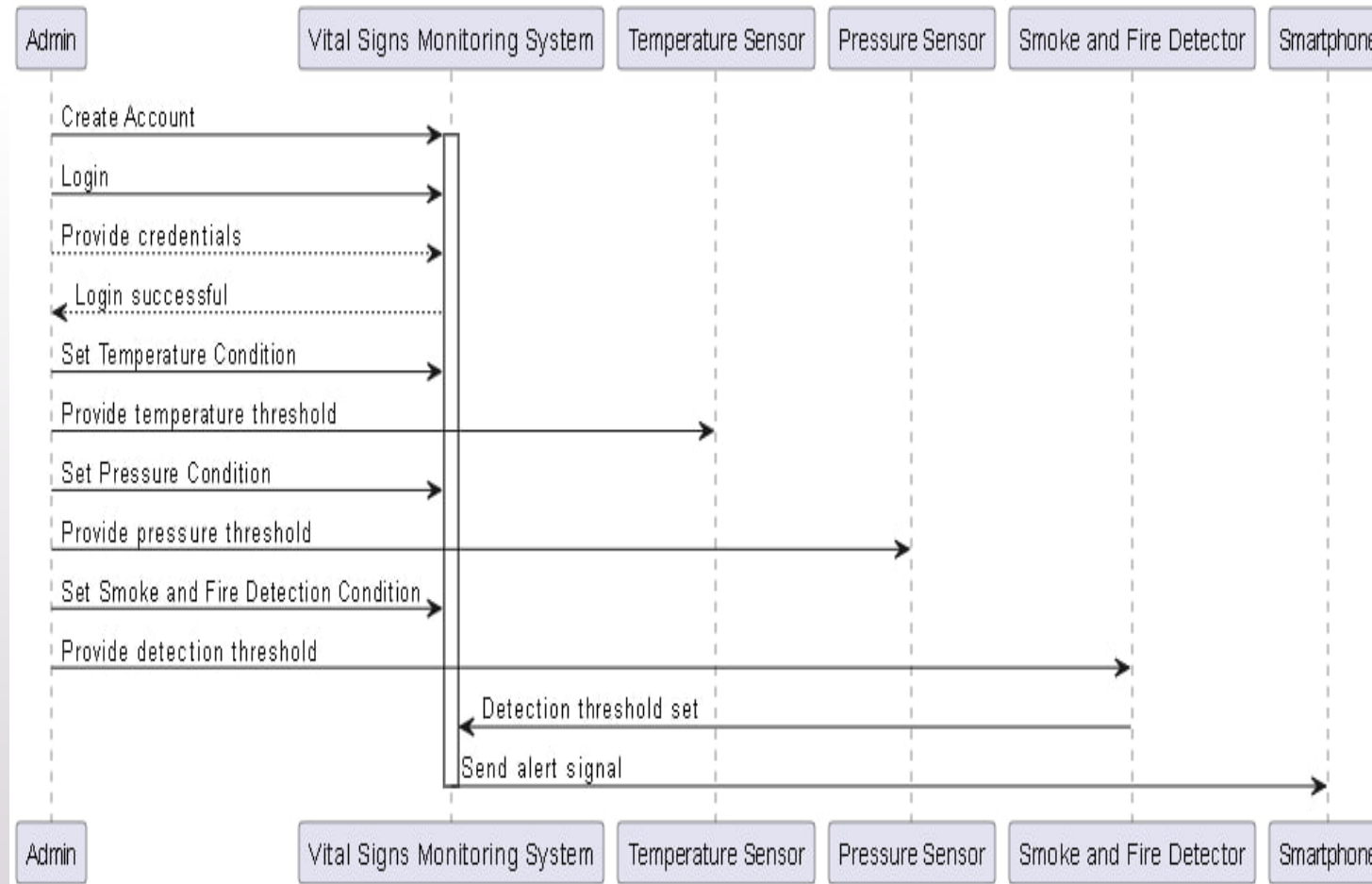
# Use case and diagram of the system

## Use case diagram



# Sequence diagram

- Sequence diagram



# Implementation

- We used Cisco packet Tracer to implement the system because it is a powerful network simulation tool that allows for the design, visualization, and analysis of network systems, including **IoT** devices.

