MEENAKSHI SUNDARARAJAN ENGINEERING COLLEGE

Kodambakkam, Chennai-600024.

SB8040 PROFESSIONAL READINGS FOR INNOVATION, EMPLOYMENT AND ENTERPRENEURSHIP

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

TOPIC: IoT Based Weather adaptive Street Lighting System

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Project submitted by,

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ABSTRACT

As we know in present era everything is based on digital technology. Adaptive street lights are a new lighting technology that uses sensors and controls to adjust their brightness based on various factors, such as the presence of people or vehicles, weather conditions, and time of day. This technology has the potential to revolutionize the way we light our cities and towns, providing a more efficient and sustainable way to provide safe and comfortable lighting to our communities.The benefits of adaptive street lights are numerous.

They can reduce energy consumption and carbonemissions, save money on electricity costs, improve safety for pedestriansand drivers, and provide better visibility in different weather conditions.Adaptive street lights can also be integrated with other smart city technologies, such as traffic management systems and environmental sensors, to optimize infrastructure and services, leading to a more efficient and sustainable urban environment.While there are some disadvantages to this technology, such as cost and maintenance requirements, the potential benefits far outweigh the drawbacks. Finally, a user study was conducted to analyze the user experience of the system developed.

Project Report Format

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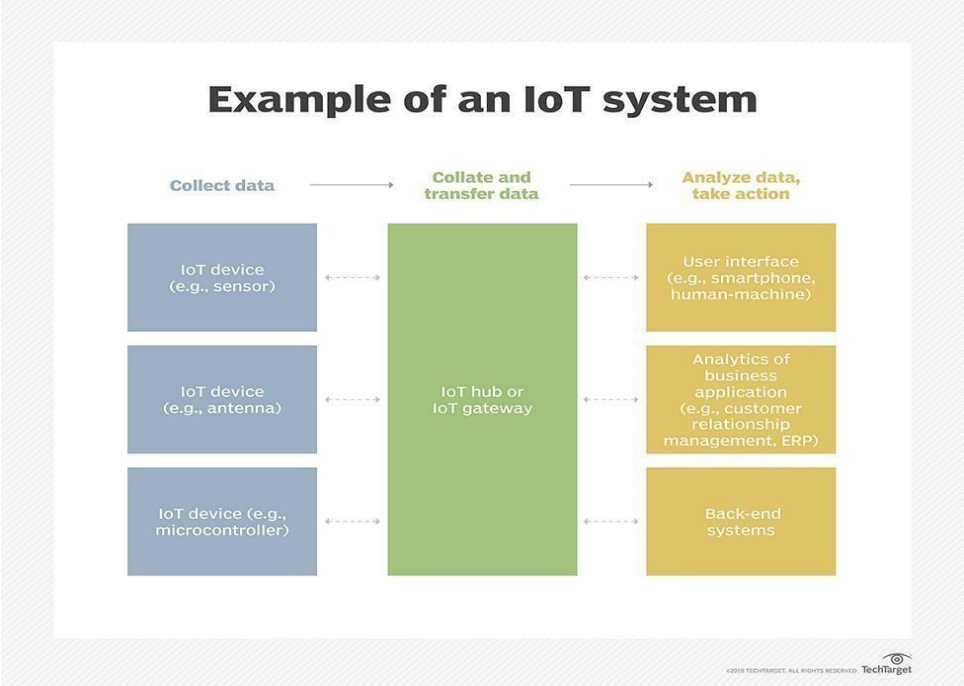
GitHub & Project Video Demo Link

INTRODUCTION

Internet of Things (IOT) is a network of physical objects or people called “things” that are embedded with software, electronics, network, and sensors that allows these objects to collect and exchange data. The goal of IOT is to extend to internetconnectivity from standard devices like computer, mobile, tablet to relatively dumb deviceslike a toaster. IOT makes virtually everything “smart,” by improving aspects of our life with the power of data collection, AI algorithm, and networks. The thing in IOT can also be aperson with a diabetes monitor implant, an animal with tracking devices, etc.

How IOT works?



