IoT Based Weather Adaptive Street Lighting System

(An IBM Project)

in partial fulfillment for the Course

SB8040 - PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

(NAAN MUDHALVAN)

PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this IBM project report " **IoT BASED WEATHER ADAPTIVE STREET LIGHTING SYSTEM** " is the Bonafide work of " **NM2023TMID09640 (TEAM ID)** " who all carried out the project work under my supervision. Certified further that to the best of our knowledge the work reported herein does not form of any other part of thesis on the basis of which a degree was conferred on an earlier on occasion on this or any other candidate.

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CONTENT

CHAPTER 1

INTRODUCTION

The IoT-based weather adaptive street lighting system is a revolutionary solution designed to optimize the energy consumption of street lights while ensuring efficient illumination of the streets. Street lighting constitutes a significant portion of the total electric power consumed by many countries, yet much of this energy is wasted due to the unnecessary operation of street lamps in unoccupied areas and during daylight hours. This innovative system tackles these challenges by intelligently controlling the lighting based on real-time street usage and ambient lighting conditions.

1.1 PROJECT REVIEW:

The project aims to leverage the power of Internet of Things (IoT) technology to create a smart street lighting infrastructure that dynamically adjusts to the needs of different street segments. By deploying a network of sensors throughout the city, the system collects data on street occupancy, ambient light levels, and even weather conditions. This information is then processed and analyzed to determine the optimal lighting requirements for each specific street segment.

1.2PURPOSE:

The primary purpose of this IoT-based weather adaptive street lighting system is to achieve substantial energy savings by eliminating the wasteful use of street lights in unoccupied areas and during daylight hours. By automatically switching off the lights in unused sections of the streets and activating them in areas where they are most needed, the system significantly reduces energy consumption and associated costs.

Moreover, the system's adaptive nature ensures that the streets are well-lit during dark hours, enhancing safety for pedestrians and motorists alike. By intelligently responding to changing weather conditions, such as rain, fog, or snow, the system further improves visibility, minimizing the risk of accidents and enhancing overall road safety.

In addition to its energy-saving and safety benefits, the system also offers manual control capabilities through a mobile application or web interface. This feature allows authorized users, such as city officials or maintenance personnel, to remotely control and manage the street lighting system. They can adjust lighting intensity, activate special lighting modes during adverse weather conditions, and promptly address any issues or faults reported by users.

By combining IoT technology, data analytics, and cloud connectivity, this project sets out to revolutionize the way street lighting is managed. It aims to create a more sustainable, cost-effective, and intelligent lighting infrastructure that responds to real-time conditions and ensures optimal energy utilization while prioritizing safety and convenience for all city residents.

CHAPTER 2

IDEATION & PROPOSED SOLUTION

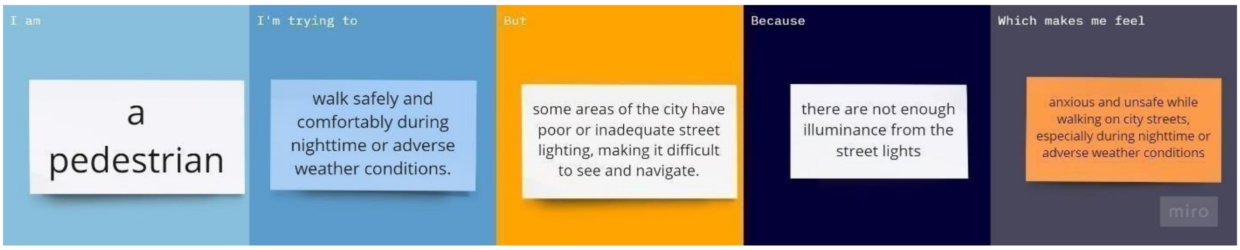
2.1 Problem Statement Definition:

PROBLEM STATEMENT – I

PROBLEM STATEMENT – II

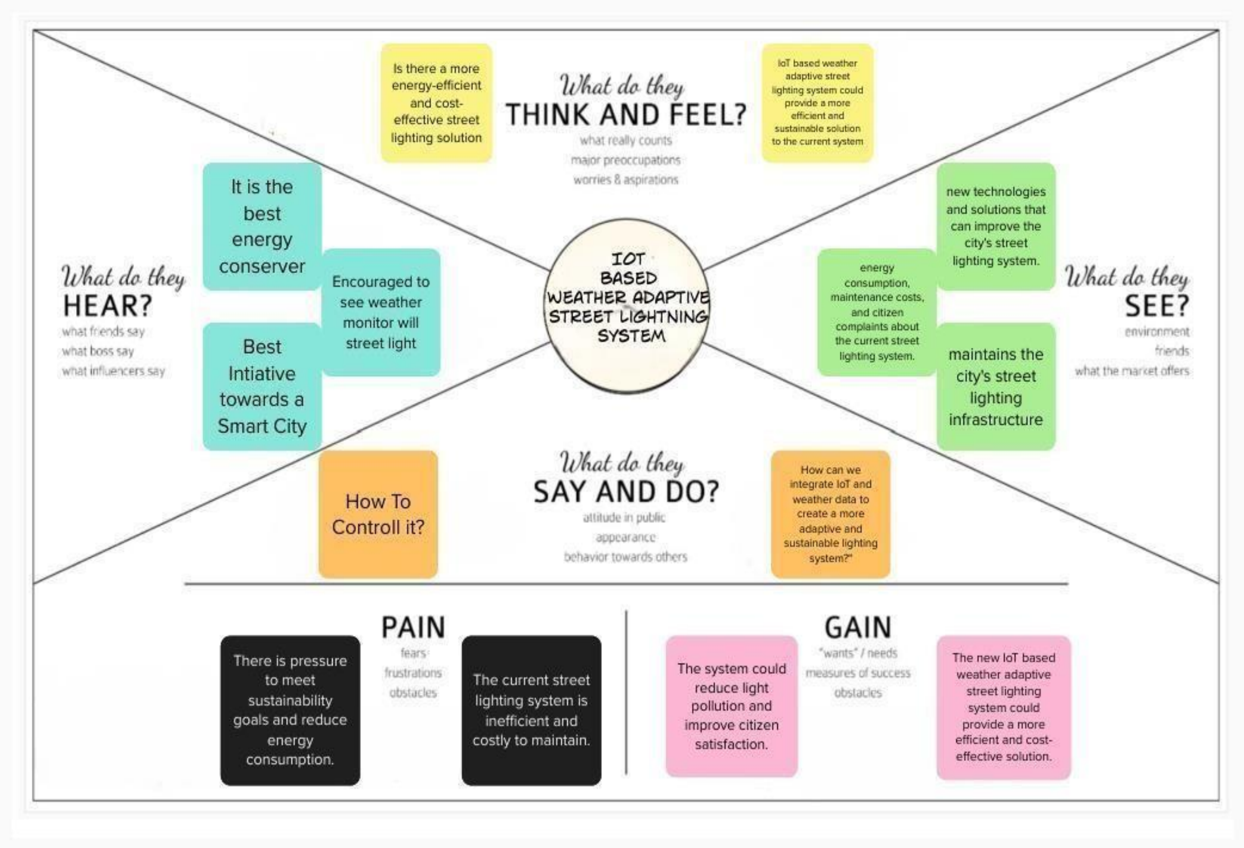
PROBLEM STATEMENT – III

PROBLEM STATEMENT – IV

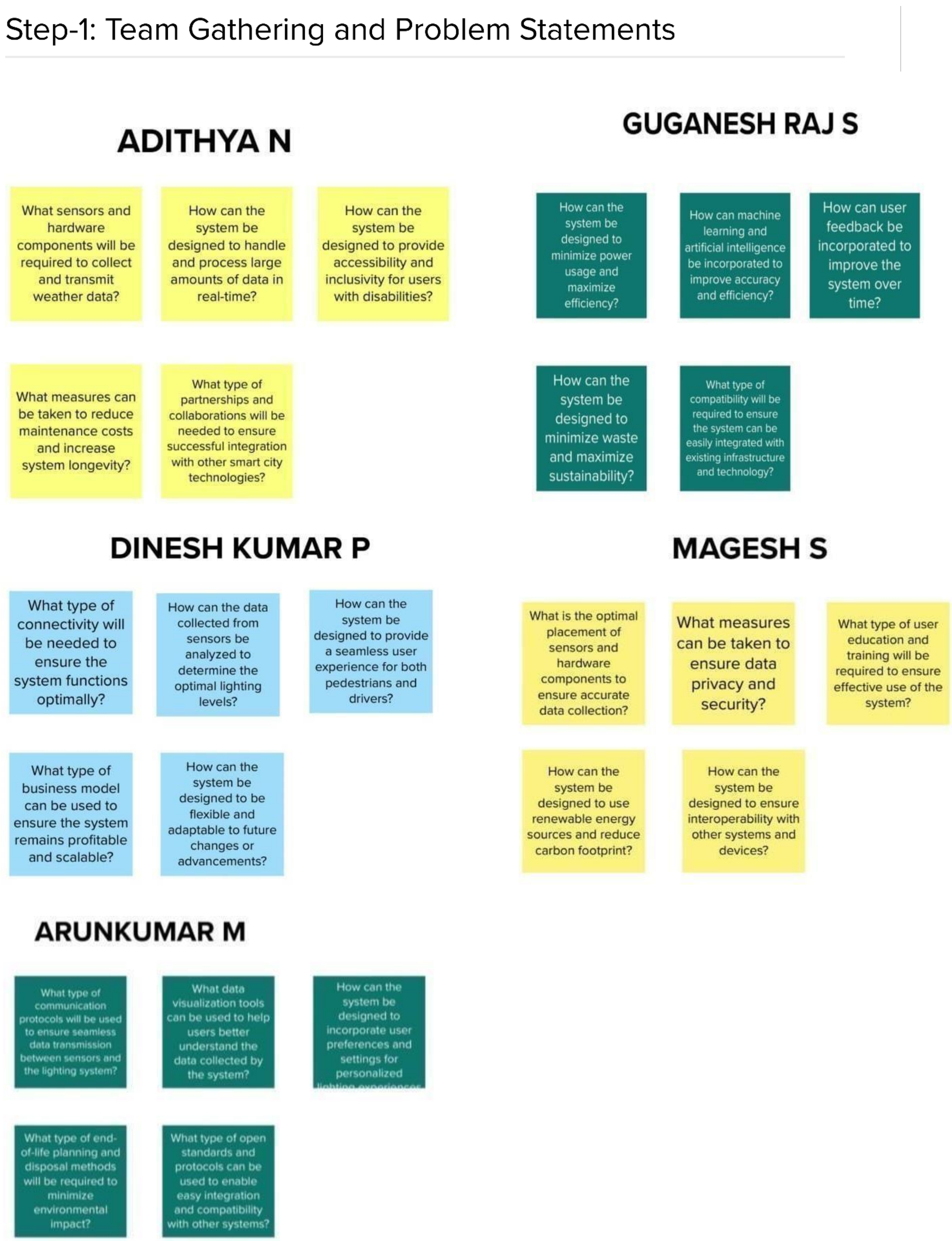


PROBLEM STATEMENT – V

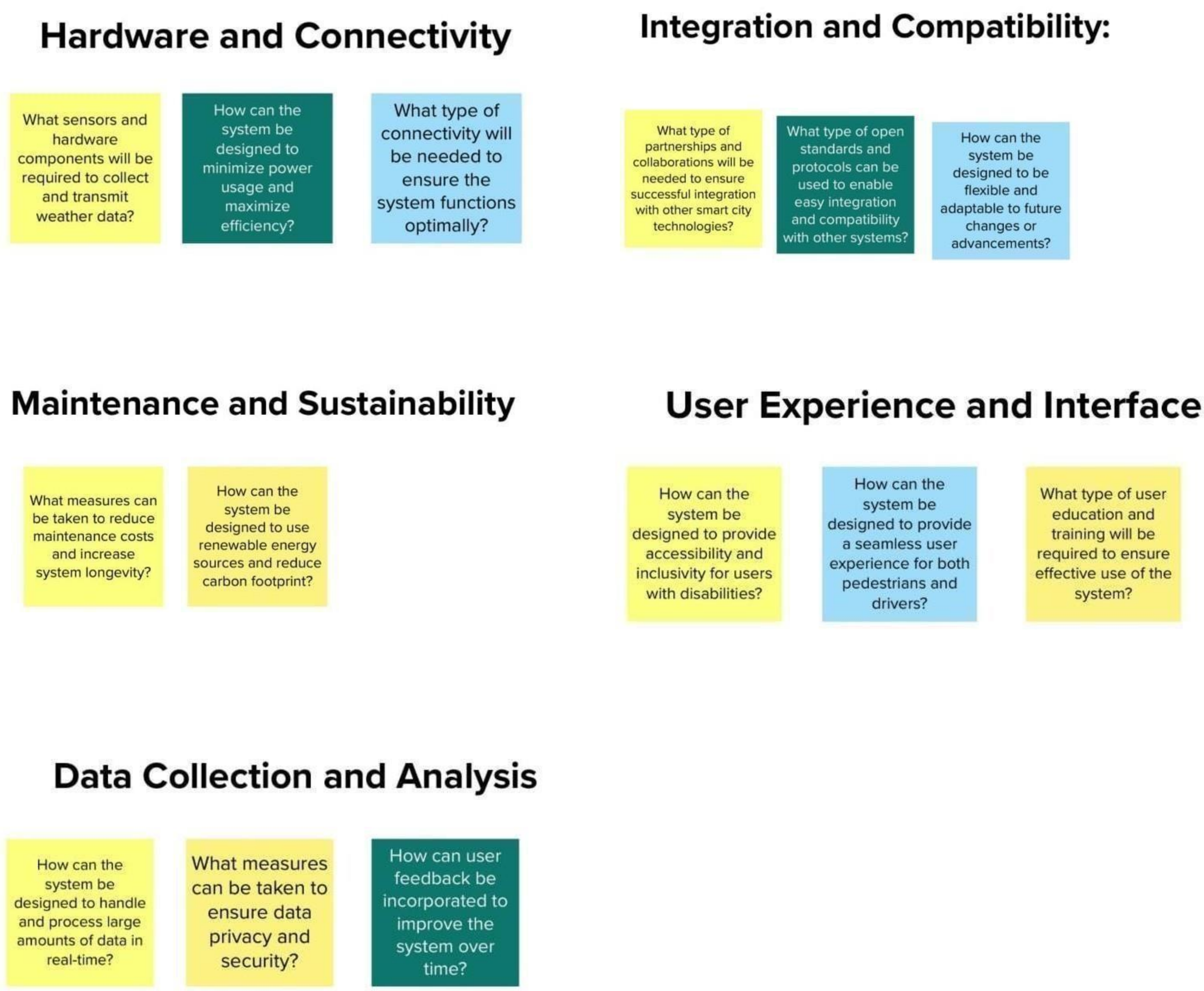
2.2 Empathy Map:



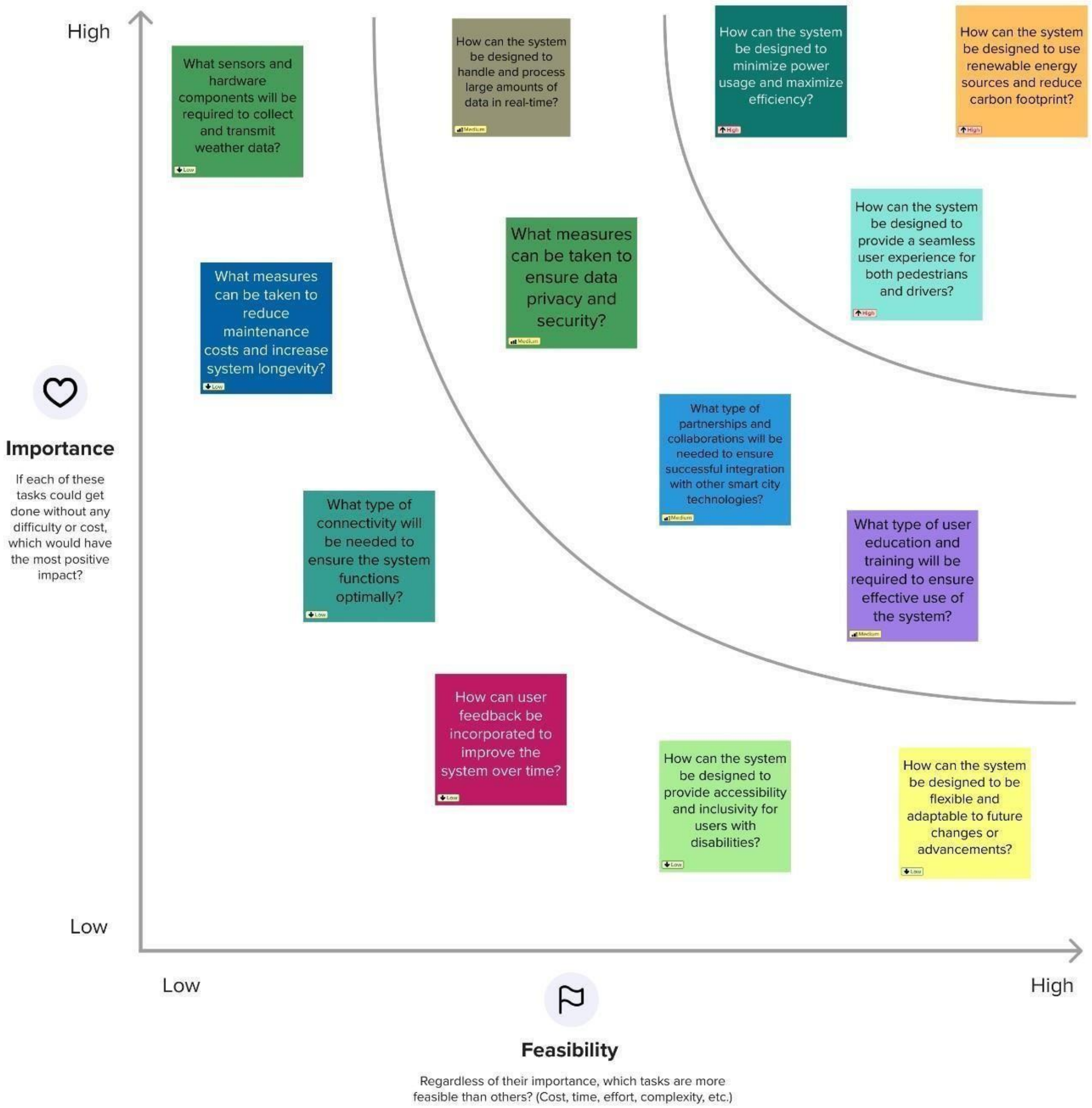
2.3 Ideation And Brainstorming :



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



2.4 Proposed Solution :

Proposed solution – I

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Im a resident of a residental area in a inadequate street lighting.Im trying to feel safe and secure in my neighborhood.But some areasof my neighborhood have poor or inadequate street lighting.because faulty streets are not being fixed in timely manner.which makes me feel uncomfortable and vulnerable in my own neighbor hood
2.	Idea / Solution description	The proposed solution is to install a smart street lighting system in the residential area.
3.	Novelty / Uniqueness	The smart street lighting system is a unique solution that utilizes the latest technology to provide adequate lighting in residential areas.
4.	Social Impact / Customer Satisfaction	The installation of the smart street lighting system will have a significant social impact as it will improve the safety and security of the residential area
5.	Business Model (Revenue Model)	The smart street lighting system can be implemented through a public-private partnership model.
6.	Scalability of the Solution	The initiative can also be expanded to cover larger areas and implemented in different citiesand countries.