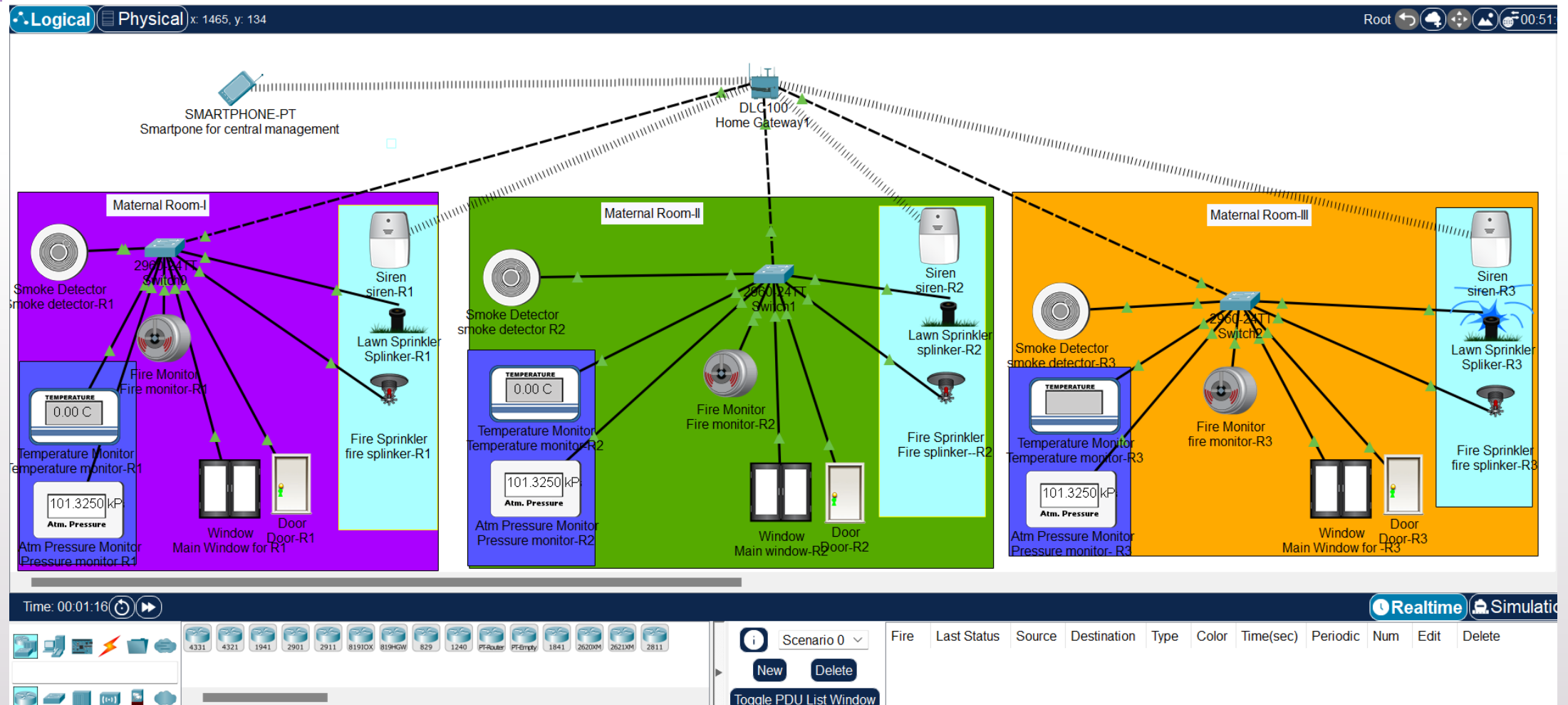
## Connecting and Configuring Smoke and Fire Detectors

- **Place Detectors:** Position Vital sign on woman giving birth and smoke and fire detectors in each hospital room ceil .
- **Connect to Gateway via switch:** Connect detectors to the Home Gateway via Wi-Fi and Ethernet cable.
- **Configure Detection Parameters:** Set detection thresholds and ensure detectors are calibrated correctly

# Programming Notifications.

- **Add Smartphones/Tablets:** Simulate smartphones using PC/Tablets.
- **Connect to Gateway:** Ensure these devices are connected to the Home Gateway for receiving notifications.
- **Notification Settings:** Program the Home Gateway to send alerts to these devices upon detection of vital fire or smoke.

