Project Report

Internet of Things

Date	4 May 2023
Team ID	NM2023TMID10876
Project Name	Industrial Workers Health and Safety System Based on Internet of Things

Introduction

Project Overview

The project aims to develop an Industrial Workers Health and Safety System based on the Internet of Things (IoT) technology. The system incorporates sensors attached to the shoes of workers to gather information such as temperature measurements, altitude parameters, and the total distance walked. This data is then transmitted to the cloud for storage and analysis.

The system provides real-time monitoring and visualization of worker data through a mobile application and a web application. Authorized authorities can access the web application to check the status of each worker. The collected data is processed and analyzed to identify potential safety hazards and provide appropriate precautions**.**

Purpose

The purpose of the Industrial Workers Health and Safety System based on the Internet of Things (IoT) is to enhance workplace safety and mitigate risks for industrial workers. By attaching sensors to the shoes of workers, the system aims to collect important data such as temperature, altitude parameters, and total distance walked. This data is then transmitted to the cloud for storage and analysis.

The project aims to serve several purposes:

Real-time Monitoring: The system allows for real-time monitoring of workers' health and safety parameters. By continuously collecting data, it can identify potential hazards and alert both the workers and the authorities promptly.

Preventing Accidents: By monitoring altitude parameters, the system can identify workers operating at higher altitudes. Precautionary measures and

safety guidelines can be sent to those workers to prevent accidents and ensure their well-being.

Data Analysis and Insights: Storing the collected data in the cloud enables analysis and generates valuable insights. Authorities can gain a better understanding of the work environment, identify trends, and make informed decisions to improve safety protocols and procedures.

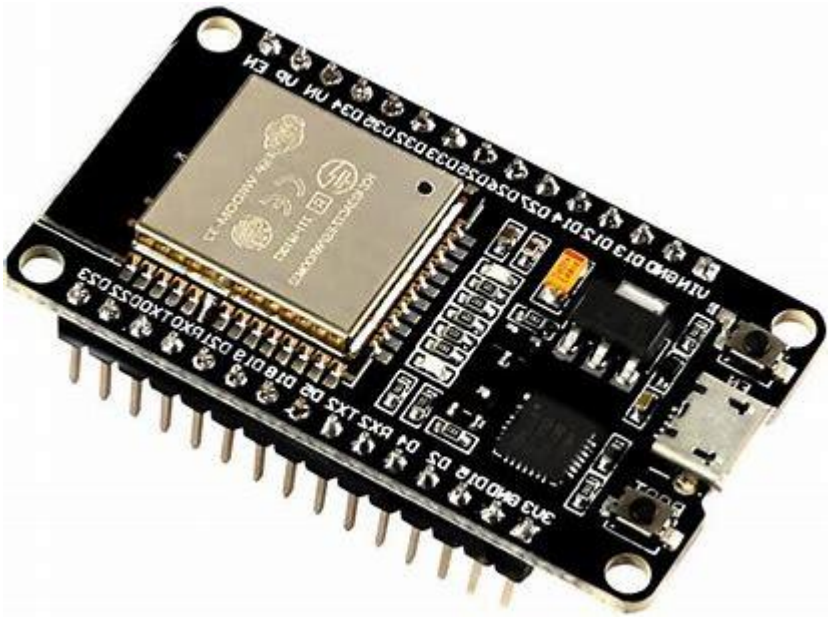
Enhanced Communication: The mobile application and web application provide a platform for effective communication between workers and authorities. Workers can receive important safety instructions, updates, and emergency alerts directly to their mobile devices, fostering a proactive safety culture.

Proactive Safety Measures: By leveraging IoT technology, the system enables the implementation of proactive safety measures. Through real-time data monitoring, potential safety hazards can be detected early, allowing for timely interventions and preventive actions.

The overall purpose of the project is to create a safer work environment by utilizing IoT technology to monitor workers' health and safety parameters, provide timely alerts and instructions, and enable data-driven decision-making for continuous improvement of safety protocols.

Components Used

ESP32



ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process.[2] It is a successor to the ESP8266 microcontroller.