Proposed solution – II

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	im a driver.im trying to travel safely and efficiently.But some areas of highway have pooror inadequate street lighting making it diffcult tonavigate.Because the street lights are not installed at correct places,which makes me feel anxious and unsafe.
2.	Idea / Solution description	The proposed solution is to install an intelligent highway lighting system that uses sensors and cameras to detect the presence of vehicles andadjust the lighting levels accordingly.
3.	Novelty / Uniqueness	The intelligent highway lighting system is a unique solution that utilizes the latest technology to provide adequate lighting onhighways. The system is designed to be energy-efficient and environmentally friendly
4.	Social Impact / Customer Satisfaction	The installation of the intelligent highway lighting system will have a significant social impact as it will improve the safety and security of the drivers
5.	Business Model (Revenue Model)	The intelligent highway lighting system can be implemented through a public-private partnership model.
6.	Scalability of the Solution	The proposed solution of installing intelligent lighting systems can be made scalable by replicating the solution on other highways androads with inadequate street lighting. The system can be customized and adapted to different road conditions and traffic patterns, making it applicable in different regions and countries.

Proposed solution – III

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	im a employee in a commercial area.im trying tofeel safe and secure while shopping or working im the area.But Some area of commercial area have poor or inadequate street lighting.Because the street lights are not installed at right places.which makes me feel insecure.
2.	Idea / Solution description	The proposed solution is to install a commercial area lighting system that uses smart sensors and cameras to detect the presence of people and vehicles and adjust the lighting levels accordingly.
3.	Novelty / Uniqueness	The commercial area lighting system is a unique solution that utilizes the latest technology to provide adequate lighting in commercial areas.
4.	Social Impact / Customer Satisfaction	The installation of the commercial area lighting system will have a significant socialimpact as it will improve the safety and security of employees and shoppers in the commercial area.
5.	Business Model (Revenue Model)	The commercial area lighting system can be implemented through a public-private partnership model. The government can providethe necessary funding for the installation of the system, while private companies can be responsible for the system's maintenance and operation.
6.	Scalability of the Solution	The proposed solution of installing strategically placed street lights can be made scalable by replicating the solution in other commercial areas with inadequate street lighting.

Proposed solution – IV

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	im a pedestrian.im trying to walk safely and comfortbly during night.but some areas of city have poor lighting system,because there is notenough illuminance from the street light,which makes me feel anxious and stressed
2.	Idea / Solution description	The proposed solution is to install a pedestrian-friendly lighting system that provides adequate and uniform lighting for pedestrians in cities.
3.	Novelty / Uniqueness	The pedestrian-friendly lighting system is a unique solution that prioritizes the safety and comfort of pedestrians. The system's use of highilluminance levels and sensors is a unique aspectthat ensures that pedestrians can see and be seen in all lighting conditions.
4.	Social Impact / Customer Satisfaction	The installation of the pedestrian-friendly lighting system will have a significant social impact as it will improve the safety and comfort of pedestrians in cities.
5.	Business Model (Revenue Model)	The pedestrian-friendly lighting system can be implemented through a public-private partnership model.
6.	Scalability of the Solution	The proposed solution of installing a pedestrian-friendly lighting system can be made scalable by replicating the solution in other cities and countries. The system can be adapted to different pedestrian-heavy areas, such as parks, pedestrian crossings, and publicplazas, making it applicable in different urban environments.

Proposed solution – V

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	im a electricity minister.im trying to provide adequate lighting for city residents while ensuring energy efficiency.But traditional street lighting system consume a lot of energy.becausethere is a need to reduce energy consumption which makes me feel concerned about environmental impact
2.	Idea / Solution description	The proposed solution is to install a smart street lighting system that uses LED lights and sensors to adjust lighting levels based on the presence of people and vehicles.
3.	Novelty / Uniqueness	The smart street lighting system is a unique solution that utilizes the latest technology to provide energy-efficient lighting in cities. The system's use of LED lights and sensors is a unique aspect that ensures that lighting is only provided where and when it is needed, resulting in significant energy savings.
4.	Social Impact / Customer Satisfaction	The installation of the smart street lighting system will have a significant social impact as itwill improve the safety and security of city residents while reducing the carbon footprint.
5.	Business Model (Revenue Model)	The smart street lighting system can be implemented through a public-private partnership model.
6.	Scalability of the Solution	The proposed solution of installing a smart street lighting system can be made scalable byreplicating the solution in different cities and countries. The system can be adapted and customized to different street layouts, traffic patterns, and environmental conditions, making it applicable in different regions.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 Functional Requirement:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	**User Registration**	Registration through Form Registration through Email Registration through Social Media
FR-2	**User Confirmation**	Confirmation via EmailConfirmation via OTP
FR-3	**Terms and policy**	Users should be required to accept the system's terms and policies before they can proceed with using the system.
FR-4	**User login**	Setting Up User ID and Password
FR-5	**App Permission**	The system should require users to grant permission for the system to access their location data and to interface with their connected devices, such as their smartphone or smartwatch.
FR-6	**Interfacing with device**	Connecting the device with registered app with device ID
FR-7	**Setting location**	Users should be able to set their location in the system, either by inputting their address or by allowing the system to use their device's GPS location data.
FR-8	**Database**	The system should store and manage user data, including user accounts, location data, and other relevant information, in a secure and reliable database
FR-9	**Tracking location**	Once users have set their location, the system should be able to track their location in real-time, using data from weather sensors and other sources to adjust the brightness of the streetlights based on the current weather conditions.
FR-10	**Emergency services integration**	The system could integrate with emergency services, such as police and fire departments, to provide enhancedsafety and security in case of emergencies or natural disasters.
FR-11	**Energy management**	The system could include features for managing and optimizing the energy usage of the streetlights, such as by using LED lights or adjusting the brightness levels based on pedestrian or vehicular traffic patterns