An IOT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. **IOT devices** share the sensor data they collectby connecting to an IOT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devicesdo most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

Define the Problem Statements

Customer Problem Statement :

Adaptive street lights use sensors to detect changes in ambient light and adjust their brightness accordingly. However, they may not always be able to accurately detect other environmental factors such as heavy rain or snow, which could significantly reduce visibility and increase the risk of accidents. This problem is compounded by the fact that drivers may be less cautious in adverse weather conditions if they assume that the street lights are providing adequate visibility. As a result, it is important to ensure that adaptive street lights are designed to detect a wide range of environmental factors and adjust their brightness and intensity accordingly to ensure the safety of drivers and pedestrians in all weather conditions**.**

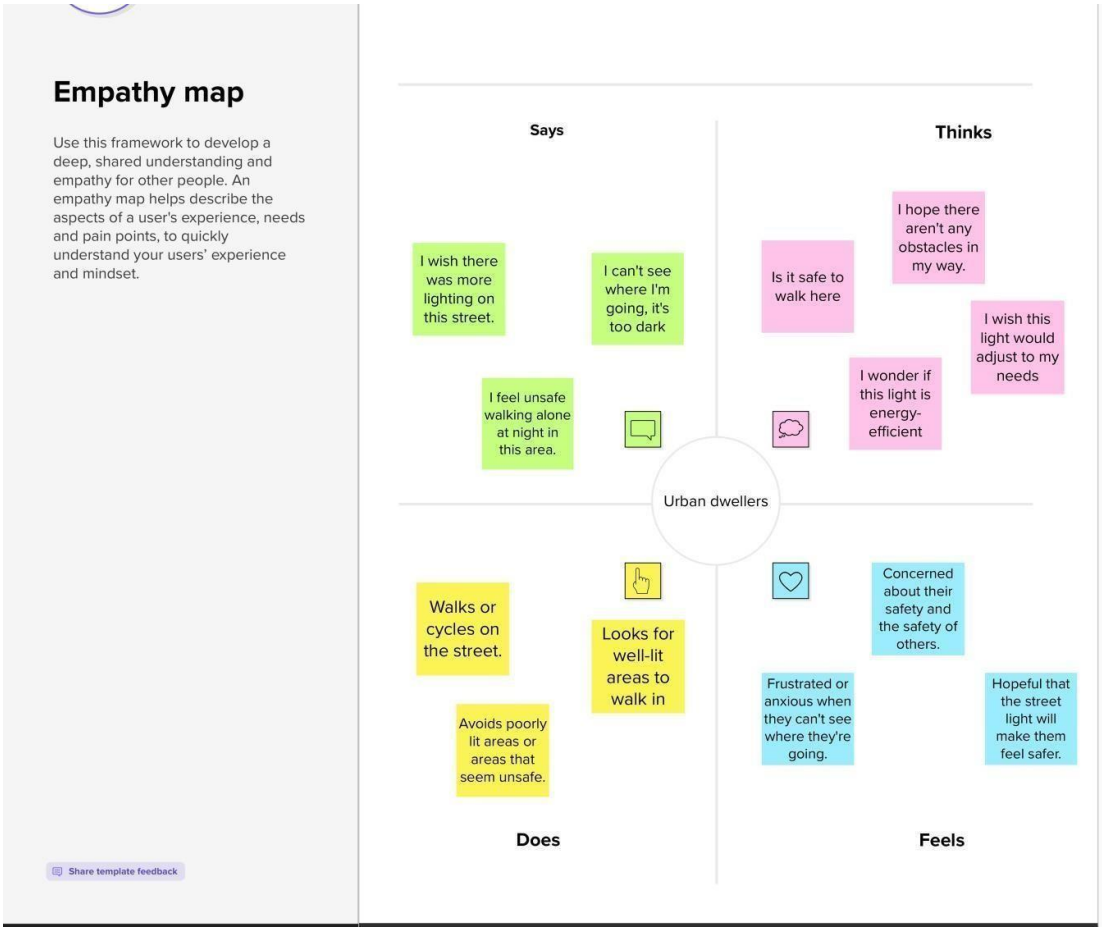
Problem ment(PS)	I am	I'm tryingto	But	Because	Which makes mefeel
PS-1	I am a pedestrian or driver	I am trying to use the advance sensor that can detect changes in ambient light and adjust the brightness and intensity of the lights accordingly.	but I am facing difficulties	Because of this, I feel anxious about my safety while walking or driving in poorly lit areas. system.	These difficulties cause me to feel frustrated and concerned about the effectiveness of the adaptive street light