DHT22

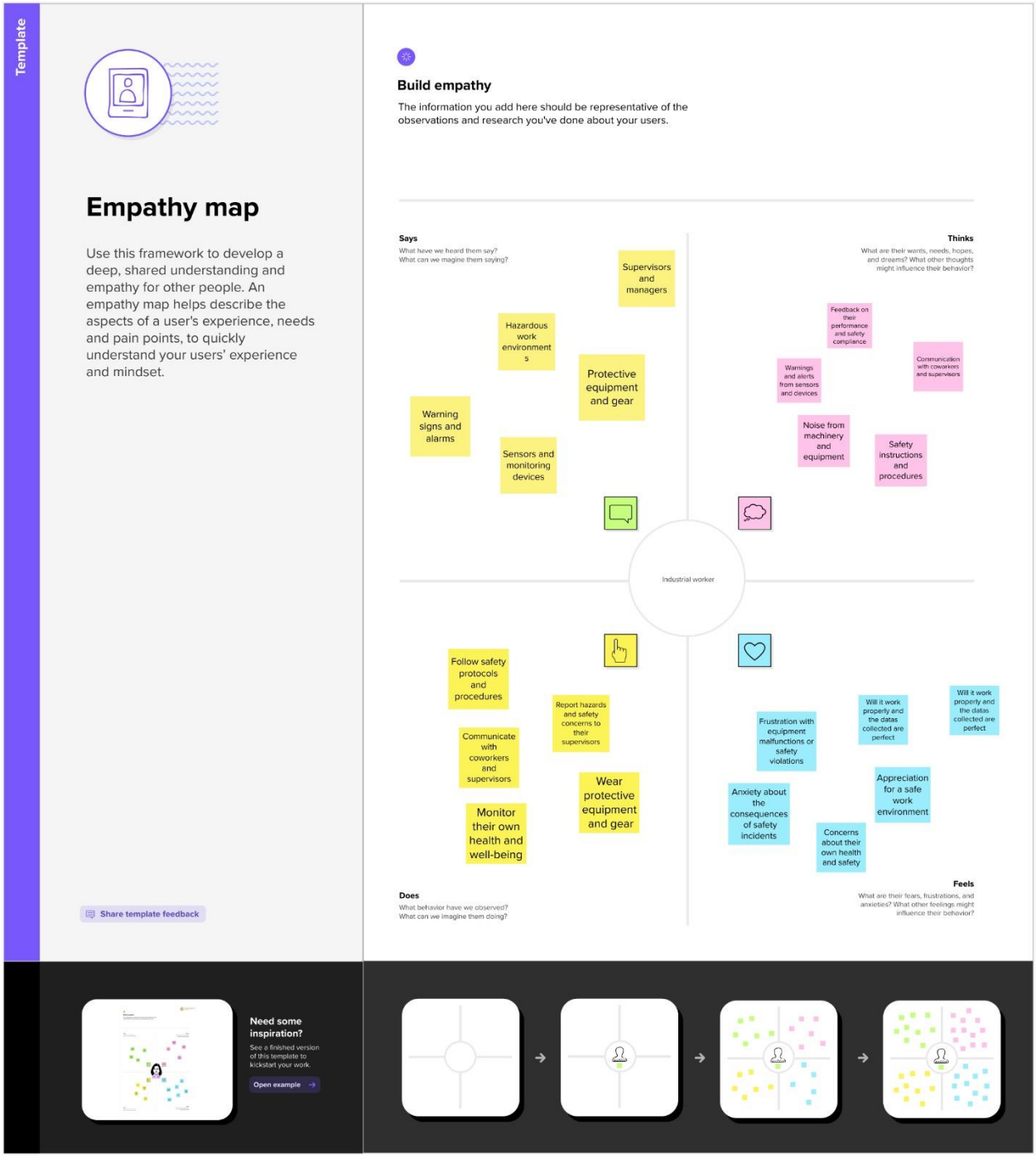
The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data**.**