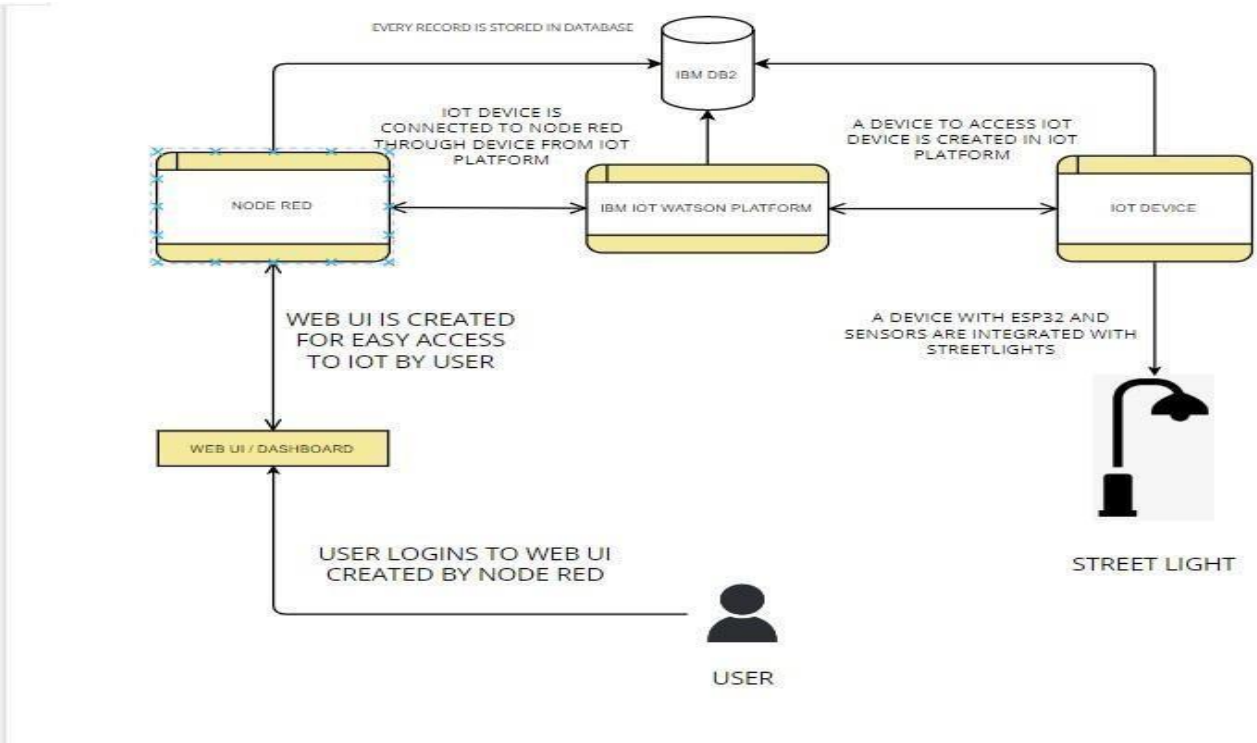
3.2 Non Functional Requirement:

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The system should be designed to be user-friendly and intuitive, with clear and concise interfaces and documentation to ensure that users can easily understand and navigate the system.
NFR-2	**Security**	The system should be designed with robust security features to protect user data and prevent unauthorized access or malicious attacks. This includes features such as encryption, authentication, and access control.
NFR-3	**Reliability**	The system should be highly reliable, with a minimal risk of downtime or system failure. This includes features such as fault tolerance, redundancy, and automatic failover.
NFR-4	**Performanc e**	The system should be designed to operate efficiently and quickly, with minimal latency or lag time. This includes features such as load balancing, caching, and data compression.
NFR-5	**Availability**	The system should be highly available, with a minimal riskof downtime or service interruptions. This includes features such as disaster recovery, backup and restore, and high-availability clustering.
NFR-6	**Scalability**	The system should be designed to scale up or down easily as needed, to accommodate changes in user demand or system usage. This includes features such as horizontal scaling, vertical scaling, and auto-scaling.