# System Architecture.





# Cont...

## List of devices remotely connected device

Smartpone for central management

Physical Config Desktop Programming Attributes

Web Browser X

< > URL <http://192.168.25.1/home.html> Go Stop

▶ Spliker-R3 (PTT0810S5KB-)	Lawn Sprinkler
▶ smoke detector-R3 (PTT081061Q5-)	Smoke Detector
▶ splinker-R2 (PTT0810T100-)	Lawn Sprinkler
▶ Fire monitor-R2 (PTT0810YWE7-)	Fire Sensor
▶ fire monitor-R3 (PTT08106T4S-)	Fire Sensor
▶ Fire monitor-R1 (PTT0810QS1Y-)	Fire Sensor
▶ fire splinker-R1 (PTT081046H1-)	Fire Sprinkler
▶ Fire splinker-R2 (PTT0810XMM-)	Fire Sprinkler
▶ fire splinker-R3 (PTT0810S6OY-)	Fire Sprinkler
▶ siren-R1 (PTT0810TG96-)	Siren
▶ siren-R2 (PTT0810J99V-)	Siren
▶ siren-R3 (PTT0810KQF8-)	Siren
▶ Main Window for -R3 (PTT0810Z3P8-)	Window
▶ Main window-R2 (PTT0810FGR7-)	Window
▼ Temperature monitor-R1 (PTT0810AK47-)	Temperature Monitor
Temperature	0.0 °C
▼ Pressure monitor R1 (PTT0810F02Q-)	Atm. Pressure Sensor
Atm. Pressure	101324
▶ Pressure monitor-R2 (PTT081042OB-)	Atm. Pressure Sensor
▶ Temperature monitor-R2 (PTT0810T88N-)	Temperature Monitor
▶ Pressure monitor- R3 (PTT0810972O-)	Atm. Pressure Sensor
▶ Temperature monitor-R3 (PTT0810XBUH-)	Smoke Detector