IDEATION AND PROPOSED SOLUTION

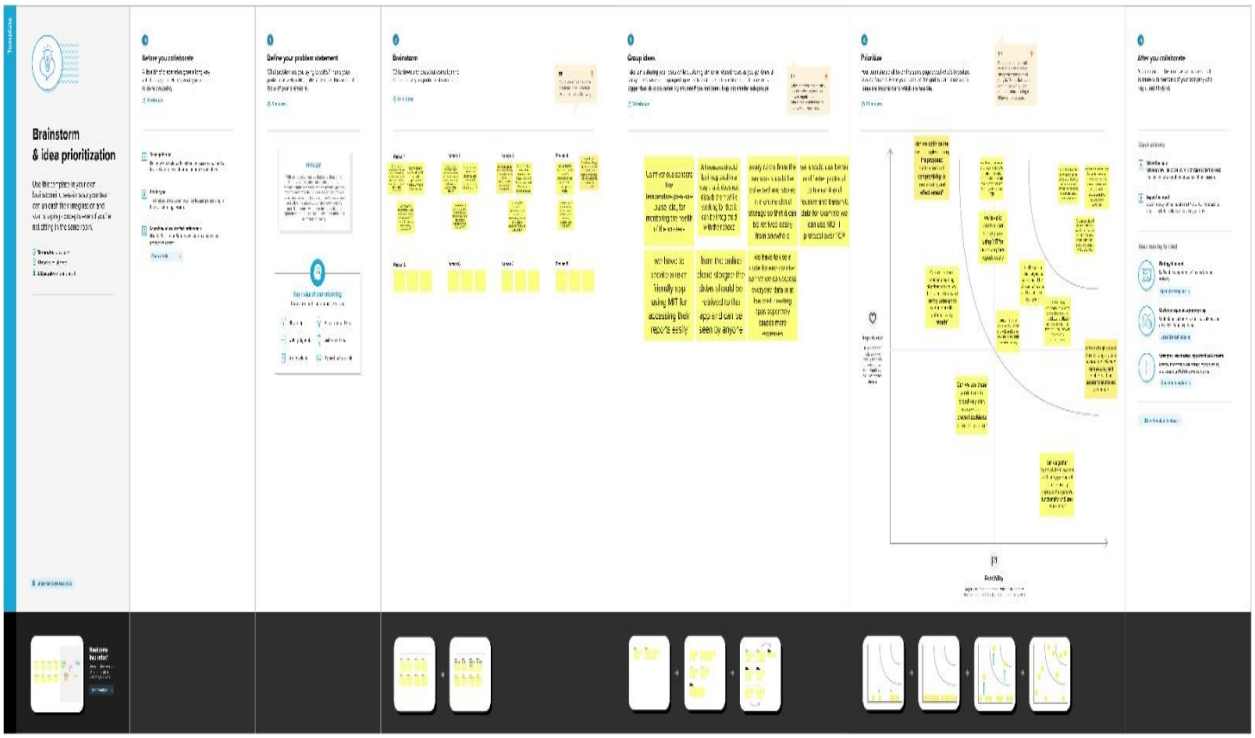
PROBLEM STATEMENT DEFINITION

To improve the safety and well-being of workers who work in challenging environments, such as those involving high altitudes, by using sensor technology integrated to shoes to monitor their working conditions.

Empathy Map


Template
Empathy map
Use this framework to develop a deep, shared understanding and empathy for other people. An empathy map helps describe the aspects of a user's experience, needs and pain points, to quickly understand your users' experience and mindset.
Share template feedback
Build empathy
The information you add here should be representative of the observations and research you've done about your users.
Says
What have we heard them say?
What can we imagine them saying?
Supervisors and managers
Hazardous work environments
Protective equipment and gear
Warning signs and alarms
Sensors and monitoring devices
Thinks
What are their wants, needs, hopes, and dreams? What other thoughts might influence their behavior?
Feedback on their performance and safety compliance
Communication with coworkers and supervisors
Warnings and alerts from sensors and devices
Noise from machinery and equipment
Safety instructions and procedures
Industrial worker
Follow safety protocols and procedures
Report hazards and safety concerns to their supervisors
Communicate with coworkers and supervisors
Wear protective equipment and gear
Monitor their own health and well-being
Does
What behavior have we observed?
What can we imagine them doing?
Will it work properly and the datas collected are perfect
Will it work properly and the datas collected are perfect
Frustration with equipment malfunctions or safety violations
Appreciation for a safe work environment
Anxiety about the consequences of safety incidents
Concerns about their own health and safety
Feels
What are their fears, frustrations, and anxieties? What other feelings might influence their behavior?
Need some inspiration?
See a finished version of this template to kickstart your work.
Open example