Ideation Phase
Empathize & Discover

Empathy Map Canvas:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.
Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

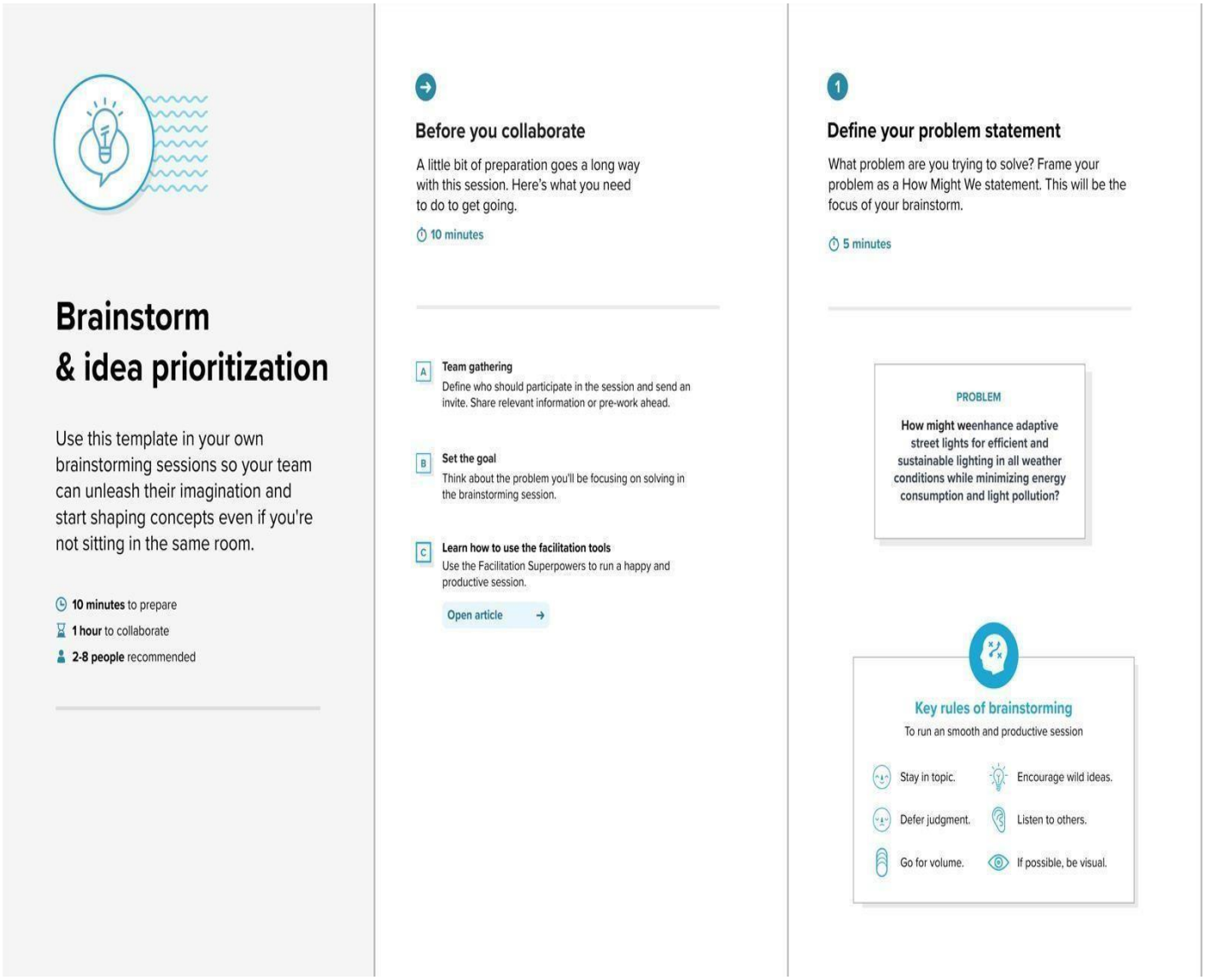


Brainstorm & Idea Prioritization Template

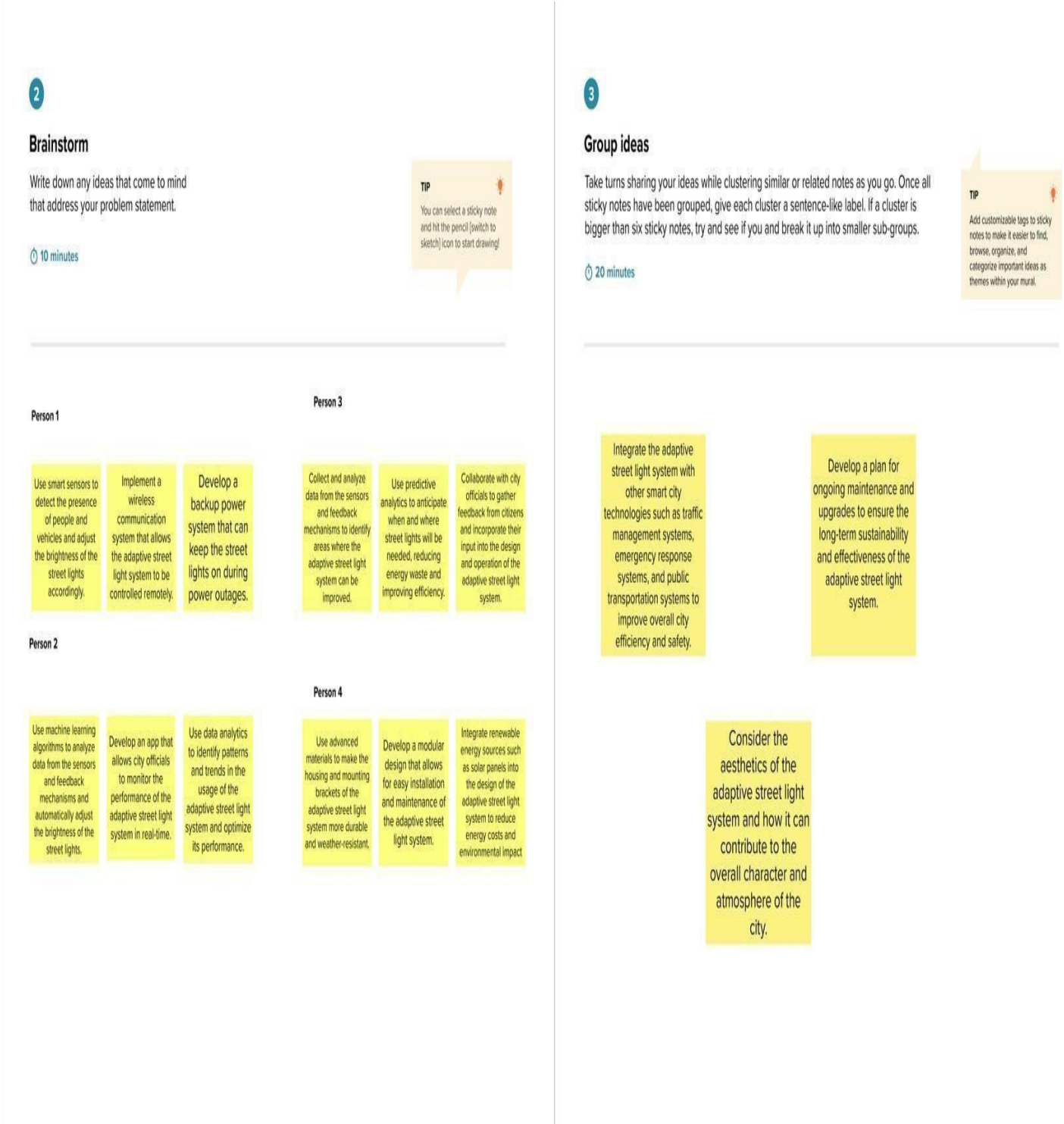
Brainstorm & Idea Prioritization Template:

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions. Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room

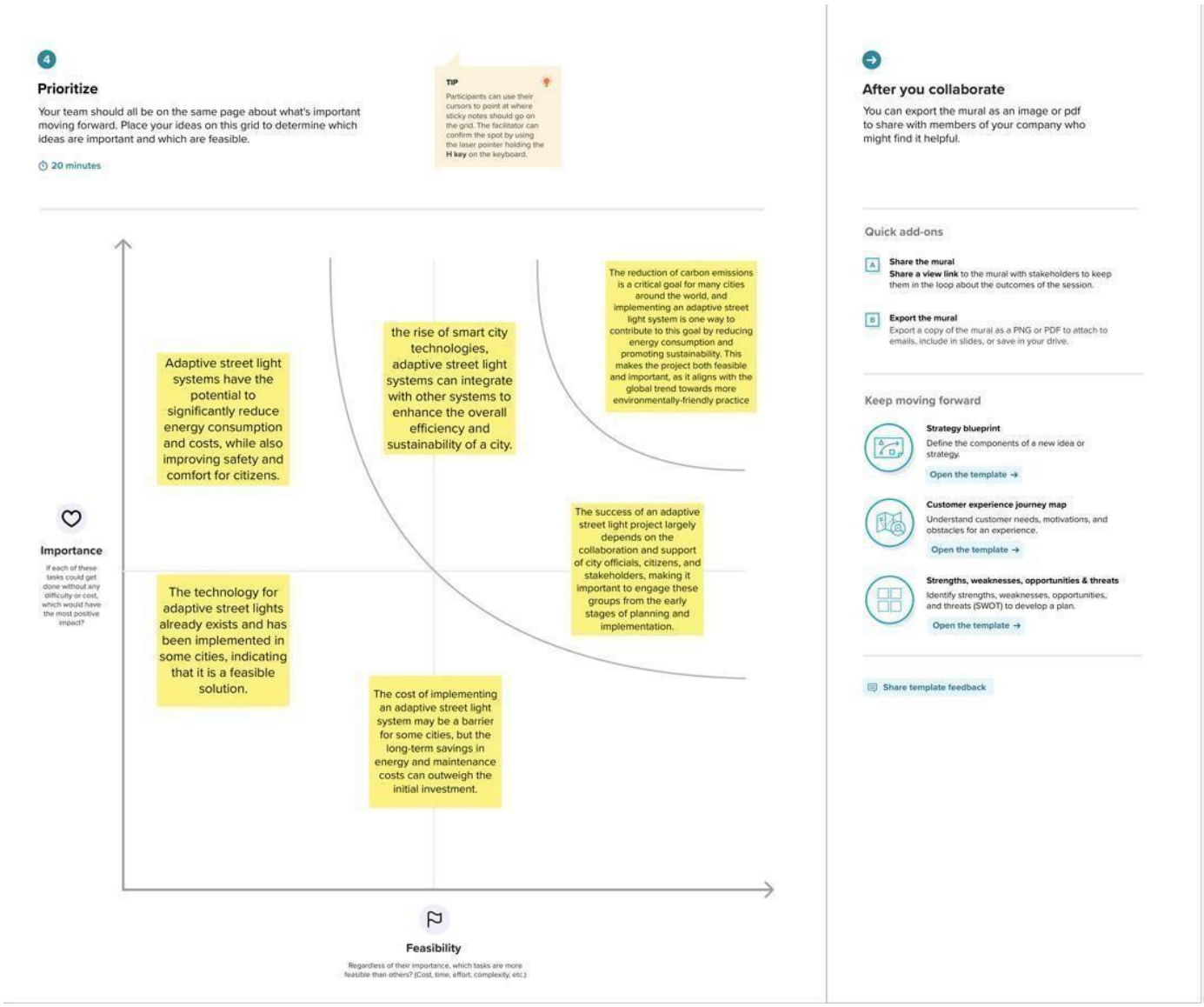
Step 1: Team Gathering, Collaboration and Select the Problem Statemet