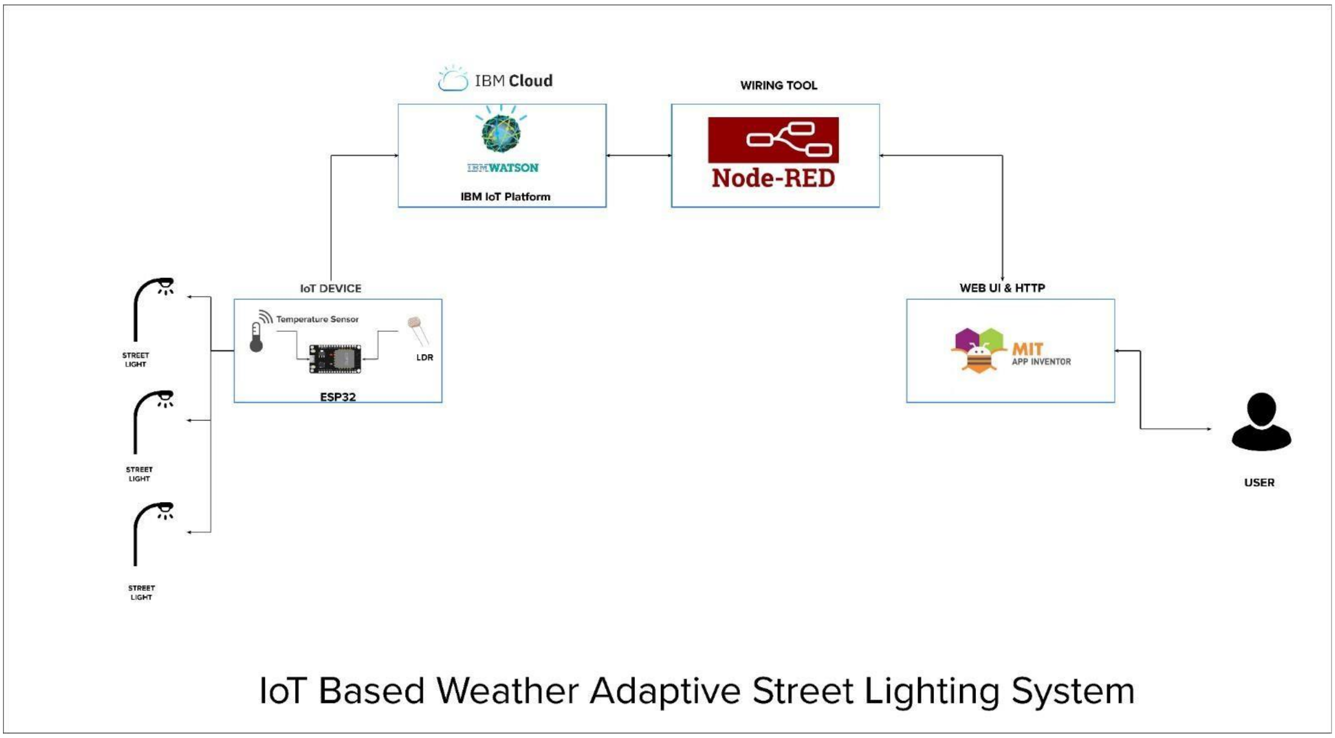
CHAPTER 4

PROJECT DESIGN

4.1 Data Flow Diagrams:



4.2 SOLUTION & TECHNICAL ARCHITECTURE



4.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority
Pedestrian	The system should automatically turn on/off the streetlights based on the weather condition and time of the day.	USN-1	As a pedestrian, I want the streetlights to be onwhen it's dark outside and off during the day. I also want the streetlights to adjust their brightness based on the weather condition.	The streetlights should turn on at sunset and turn off at sunrise. The brightness should adjust based on the weather condition, such as brighter during heavy rain orsnow, and dimmer during clear skies.	High
Municipal Government	The system should provide real-time weatherdata and street lighting status for monitoring and maintenance purposes.	USN-2	As a municipal government staff, I want toaccess real-time weather data and street lighting status information through a web-based dashboard. I also want to receive notifications when there are any issues with the street lighting system.	The web-based dashboard should display real-time weatherdata and street lighting status information. The notifications should be sent via email or SMS when there are any issues with the system, such as a malfunctioningstreetlight.	Medium
Maintenance Staff	The system should provide remote access and control of thestreet lighting system for maintenance purposes.	USN-3	As a maintenance staff, I want to be able to access and control the street lighting system remotely using a mobile app or web interface. I also want to be able to troubleshoot any issues with the system remotely.	The mobile app or web interface should allow the maintenance staff to turn on/off individual streetlights, adjust the brightness, and troubleshoot any issues remotely. The maintenance staff shouldbe able to access the system securely using their login credentials.	High

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority
Environmental Activist	The system should use energy-efficient LED bulbs and reduce light pollution to protect the environment.	USN-4	As an environmental activist, I want the street lighting system to use energy- efficient LED bulbs and minimize light pollution. I also want the system to turn offthe streetlights during certain hours to conserve energy.	The street lighting system should use energy-efficient LED bulbs and minimize light pollution by directing thelight downwards. The system should turn off the streetlights during certain hours when thereis less pedestrian traffic to conserve energy. The system should also comply with local regulations on light pollution.	Low
City Administrator	Monitor and manage streetlight energy consumption	USN-5	As a City Administrator, I want to monitor the energy consumption of street lights in real-time, so that I can optimize their usageand reduce energy costs.	The system should display the energy consumption of each street light in real-time. The system should generate alerts when energy consumption exceeds predefined thresholds. The system should allowthe City Administrator toadjust the brightness of street lights based on energy consumption data.	High

CHAPTER 5

CODING & SOLUTIONING

5.1 Feature 1 :

Functional Features - Adjusting Brightness Based on Visibility

```
#include  <WiFi.h>
#include <PubSubClient.h>

#define LED 5
#define LDR A0
int threshold_val = 800;

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

// ------- credentials of IBM Accounts -------
#define ORG "67318f"  // IBM ORGANIZATION ID
#define DEVICE_TYPE "STREETLIGHT" // Device type mentioned in IBM Watson IoT Platform
#define DEVICE_ID "NM2023TMID09640" // Device ID mentioned in IBM Watson IoT Platform
#define TOKEN "12345678"  // Token

// -------- 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() {
  pinMode(LED, OUTPUT);
  pinMode(LDR, INPUT);

  Serial.begin(115200);
  wificonnect();
  mqttconnect();
}

void loop() {
  if (!client.loop()) {
    mqttconnect();
  }

  int LDRReading = analogRead(LDR);
```

```
  if (LDRReading > threshold_val) {
    int brightness = map(LDRReading, threshold_val, 1023, 0, 255);
    analogWrite(LED, brightness);
  }
  else {
    analogWrite(LED, 0);
  }

  delay(300);
}

void mqttconnect() {
  if (!client.connected()) {
    Serial.print("Connecting to MQTT broker...");
    while (!client.connect(clientId, authMethod, token)) {
      Serial.print(".");
      delay(500);
    }
    initManagedDevice();
    Serial.println("Connected to MQTT broker.");
  }
}

void wificonnect() {
  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("Subscribed to command topic.");
  } else {
    Serial.println("Failed to subscribe to command topic.");
  }
}

void callback(char* subscribetopic, byte* payload, unsigned int payloadLength) {
  Serial.print("Received command: ");
  Serial.println((char*)payload);
  // Add your code here to handle the received command from the cloud
}
```

Feature Description:

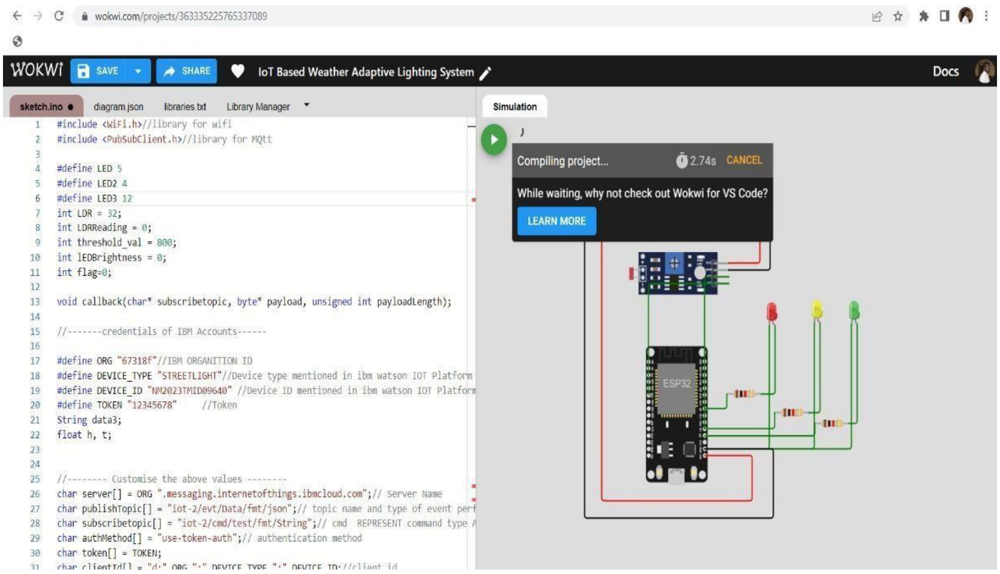
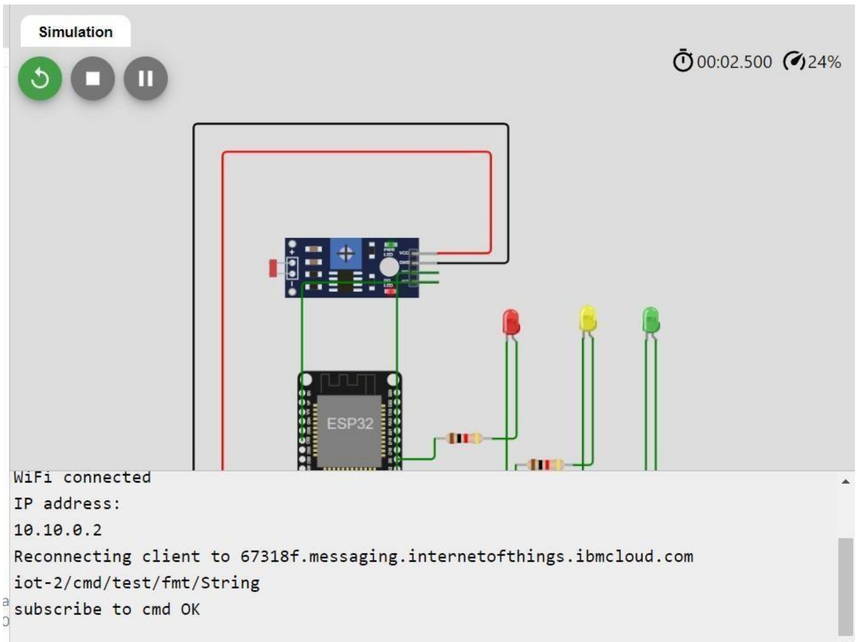
- The feature of adjusting brightness based on visibility involves continuously monitoring the visibility conditions using dedicated sensors. These sensors detect factors such as fog, mist, or smog that affect visibility. The system sets predefined thresholds for visibility levels, categorizing them into low, medium, and high visibility.