Brainstorming



Proposed Solutions

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To improve the safety and well-being of workers who work in challenging environments, such as those involving high altitudes, by using sensor technology to monitor their working conditions.
2.	Idea / Solution description	Our Goal is to collect data on factors like temperature and distance walked, etc., transmit it to the cloud for storage, and visualize it in a mobile app and web application that can be accessed by authorities.
3.	Novelty / Uniqueness	Integrating sensors in the shoes is a unique way. Because carrying a external device for monitoring these parameters cause discomfort to the users. So, it is a unique and user-friendly way to monitor their Health

4.	Social Impact / Customer Satisfaction	1. Reduced Healthcare Costs: By monitoring workers' health, early intervention can prevent minor health issues from becoming major medical problems, reducing healthcare costs for workers and employers. 2. Enhanced Workplace Productivity: When workers' health is monitored, their well-being is maintained, and they are less likely to experience absenteeism, sick days, or work-related injuries, resulting in increased productivity. 3. 3.Increased Worker Morale: Workers feel valued when employers prioritize their health and safety. The integration of sensors in the shoes can demonstrate that employers care about their well-being, which can lead to increased job satisfaction and worker retention. 4. Positive Environmental Impact: Monitoring workers' health through sensors can lead to a more efficient use of resources and energy, reducing environmental impacts from workplace accidents or illnesses.
5.	Business Model (Revenue Model)	From a business perspective, this technology can provide several benefits. First, it can reduce the risk of workplace accidents, which can lead to lower costs associated with workers' compensation claims and lost productivity. Additionally, by improving the health and well-being of workers, companies may

REQUIREMENT ANALYSIS

FUNCTIONAL REQUIREMENTS

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Sensor Integration	The system should be able to integrate sensors with the shoes of the workers to collect data about the temperature measure, altitude parameters, and distance walked.
FR-2	Data Collection and Storage	The system should be capable of collecting data from the sensors and storing it in a cloud-based platform.
FR-3	Real-time Data Visualization	The system should provide real-time data visualization to the workers via a mobile application to help them track their status.
FR-4	Authority Access	The system should enable authorized authorities to access the collected data through a web application.
FR -5	User Management	The system should have user management functionality to allow the authorities to manage user accounts and access rights.

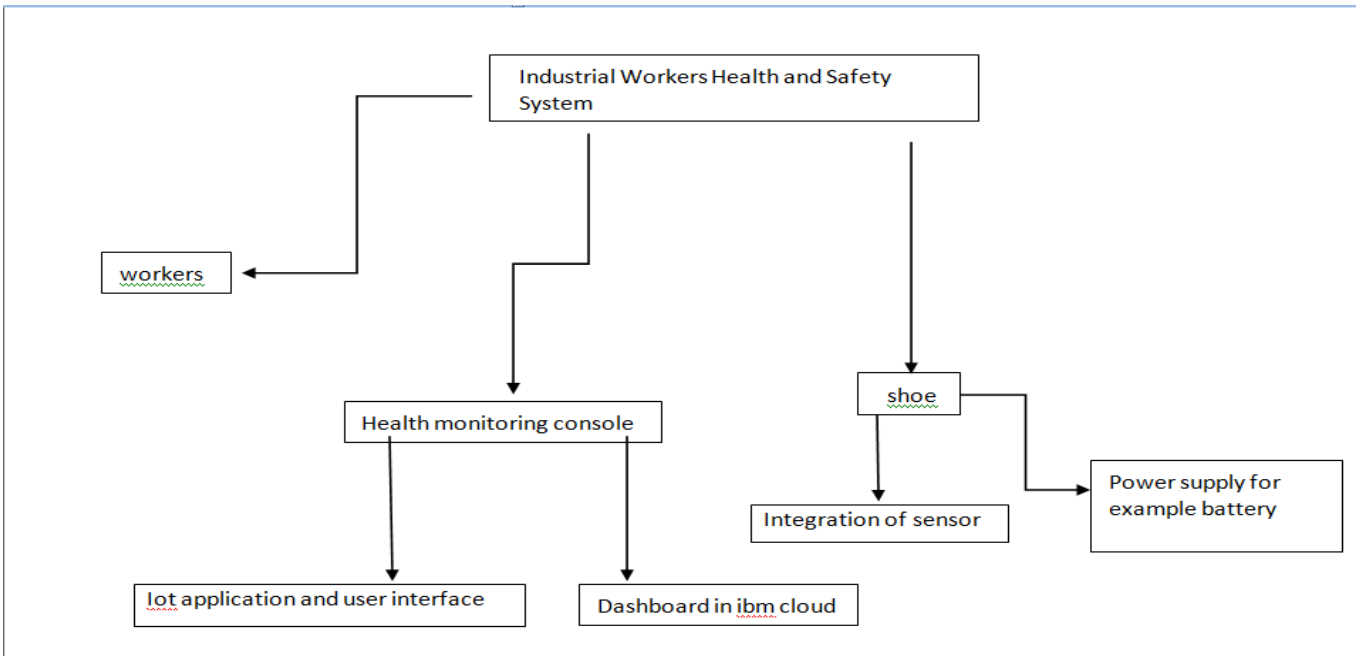
FR -6	Data Analysis	The system should provide tools for data analysis and reporting, which can help the authorities to gain insights into the workers' activity patterns, such as the amount of time they spend working, the distance they cover, and the altitude they climb.
FR-7	Notification	The system should have the capability to send notifications to the workers and the authorities in case of any critical information such as an emergency or an alarm.
FR-8	Data Security	The system should have robust security features to ensure the confidentiality, integrity, and availability of the collected data. The system should use authentication and encryption techniques to prevent unauthorized access to the data.