## Set of condition

Smartpone for central management

Physical Config Desktop Programming Attributes

Web Browser X

< > URL <http://192.168.25.1/conditions.html> Go Stop

Edit	Remove	Yes	doorww	Fire monitor-R1 Fire Detected is false	Set Door-R1 Lock to Lock
Edit	Remove	Yes	siren	Fire monitor-R1 Fire Detected is true	Set siren-R1 On to true
Edit	Remove	Yes	siren2	Fire monitor-R1 Fire Detected is false	Set siren-R1 On to false
Edit	Remove	Yes	siren21	Fire monitor-R2 Fire Detected is true	Set siren-R2 On to true
Edit	Remove	Yes	siren222	Fire monitor-R2 Fire Detected is false	Set siren-R2 On to false
Edit	Remove	Yes	silrenb3333	fire monitor-R3 Fire Detected is true	Set siren-R3 On to true
Edit	Remove	Yes	siren433	fire monitor-R3 Fire Detected is false	Set siren-R3 On to false
Edit	Remove	Yes	window3	fire monitor-R3 Fire Detected is true	Set Main Window for -R3 On to true
Edit	Remove	Yes	window32	fire monitor-R3 Fire Detected is false	Set Main Window for -R3 On to false
Edit	Remove	Yes	window2	Fire monitor-R2 Fire Detected is true	Set Main window-R2 On to true
Edit	Remove	Yes	window223	Fire monitor-R2 Fire Detected is false	Set Main window-R2 On to false
Edit	Remove	Yes	DOOR-B2	Fire monitor-R2 Fire Detected is true	Set Door-R2 Lock to Unlock
Edit	Remove	Yes	DOOR-B3	Fire monitor-R2 Fire Detected is false	Set Door-R2 Lock to Lock
Edit	Remove	Yes	DOOR-B33	fire monitor-R3 Fire Detected is true	Set Door-R3 Lock to Unlock
Edit	Remove	Yes	DOOR-B33	fire monitor-R3 Fire Detected is false	Set Door-R3 Lock to Lock
Edit	Remove	Yes	Temprature-B1	Temperature monitor-R1 Temperature >= 27.0 °C	Set Splinker-R1 Status to true
Edit	Remove	Yes	Temprature-B11	Temperature monitor-R1 Temperature < 27.0 °C	Set Splinker-R1 Status to false
Edit	Remove	Yes	Temprature-B2	Temperature monitor-R2 Temperature >= 27.0 °C	Set splinker-R2 Status to true
Edit	Remove	Yes	Temprature-B22	Temperature monitor-R2 Temperature < 27.0 °C	Set splinker-R2 Status to false
Edit	Remove	Yes	Temprature-B3	Temperature monitor-R3 Temperature >= 27	Set Spliker-R3 Status to true
Edit	Remove	Yes	Temprature-B33	Temperature monitor-R3 Temperature < 27	Set Spliker-R3 Status to false
Edit	Remove	Yes	Pressure-b1	Pressure monitor R1 Atm. Pressure > 101.325	Set Splinker-R1 Status to true
Edit	Remove	Yes	Pressure-b11	Pressure monitor R1 Atm. Pressure >= 101.325	Set Splinker-R1 Status to false
Edit	Remove	Yes	Pressure-b2	Pressure monitor-R2 Atm. Pressure > 101.325	Set splinker-R2 Status to true
Edit	Remove	Yes	Pressure-b22	Pressure monitor-R2 Atm. Pressure <= 101.325	Set splinker-R2 Status to false
Edit	Remove	Yes	Pressure-b3	Pressure monitor- R3 Atm. Pressure > 101.325	Set Spliker-R3 Status to true
Edit	Remove	Yes	Pressure-b33	Pressure monitor- R3 Atm. Pressure <= 101.325	Set Spliker-R3 Status to false