Step 2: Brainstorm, Idea Listing and Grouping



Step 3: Idea Prioritization



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Adaptive street lights use sensors to detect changes in ambient light and adjust their brightness accordingly. However, they may not always be able to accurately detect other environmental factors such as heavy rain or snow, which could significantly reduce visibility and increase the risk of accidents. This problem is compounded by the fact that drivers may be less cautious in adverse weather conditions if they assume that the street lights are providing adequate visibility. As a result, it is important to ensure that adaptive street lights are designed to detect a wide range of environmental factors and adjust their brightness and intensity accordingly to ensure the safety of drivers and pedestrians in all weather conditions**.**

Problemmet (PS)	I am	I'm tryingto	But	Because	Which makes mefeel
PS-1	I am a pedestrian or driver	I am trying to use the advance sensor that can detect changes in ambient light and adjust the brightness and intensity of the lights accordingly.	but I am facing difficulties	Because of this, I feel anxious about my safety while walking or driving in poorly lit areas. system.	These difficulties cause me to feel frustrated and concerned about the effectiveness of the adaptive street light

Proposed Solution Template:

Project team shall fill the following information in the proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Drowsy driving can lead to accidents that result in significant property damage, injury, or death These accidents can cause a financial burden on individuals, insurance companies, and society as a whole.The problem of drowsy driving is likely to become more significant as the use of autonomous vehicles increases.Therefore, there is a need for a reliable and practical solution that can detect drowsiness in real-time and alert drivers or autonomous vehicles '
2.	Idea / Solution description	passengers before an accident occurs The proposed drowsiness detection and alerting system using the EAR algorithm can provide a solution to this problem.The system will use a camera mounted on the dashboard of the car to monitor the driver's eyes. The EAR algorithm uses computer vision to analyze the changes in the ratio between the length and width of the eye region to determine if the driver is getting drowsy. The system can also provide a warning if the driver's eyes are closed for an extended period, indicating that they may have fallen asleep.The algorithm is accurate and reliable, even in low light conditions, making it ideal for
3.	Novelty / Uniqueness	use in a car.If the system detects that the driver is getting drowsy, it will trigger an alarm or vibration to alert the driver to take necessary action, such as taking a break or pulling over. The proposed system uses the EAR algorithm, which is a unique approach compared to traditional systems The system can be customized to each driver's facial features and

		driver. The alerting mechanism can also be customized based on the driver's preference.
4.	SocialImpact / Customer Satisfaction	The proposed system can significantly reduce the number of accidents caused by drowsy driving, potentially saving many lives. Additionally, the system can provide peace of mind for drivers who often drive long distances or work long hours, knowing that they have a reliable system to keep them safe on the road.The system's customization features can provide a personalized experience for each driver, increasing their satisfaction with the product.
5.	Business Model (Revenue Model)	The drowsiness detection and alerting system can be sold as an aftermarket product to car owners or integrated into new cars as a feature. The system's data can be used to provide insights into the driver's behavior and potentially be sold to insurance companies. The system can potentially form partnerships with car manufacturers, insurance companies, and other stakeholders in the automotive industry. These partnerships can provide additional revenue streams and increase the system's adoption by car owners
6.	Scalability of the Solution	The proposed system can be easily scaled up to meet the demand for the product. Additionally, the system can be integrated with other smart car features such as autonomous driving and parking, making it a valuable addition to the car of the future.