NON-FUNCTIONAL REQUIREMENTS

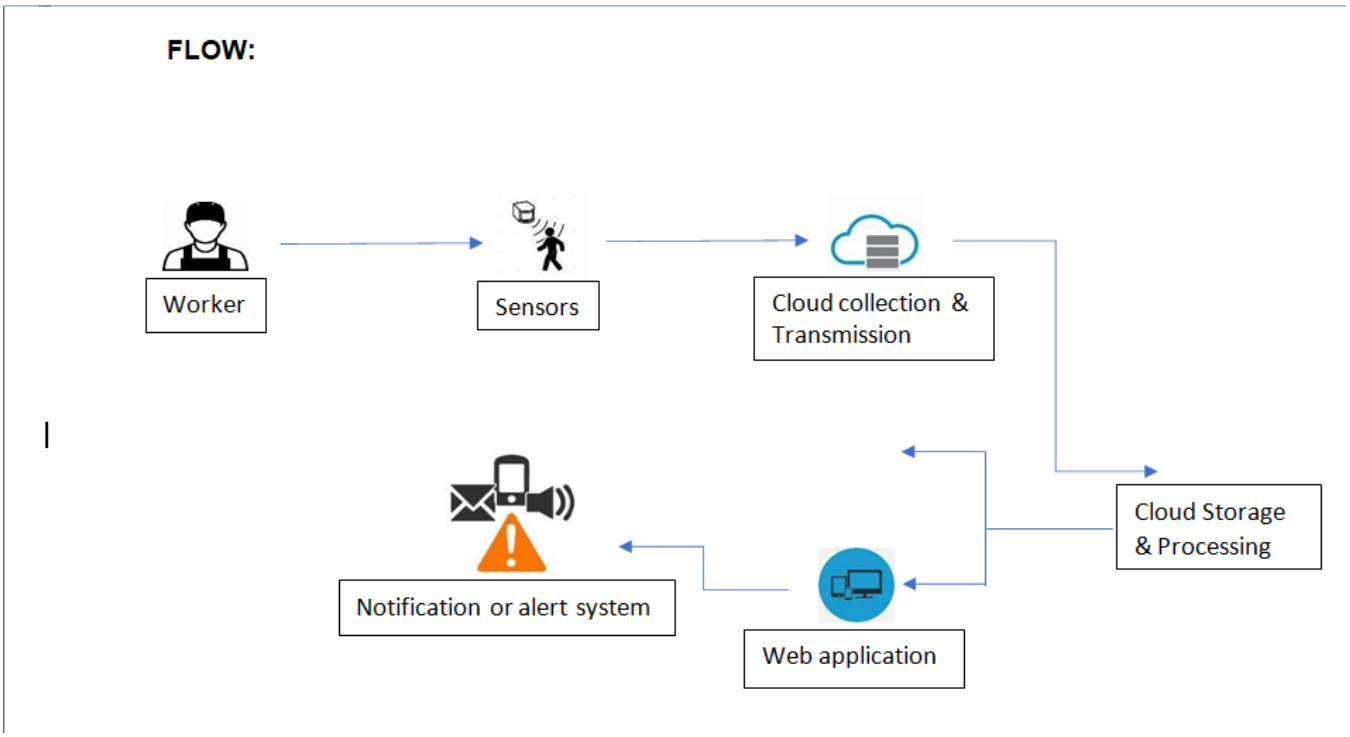
FR No.	Non-Functional Requirement	Description
NFR-1	**Security**	The system should ensure the security and privacy of the data being collected, transmitted, and stored. This includes measures such as encryption, access control, and data anonymization to protect sensitive information and prevent unauthorized access.
NFR-2	**Reliability**	The system should be dependable and consistently provide accurate and timely data. It should be able to handle large volumes of data and operate continuously without downtime or data loss.
NFR-3	**Performance**	The system should be fast and responsive, with minimal latency and delay in transmitting and processing data. It should be able to handle concurrent users and traffic spikes without degradation in performance.
NFR-4	**Availability & Maintainablity**	The system should be easy to maintain and update, with clear documentation and modular architecture that enables easy troubleshooting and debugging. It should be able to adapt to changing requirements and new technologies without major rework or disruption.
NFR-5	**Scalability**	The system should be able to accommodate increasing amounts of data and users as the organization grows and expands. It should be able to scale up or down easily and cost-effectively as needed.