Add

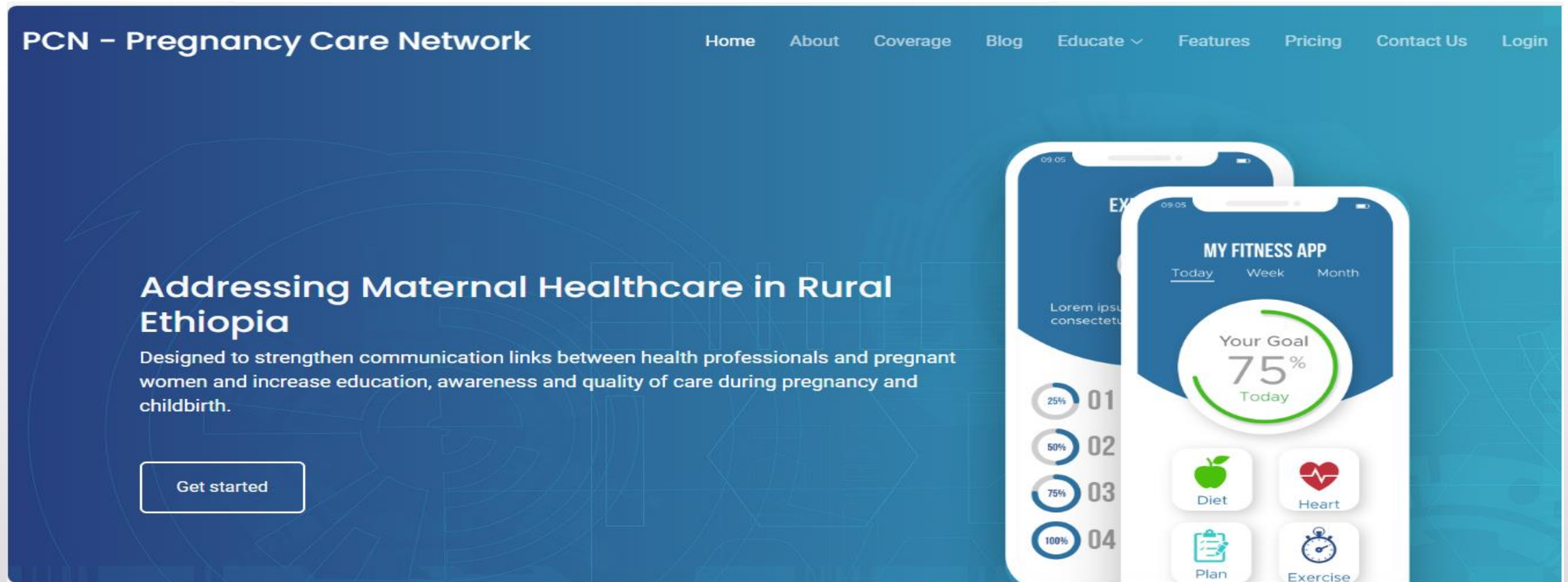


# Network Configuration.

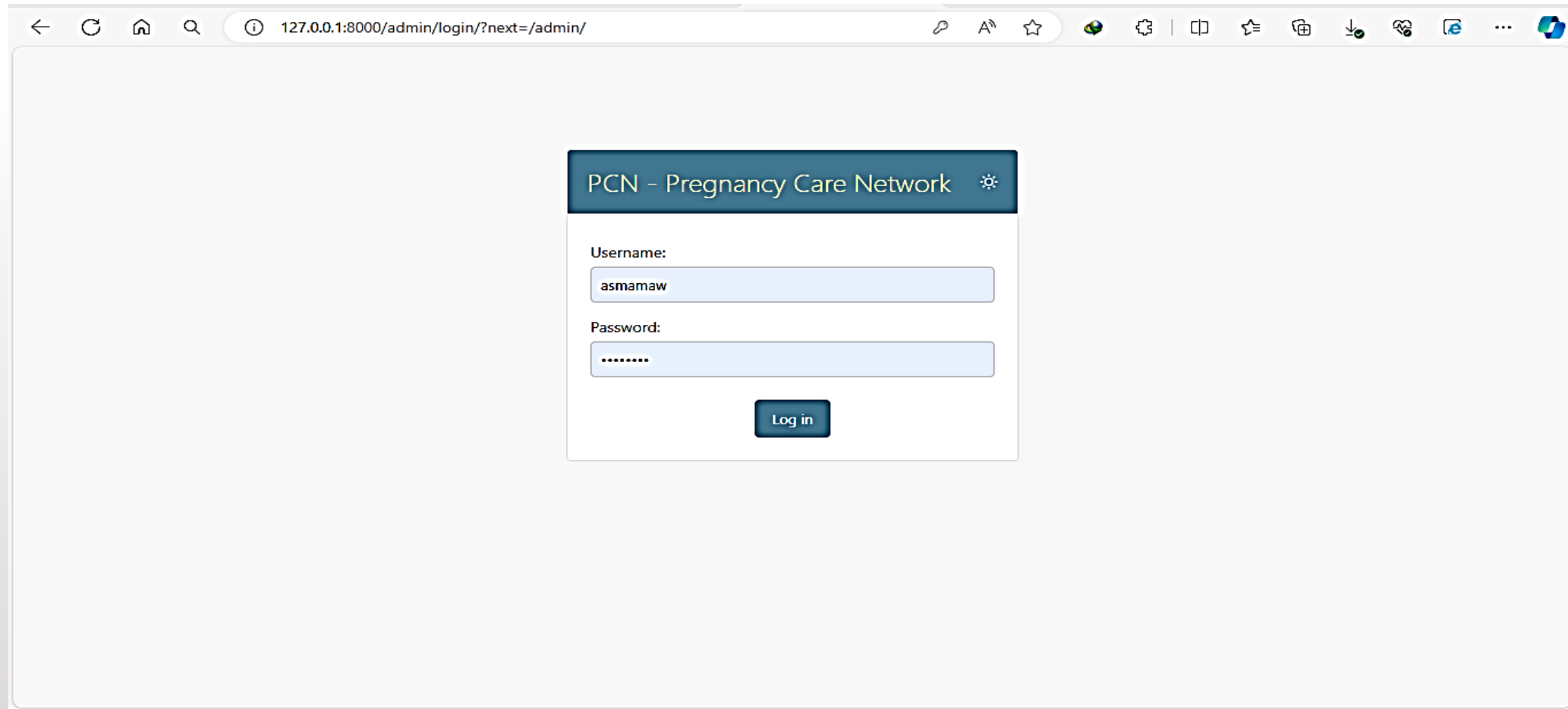
- **IP Addressing and DHCP.**
- **Assign IP Addresses:** Assign static IP addresses to critical devices like the Home Gateway, switches, and servers.
- **DHCP Setup:** Configure the Home Gateway to act as a DHCP server for dynamic IP addressing of other IoT devices.
- **Wireless Configuration.**
- **Configure Wi-Fi:** Set up SSID and security parameters for the wireless network.
- **Ensure Coverage:** Place Wi-Fi access points to ensure coverage in all areas of the dormitory.