Solution Requirements
(Functional & Non-functional)

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User authentication:	Biometric authentication Smart card authentication Gmail and
FR-2	Registration and tracking:	The system can use GPS tracking Barcoding. This data can be integrated into a central management system to track the status andmaintenance needs of each street light.
FR-3	Real-time Weather Monitoring	The system should have sensors to measure weather parameters such as temperature, humidity, and precipitation in real-time This information should be fed into the system to determine the required lighting levels. Methods to implement this requirement include installing weather sensors and using wireless communication to transmit data to the system's control center.
FR-4	Energy Efficiency:	The system should be designed to conserve energy while still maintaining safe lighting levels. This can be achieved by using LED lights that are energy-efficient and have a long lifespan. Additionally, the system should have an automatic shut-off feature that turns off the lights during daylight hours to save energy.
FR-5	Maintenance and Diagnostics	The system should be designed to provide maintenance alerts and diagnostics to ensure optimal performance. For example, the system can detect when a light bulb needs to be replaced and send an alert to maintenance staff. Additionally, the system should have self-diagnostic features that detect faults and notify operators. Methods to implement this requirement include using sensors to monitor system performance and setting up an alert system to notify maintenance staff.
FR-6	Data Analytics	The street lights should collect and analyze data to optimize their operation and reduce energy consumption. This can be achieved by implementing data analytics algorithms that analyze data from the sensors and make recommendations based on the data. To implement data analytics, a system should be installed that collects data from the sensors in the street lights and analyzes it using data analytics algorithms. The algorithms should be designed to identify patterns in the data and make recommendations based on the patterns.

Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	User-friendly interface that allows for easy and intuitive customization of lighting settings based on weather conditions. This could include features such as adjusting brightness levels, colour ,temperature, and light direction to enhance visibility in foggy or snowy conditions. Additionally, the street light could be equipped with sensors to detect weather conditions and automatically adjust lighting settings accordingly, without requiring user input
NFR-2	**Security**	Security is an important non-functional requirement for the weather adaptive street light project. The street light should be designed with security features to prevent unauthorized access, tampering, or hacking. This is particularly important for smart street lights that are connected to the internet or other networked devices.
NFR-3	**Reliability**	The street light could be equipped with redundant components, such as backup power sources or duplicate sensors, to ensure that it continues to operate even in the event of component failures. Additionally, regular maintenance and testing should be performed to identify and address potential issues before they result in downtime or reduced performance. The street light should also be designed to withstand harsh weather conditions, such as high winds, heavy rain, or extreme temperatures, without affecting its performance or reliability.
NFR-4	**Performance**	The street light could be equipped with high-quality sensors and processors that can quickly detect changes in weather conditions and adjust lighting settings accordingly. Additionally, the street light should be designed to optimize energy efficiency, using energy-saving technologies such as LED lighting and intelligent power management systems. The street light should also be capable of operating at peak performance under varying environmental conditions, such as extreme temperatures or humidity levels. This could involve using heat dissipation technologies to prevent overheating
NFR-5	**Availability**	The street light should also be designed to have a long service life, with components and materials that can withstand the wear and tear of continuous use over an extended period of time. This could involve using high-quality materials and manufacturing processes to ensure that the street light is built to last.
NFR-6	**Scalability**	The street light could be designed with modular components that can be easily added or removed as needed, allowing for the system to be expanded or reduced as necessary. Additionally, the street light should be designed to integrate with other smart city systems, such as traffic management or emergency response systems, to provide a more comprehensive and connected solution.