PROJECT DESIGN

Data flow Diagrams



Solution and technical Architecture



User stories

USER TYPE	FUNCTIONAL REQUIREMENT (EPIC)	USER STORY / TASK	ACCEPTANCE CRITERIA	PRIORITY
worker	Real-time monitoring	I want the recorded sensor data to be sent to the cloud for storage so that it can be accessed and analyzed later for safety assessments and performance evaluations.	I can receive real time alerts.	High
supervisor	Maintenance tracking	I want to receive alerts and notifications in the web application when workers are working at higher altitudes so that I can provide them with important precautions and ensure their safety.	I can able to view the status & identify the issues	High

Key Features

- Sensor Integration: The system utilizes sensors attached to the workers' shoes to collect relevant data, including temperature, altitude, and distance walked. The sensors should be designed to withstand harsh industrial environments.
- Cloud Storage and Analysis: The collected data is securely transmitted to the cloud for storage and analysis. This enables centralized access and allows for real-time monitoring of worker conditions.
- Mobile and Web Applications: A mobile application is developed to provide workers with personalized feedback and alerts regarding safety precautions based on their location and environmental conditions. A web application is created for authorities to monitor the overall safety status of workers and respond to any potential risks.
- Real-time Alerts and Precautions: The system employs data analysis algorithms to identify potentially hazardous conditions, such as working at

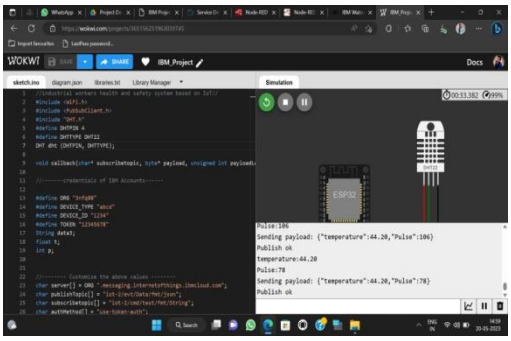
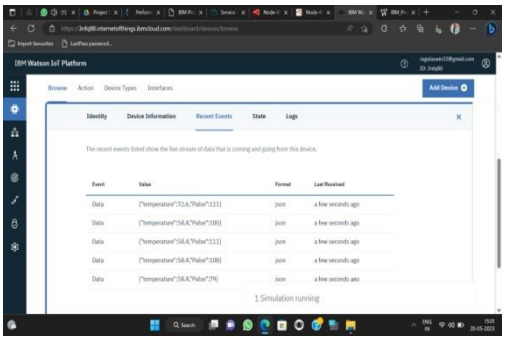
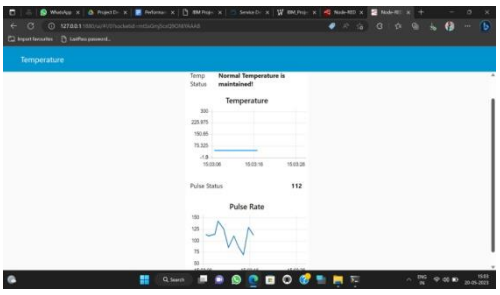
higher altitudes. It sends real-time alerts and necessary precautions to workers to enhance their safety and prevent accidents.