# The System Database Architecture.

## Web Front End Pages



# Cont...



← ↻ 🏠 🔍 ⓘ 127.0.0.1:8000/admin/login/?next=/admin/ 🔍 🔊 ☆ 🌐 ⚙️ | 📄 ☆ 📌 ⬇️ 🔄 📄 ... 🌐

PCN - Pregnancy Care Network ⚙️

Username:

Password:

Log in

# Cont...

PCN - Pregnancy Care Network

WELCOME, **ASMAMAW**. [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#) ⚙️

Site administration

ADDRESS

Addresss	+ Add	✎ Change
Kebeles	+ Add	✎ Change
Regions	+ Add	✎ Change
Woredas	+ Add	✎ Change
Zones	+ Add	✎ Change

AUTHENTICATION AND AUTHORIZATION

Groups	+ Add	✎ Change
Users	+ Add	✎ Change

EDUCATE

Authors	+ Add	✎ Change
Cares	+ Add	✎ Change
Conditions	+ Add	✎ Change
Donts	+ Add	✎ Change

Recent actions

My actions

+ Description

Vital sign

+ MisterX, FirstV

Author

+ Health

Educate

+ FloatField

Language

+ General

Genre

+ 1234567891234

Mother

Database Admin

# Cont...

## Features

- All users management
- Location/Address
- Educate Mothers
- Health centers
- Monitor Mothers Health
- Vital sign and other records

PCN - Pregnancy Care Network

Site administration

ADDRESS		
Addresses	+ Add	Change
Kebeles	+ Add	Change
Regions	+ Add	Change
Woredas	+ Add	Change
Zones	+ Add	Change

AUTHENTICATION AND AUTHORIZATION		
Groups	+ Add	Change
Users	+ Add	Change

EDUCATE		
Authors	+ Add	Change
Cares	+ Add	Change
Conditions	+ Add	Change
Donts	+ Add	Change
Dos	+ Add	Change
Educates	+ Add	Change
Figures	+ Add	Change
Genres	+ Add	Change
Languages	+ Add	Change
Procedures	+ Add	Change
Steps	+ Add	Change
Symptoms	+ Add	Change
Tests	+ Add	Change
Topics	+ Add	Change
Treatments	+ Add	Change

HEALTH CENTER		
General managers	+ Add	Change
Health centers	+ Add	Change
Health officers	+ Add	Change

MOTHER		
Advices	+ Add	Change
Cares	+ Add	Change
Conditions	+ Add	Change
Donts	+ Add	Change
Dos	+ Add	Change
Mothers	+ Add	Change
Procedures	+ Add	Change
Symptoms	+ Add	Change
Tests	+ Add	Change
Treatments	+ Add	Change
Vital signs	+ Add	Change

Recent actions

My actions

- + Description  
Vital sign
- + MisterX, FirstV  
Author
- + Health  
Educate
- + ElocatField  
Language
- + General  
Genre
- + 1234567891234  
Mother

# Cont...

PCN – Pregnancy Care Network

WELCOME, **ASMAMAW**. [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#)

Home > Address > Addresss > Add address

Start typing to filter...