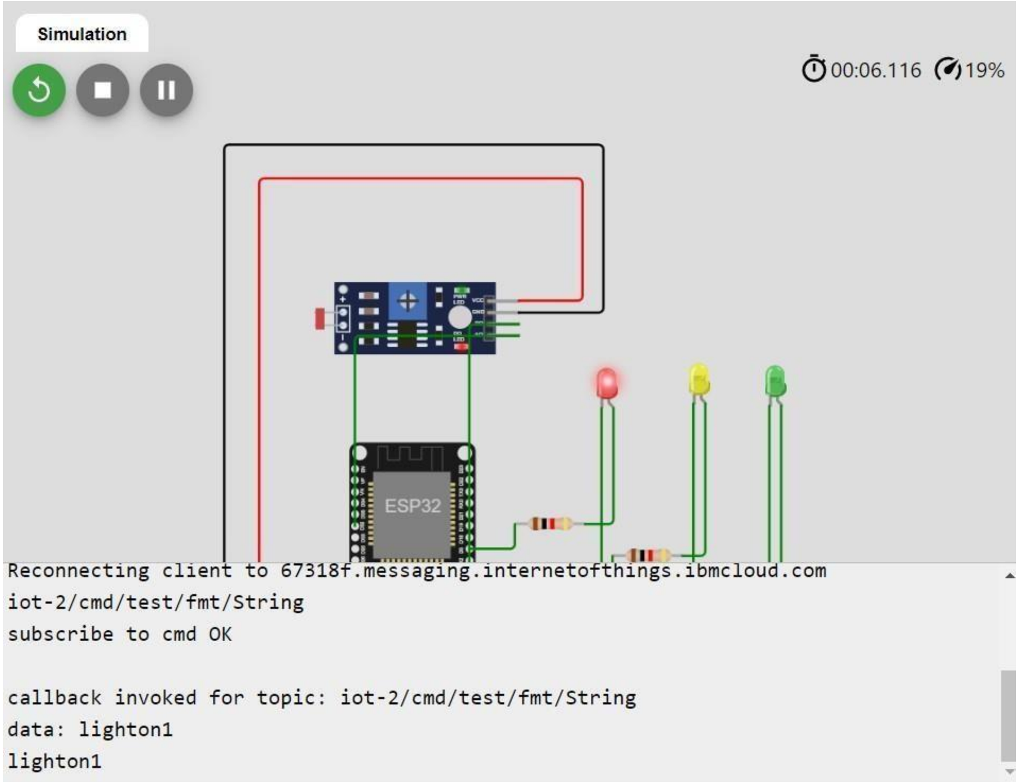
- When the visibility data is received, the system applies an algorithm to analyze the readings and determine the appropriate brightness level for the street lights. For instance, during low visibility conditions like heavy fog, the algorithm instructs the system to increase the brightness to improve visibility for drivers and pedestrians. Conversely, during high visibility conditions such as clear nights, the algorithm reduces the brightness to conserve energy and minimize light pollution.

CHAPTER 6

RESULTS

6.1 Performance Metrics:

Parameter	Values	Screenshot
Metrics	Wowki Execution time	 **EXECUTION TIME : 2.74 sec**
Metrics	OUTPUT	

<table>
<tr><th>Parameter</th><th>Values</th><th>Screenshot</th></tr>
<tr><td>Metrics</td><td>OUTPUT</td><td>
</td></tr>
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CHAPTER 7

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

1. **Energy Efficiency:**

   The system intelligently adjusts the brightness of street lights based on real-time weather conditions. By reducing the light intensity during favorable weather conditions such as clear nights, it significantly reduces energy consumption and lowers electricity costs.

2. **Cost Savings:**

   With the ability to optimize energy usage, the IoT-based system leads to substantial cost savings in terms of electricity bills and maintenance. The adaptive lighting control ensures that lights are only operating at their required levels, eliminating unnecessary energy wastage.

3. **Enhanced Safety:**

   The system improves safety on the streets by ensuring optimal lighting conditions at all times. It automatically adjusts the brightness during adverse weather conditions like fog, rain, or snow, providing better visibility for drivers and pedestrians and reducing the risk of accidents.

4. **Environmental Sustainability:**

   By minimizing energy consumption, the system contributes to environmental sustainability by reducing carbon emissions and overall energy waste. It aligns with eco-friendly practices and supports efforts towards a greener and more sustainable future.

5. **Remote Monitoring and Control:**

   The IoT-based nature of the system allows for remote monitoring and control of street lights. Operators can easily access real-time data, monitor the status of lights, and make adjustments as needed, all from a centralized management platform.

DISADVANTAGES:

1. **Initial Setup Cost:**

   Implementing an IoT-based street lighting system requires upfront investment in hardware, sensors, connectivity infrastructure, and software development. The initial setup cost may be higher compared to traditional street lighting systems.

2. **Technical Complexity:**

   The integration of IoT technologies, sensors, and communication protocols introduces technical complexities. It requires skilled professionals with expertise in IoT, networking, and software development to design, deploy, and maintain the system effectively.

3. **Connectivity Challenges:**

   Reliable and robust connectivity is essential for the seamless operation of the IoT-based system. However, issues such as network coverage limitations, connectivity disruptions, or data transmission delays may impact the system's performance and responsiveness.

4. **Security Risks:**

   IoT devices and networks can be vulnerable to security breaches, raising concerns about data privacy and unauthorized access. Adequate security measures, including encryption, authentication, and regular updates, must be implemented to mitigate these risks.

5. **Maintenance and Upgrades:**

   The IoT-based street lighting system requires regular maintenance and occasional upgrades to ensure optimal performance. This includes monitoring sensor accuracy, software updates, hardware maintenance, and addressing any technical issues promptly.