- Security and Privacy: Strong security measures are implemented to protect the collected data and ensure the privacy of workers. Encryption protocols, access controls, and secure communication channels are employed to prevent unauthorized access.
- Maintenance and Scalability: The system is designed for easy maintenance, with regular updates and calibration of sensors. It should also be scalable to accommodate a growing number of workers and provide reliable performance as the system expands.

Benefits

- Enhanced Worker Safety: By continuously monitoring and analyzing worker data, the system helps identify potential safety hazards and provides timely precautions, reducing the risk of accidents and injuries.
- Real-time Monitoring: Authorities can have a comprehensive overview of workers' status in real-time through the web application, allowing for quick response and intervention in case of emergencies.
- Improved Compliance: The system helps ensure compliance with safety regulations by automating data collection and providing an auditable record of safety measures taken.
- Cost Savings: By implementing proactive safety measures, the system can potentially reduce costs associated with worker injuries, medical expenses, and downtime due to accidents.

RESULT

Parameter	Values	Screenshot
Metrics	Execution time : 2.34 sec	  

ADVANTAGE AND DISADVANTAGE

Advantages

Real-time Monitoring: The use of sensors attached to workers' shoes enables real-time monitoring of various parameters such as temperature and altitude. This allows for immediate detection of potential safety hazards and timely intervention to prevent accidents.

Enhanced Safety: By continuously monitoring workers' conditions, the system can alert them and provide necessary precautions when working in higher altitudes. This proactive approach increases worker safety and reduces the risk of accidents or health issues.

Data-driven Insights: The collected data can be stored and analyzed in the cloud, providing valuable insights into workers' activities, environmental conditions, and potential risks. This data can be utilized to identify patterns, optimize safety procedures, and improve overall workplace safety.

Remote Access and Visualization: The mobile and web applications allow authorities to access and monitor workers' status from anywhere. This remote access facilitates real-time decision-making and enhances the effectiveness of safety management.

Disadvantages

Sensor Reliability: The accuracy and reliability of the sensors attached to the shoes can be a concern. Malfunctioning or inaccurate readings may lead to

false alarms or fail to detect actual safety hazards, compromising the effectiveness of the system.

Privacy Concerns: Collecting and storing workers' data, including their location and physical parameters, raises privacy concerns. Proper measures must be implemented to ensure data security, obtain informed consent, and comply with relevant privacy regulations.

Cost and Implementation: Implementing the system requires an initial investment in sensors, infrastructure, and software development. The cost may be a barrier for small industries or organizations with limited budgets.

Maintenance and Training: Regular maintenance and calibration of the sensors are necessary to ensure accurate readings. Additionally, training workers and authorities on using the system effectively can be time-consuming and require additional resources.

Compatibility and Integration: Ensuring compatibility and seamless integration between different sensors, the cloud storage system, and the mobile/web applications can be a challenge. The system's effectiveness relies on the smooth functioning of all components.

CONCLUSION

Implementing an Industrial Workers Health and Safety System based on IoT technology, specifically using sensors attached to workers' shoes, offers significant advantages in monitoring and enhancing worker safety. By recording data such as temperature measures, altitude parameters, and distance walked, and sending it to the cloud for storage and analysis, the system provides

valuable insights into the workers' conditions and potential hazards they may encounter.

The visual representation of this data through mobile and web applications enables authorities to monitor the status of each worker in real-time. By leveraging this information, proactive measures and precautions can be communicated to workers, especially those operating at higher altitudes where additional safety measures are crucial. This system helps improve worker safety by providing timely warnings and recommendations, ultimately reducing the risk of accidents and injuries.