ADDRESS

Addresss + Add

Kebeles + Add

Regions + Add

Woredas + Add

Zones + Add

AUTHENTICATION AND AUTHORIZATION

Groups + Add

Users + Add

EDUCATE

Authors + Add

Cares + Add

Conditions + Add

Donts + Add

Dos + Add

Educates + Add

Figures + Add

Add address

Address:

Name:

Region:

+

x

Zone:

+

x

Woreda:

+

x

Kebele:

+

x

Tele:

Enter Tele

Email:

Enter Email

Contact person:

Enter Contact Name

Latitude:

Longitude:

Number of pregnancy:

Number of abortion:

SAVE

Save and add another

Save and continue editing

Address Record With Longitudes and Latitudes



# Educate Mothers: Give General Maternal Health Information

## PCN - Pregnancy Care Network

Home > Educate

Educate administration

EDUCATE		
Authors	+ Add	Change
Cares	+ Add	Change
Conditions	+ Add	Change
Donts	+ Add	Change
Dos	+ Add	Change
Educates	+ Add	Change
Figures	+ Add	Change
Genres	+ Add	Change
Languages	+ Add	Change
Procedures	+ Add	Change
Steps	+ Add	Change
Symptoms	+ Add	Change
Tests	+ Add	Change
Topics	+ Add	Change
Treatments	+ Add	Change

# Cont...

## PCN – Pregnancy Care Network

Home > Health\_Center > Health centers > Add health center

### Add health center

Health center:	<input type="text" value="Hospital Name"/> Enter Health Center Name
Name:	<input type="text"/> Enter Health Center Name
Region:	<input type="text"/> Enter Region Name
Zone:	<input type="text"/> Enter Zone Name
Woreda:	<input type="text"/> Enter Woreda Name
Kebele:	<input type="text"/> Enter Kebele Name
Tele:	<input type="text"/> Enter Health Center Name
Email:	<input type="text"/> Enter Health Center Name
Latitude:	<input type="text"/>
Longitude:	<input type="text"/>
Number of pcn:	<input type="text"/>
Capacity:	<input type="text"/>

Start typing to filter...

ADDRESS

Addressss

Kebeles

Regions

Woredas

Zones

AUTHENTICATION AND AUTHORIZATION

Groups

Users

EDUCATE

Authors

Cares

Conditions

Donts

Dos

Educates

Figures












Health Centers

Health Officials

Hospital

Managers

# Mothers' Follow-up

PCN – Pregnancy Care Network		
Home > Mother		
Mother administration		
MOTHER		
Advices	+ Add	 Change
Cares	+ Add	 Change
Conditions	+ Add	 Change
Donts	+ Add	 Change
Dos	+ Add	 Change
Mothers	+ Add	 Change
Procedures	+ Add	 Change
Symptoms	+ Add	 Change
Tests	+ Add	 Change
Treatments	+ Add	 Change
Vital signs	+ Add	 Change

# Cont...

PCN - Pregnancy Care Network

Home > Mother > Mothers > Add mother

WELCOME, ASMAMAW VIEW SITE / CHANGE PASSWORD / LOG OUT

Add mother

First name:

Middle name:

Last name:

Blood group:

Weight:

Height:

Residence type:

Health center:

Health officer:

Region:

Zone:

Woreda:

Kebele:

Tele:

Email:

Contact person:

Latitude:

Longitude:

Number of pregnancy:

Number of abortion:

Trimester:

Obstetric history:

ISBN:

Enter Region Name

Enter Zone Name

Enter Woreda Name

Enter Kebele Name

Enter Tele

Enter Email

Enter Contact Name

Enter a brief description of the book

13 Character ISBN number

SAVE

Save and add another

Save and continue editing

Start typing to filter...