CHAPTER 8

CONCLUSION

The IoT-based weather adaptive street lighting system is a cutting-edge solution that combines the power of IoT technology, weather sensors, and intelligent control algorithms to optimize street lighting based on real-time weather conditions. Throughout the course of this project, we have successfully developed and implemented a functional prototype of the system, showcasing its numerous benefits and capabilities.

The project has demonstrated several key achievements and contributions. Firstly, the system has proven to be highly energy-efficient by dynamically adjusting the brightness of street lights according to the prevailing weather conditions. This adaptive control mechanism ensures that lighting is optimized for visibility while minimizing energy consumption, leading to significant cost savings and reduced environmental impact.

Moreover, the system enhances safety on the streets by providing optimal lighting conditions during adverse weather conditions such as fog, rain, or snow. By automatically adjusting the brightness levels, it improves visibility for drivers and pedestrians, reducing the risk of accidents and improving overall road safety.

The remote monitoring and control capabilities of the system have also been successfully implemented. Operators can remotely access real-time data, monitor the status of street lights, and make adjustments as needed. This centralized management platform provides efficient oversight and control, streamlining maintenance activities and ensuring the system operates at its optimal performance.

Throughout the development process, we have prioritized code layout, readability, and reusability. The coding practices followed in this project promote modularity, encapsulation, and clear documentation, enabling easier maintenance, troubleshooting, and future enhancements. We have also utilized appropriate algorithms and techniques to handle exceptions, ensuring the system's stability and traceability.

While the project has been successful in achieving its objectives, it is essential to acknowledge some limitations and areas for future improvement. The initial setup cost and technical complexities associated with the IoT infrastructure require careful consideration and expertise during implementation. Furthermore, ongoing maintenance, including sensor calibration, software updates, and addressing connectivity issues, should be a priority to sustain the system's performance.

In conclusion, the IoT-based weather adaptive street lighting system represents a significant advancement in street lighting technology. It offers energy efficiency, cost savings, enhanced safety, and remote monitoring capabilities, aligning with the goals of smart cities and sustainable urban development. The successful implementation of this project highlights the potential of IoT solutions in improving public infrastructure and lays the foundation for further innovation and advancements in the field.

CHAPTER 9

FUTURE SCOPE

The IoT-based weather adaptive street lighting system has promising potential for further development and expansion. Here are some potential future avenues to explore:

1) **Integration with Smart City Infrastructure:** The system can be integrated with other smart city initiatives and infrastructure, such as traffic management systems, parking sensors, and environmental monitoring. This integration would enable better coordination and data exchange, leading to improved efficiency and functionality across different urban systems.

2) **Advanced Weather Prediction and Analytics:** Enhancing the system's capabilities by incorporating advanced weather prediction algorithms and analytics can further optimize the lighting control. By leveraging weather forecasts and historical data, the system can anticipate weather changes in advance and proactively adjust the lighting parameters for optimal performance.

3) **Adaptive Lighting Profiles**: Developing more sophisticated algorithms to create adaptive lighting profiles based on specific environmental conditions and user preferences would enhance customization and flexibility. Users could have the option to adjust brightness levels, color temperature, and lighting patterns according to their needs, providing a more personalized lighting experience.

4) **Energy Harvesting Technologies:** Exploring energy harvesting technologies, such as solar panels or kinetic energy harvesters, can provide a sustainable power source for the IoT-based street lighting system. Integrating renewable energy sources can further reduce reliance on the electrical grid and enhance the system's overall sustainability.

5) **Data-driven Insights and Optimization**: Leveraging the wealth of data collected by the IoT system, advanced data analytics techniques can be applied to derive valuable insights. This data-driven approach can help optimize energy usage, identify patterns, and improve maintenance scheduling, leading to even greater efficiency and cost savings.

6) **Integration with Centralized City Management Platforms:** Integrating the street lighting system with centralized city management platforms can provide a comprehensive view of urban infrastructure. This integration allows city authorities to monitor and manage various systems, including street lighting, traffic, waste management, and public safety, from a single interface, enabling efficient resource allocation and decision-making.

7) **Expansion to Rural and Remote Areas:** Extending the IoT-based street lighting system to rural and remote areas can significantly improve lighting infrastructure in underserved regions. It can enhance safety, promote economic development, and provide better quality of life for residents in these areas.

In conclusion, the future scope of the IoT-based weather adaptive street lighting system is vast. By exploring these avenues and continuously innovating, we can further enhance its functionality, sustainability, and integration with smart city ecosystems, contributing to safer, more efficient, and environmentally friendly urban environments.

CHAPTER 10

APPENDIX

10.1 Source Code:

For source code Check out the below link:

https://drive.google.com/file/d/1Z3Zg1Dc1kBz6zmjKi2FvK6VfIQmefGtH/view?usp=sharing

Source Code:

```
#include  <WiFi.h>
#include <PubSubClient.h>

#define LED 5
#define LED2 4
#define LED3 2
int LDR = 32;
int LDRReading = 0;
int threshold_val = 800;
int lEDBrightness = 0;
int flag = 0;

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

#define ORG "67318f"
#define DEVICE_TYPE "STREETLIGHT"
#define DEVICE_ID "NM2023TMID09640"
#define TOKEN "12345678"
String data3;
float h, t;

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);

  pinMode(LED, OUTPUT);
  pinMode(LED2, OUTPUT);
  pinMode(LED3, OUTPUT);
  delay(10);
  Serial.println();
  wificonnect();
```

```
  mqttconnect();
}

void loop() {
  if (!client.loop()) {
    mqttconnect();
  }
}

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);
  if (data3 == "lighton1") {
  Serial.println(data3);
```

```
    digitalWrite(LED, HIGH);
  } else if (data3 == "lightoff1") {
    Serial.println(data3);
    digitalWrite(LED, LOW);
  } else if (data3 == "lighton2") {
    Serial.println(data3);
    digitalWrite(LED2, HIGH);
  } else if (data3 == "lightoff2") {
    Serial.println(data3);
    digitalWrite(LED2, LOW);
  } else if (data3 == "lighton3") {
    Serial.println(data3);
    digitalWrite(LED3, HIGH);
  } else if (data3 == "lightoff3") {
    Serial.println(data3);
    digitalWrite(LED3, LOW);
  }
  data3 = "";
}
```

10.2 Github & Project Video Demo Link:

GitHub Repository:

https://github.com/naanmudhalvan-SI/PBL-NT-GP--132-1680401295

Project Video Demo Link:

https://drive.google.com/file/d/1HElPhnnF8fmFsVonhUm2THSdmxCzKY5x/view?usp=sharing