Furthermore, the integration of IoT technology allows for efficient data collection, analysis, and decision-making. The system can identify patterns and trends, enabling proactive safety measures to be implemented across the organization. By centralizing data storage in the cloud, it becomes accessible from anywhere, facilitating better coordination and collaboration between authorities and workers.

However, successful implementation of an IoT-based safety system requires addressing challenges such as compatibility issues, security concerns, cost, and maintenance. Collaboration with IoT device manufacturers and ensuring compatibility standards can streamline integration. Implementing robust security measures, including encryption and access controls, is vital to protect sensitive worker data. Considering cost-effective IoT solutions and exploring potential funding options can help mitigate financial barriers. Regular maintenance and updates must be performed to ensure the system's reliability and accuracy.

In conclusion, an Industrial Workers Health and Safety System based on IoT technology, particularly utilizing shoe-attached sensors, has the potential to revolutionize workplace safety. By collecting and analyzing real-time data,

authorities can make informed decisions and provide necessary precautions to workers, reducing accidents and promoting a safer work environment.

FUTURE SCOPE

The future scope of an IoT-based Industrial Workers Health and Safety System is extensive, with potential advancements in predictive analytics, real-time monitoring, wearable device integration, augmented reality support, remote assistance, data-driven improvements, regulatory compliance, and enhanced data privacy and security measures. These advancements can significantly contribute to improving worker safety and reducing workplace accidents in various industries.

Appendix

Source code

```
//industrial workers health and safety system based on IoT//
#include <WiFi.h>
#include <PubSubClient.h>
#include "DHT.h"
#define DHTPIN 4
#define DHTTYPE DHT22
DHT dht (DHTPIN, DHTTYPE);

void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength);
```

```
//-------credentials of IBM Accounts------

#define ORG "3nfq88"
#define DEVICE_TYPE "abcd"
#define DEVICE_ID "1234"
#define TOKEN "12345678"
String data3;
float t;
int p;


//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/Data/fmt/json";
char subscribetopic[] = "iot-2/cmd/test/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;


//-----------------------------------------
WiFiClient wifiClient;
PubSubClient client(server, 1883, callback ,wifiClient);
void setup()
{
  Serial.begin(115200);
  dht.begin();
  delay(10);
  Serial.println();
```

```
  wificonnect();
  mqttconnect();
}

void loop()
{


  p= random(60,150);
  t = dht.readTemperature();
  Serial.print("temperature:");
  Serial.println(t);
  Serial.print("Pulse:");
  Serial.println(p);

  PublishData(t, p);
  delay(1000);
  if (!client.loop()) {
    mqttconnect();
  }
}



/*.....................................retrieving to Cloud.....................................*/

void PublishData(float temp, int pulse) {
  mqttconnect();

  String payload = "{\"temperature\":";
```

```
  payload += temp;
  payload += "," "\"Pulse\":";
  payload += pulse;
  payload += "}";


  Serial.print("Sending payload: ");
  Serial.println(payload);


  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish ok");
  } else {
    Serial.println("Publish failed");
  }

}
void mqttconnect() {
  if (!client.connected()) {
    Serial.print("Reconnecting client to ");
    Serial.println(server);
    while (!!!client.connect(clientId, authMethod, token)) {
      Serial.print(".");
      delay(500);
    }

     initManagedDevice();
     Serial.println();
  }
}
```

```
void wificonnect()
{
  Serial.println();
  Serial.print("Connecting to ");

  WiFi.begin("Wokwi-GUEST", "", 6);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

void initManagedDevice() {
  if (client.subscribe(subscribetopic)) {
    Serial.println((subscribetopic));
    Serial.println("subscribe to cmd OK");
  } else {
    Serial.println("subscribe to cmd FAILED");
  }
}

void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength)
{

  Serial.print("callback invoked for topic: ");
```

```
            Serial.println(subscribetopic);
            for (int i = 0; i < payloadLength; i++) {

              data3 += (char)payload[i];
            }

            Serial.println("data: "+ data3);

           data3="";


  }
```

Github link

https://github.com/naanmudhalvan-SI/IBM--8309-1682404214/tree/main

Drive link

https://drive.google.com/file/d/1M2JkL7e37qibh4ePKnfhsVmRh4ltX_ek/view?usp=drivesdk