ADDRESS

Address

Kebeles

Regions

Woredas

Zones

AUTHENTICATION AND AUTHORIZATION

Groups

Users

EDUCATE

Authors

Cares

Conditions

Donts

Dos


Educates

Figures

Registration Page

Cont...

PCN - Pregnancy Care Network

WELCOME, **ASMAMAW** [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#) 

Home > Mother > Vital signs > Description





Change vital sign

HISTORY

VIEW ON SITE >

Description

Mother:

1234567891234    

Name:

Topic Name

Enter a topic name

Vitalsign:

Description

Enter a brief description of the topic

Temperature:

37.05

Normal: 97.8°F to 99.1°F (36.5°C to 37.3°C)

Blood pressure:

85

Normal: 90/60 mmHg and 120/60 mmHg

Breathing:

14

Normal: 12 to 18 breaths per minute

Mother pulse:

80

Normal: 60 to 100 beats per minute


Child pulse:

65

Normal: 60 to 100 beats per minute

Vitalsign date:


2024-06-10

Today | 

Note: You are 3 hours ahead of server time.

Vitalsign time:

02:44:31

Now | 

Note: You are 3 hours ahead of server time.

SAVE


Save and add another


Save and continue editing


Delete


Start typing to filter...


ADDRESS

Addressss 


Kebeles 


Regions 

Woredas 


Zones 


AUTHENTICATION AND AUTHORIZATION


Groups 


Users 


EDUCATE


Authors 


Cares 

Conditions 

Donts 

Dos 

Educates 

Figures 

Vital Signs Record

Summer 2024 Healthcare Hackathon, ImpactXcelerate in Collaboration with Haramaya University

Monday, June 10, 2024

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# Business Model

<b>Key Partner</b> Haramaya University (Supplier) East Hararge zone Health Bureau (End users) Ethiopian Ministry of Health	<b>Marketing Activities</b> The health Bureau will develop comprehensive marketing and sales strategy to Hospitals effectively reach and engage the target customer segments, including pregnant women and new mothers	<b>Team and Key roles</b> CEO: Overall strategy and leadership CTO: Technology and product development CMO: Marketing strategy and execution CFO: Financial planning and management Head of R&D: Oversees development of the wearable device and software Sales Director: Manages sales strategies and partnerships Customer Support Manager: Handles customer inquiries and support.
<b>SWOT Analysis</b> <b>Strengths:</b> Advanced technology, strong team, growing market. <b>Weaknesses:</b> High development costs, need for regulatory approval. <b>Opportunities:</b> Increasing health awareness, growing wearable tech market. <b>Threats:</b> Competitive market, rapid technological changes.	<b>Revenue Stream</b> The revenue model will include device sales to pregnant women and new mothers, as well as potential subscription-based services for data analytics and remote monitoring	<b>Channels</b> <ul style="list-style-type: none"><li>Professional Conferences and Medical Trade Shows</li><li>Medical Journals and Industry Publications</li><li>Direct Sales Representatives</li><li>Online Webinars and Training Programs</li></ul>



## Key resources

- ☐ Sensors
- ☐ Switches
- ☐ Gate ways
- ☐ Cables
- ☐ Smart electronic devices

## Cost Structure (per unit)

Home gateway.....60-100\$

Switches..... 75-90\$

Smartphone.....250-300\$

Wearable device:

Oxygen sensor.....55-75\$

Temperature sensor.....30-45\$

Pressure sensor.....50-60\$

Smoke and fire sensor.....57-65\$

Smart door .....68-90\$

Smart window.....46-60\$

Fire Splinker .....50-60\$

Ethernet cable.....18-25 \$/roll

Human resource .....100-200

Total \*57 ETB

This is the cost required for one unit to be completed.

## Milestone

As customers such as Hospitals, Clinics and health institute need growth wearable device for vital sign will advertise in target market specially in advance of emergency case.