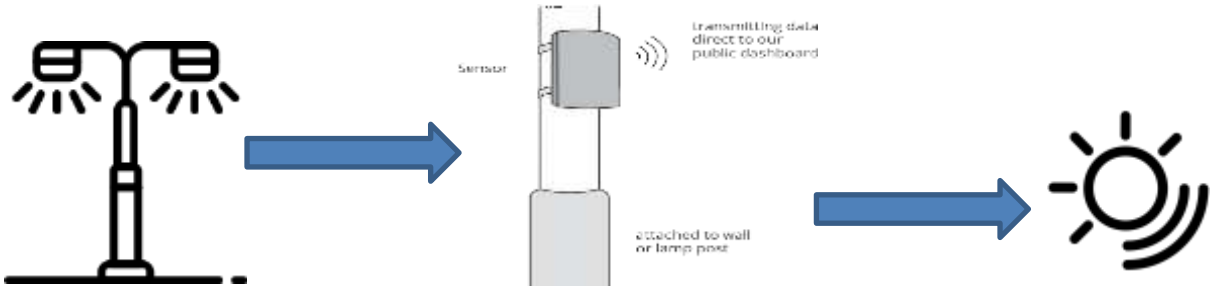
Solution Architecture

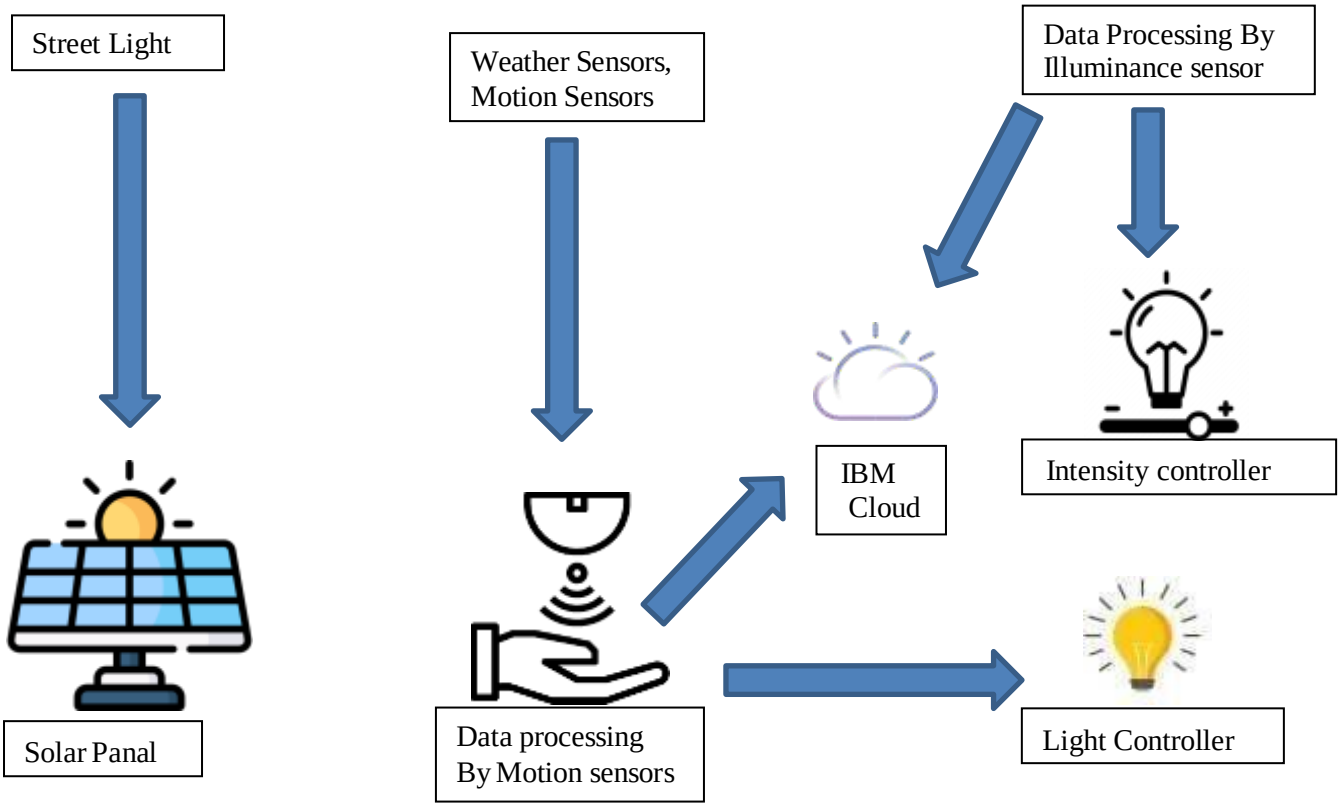
Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behaviour, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

Solution Architecture Diagram:





1. **Weather Sensors**: Detecting Current Weather Conditions
Weather sensors play a critical role in a weather adaptive street light system by collecting data on current weather conditions such as temperature, humidity, precipitation, and wind speed. These sensors can detect various types of weather conditions such as rainfall, snow, fog, or haze and send the data to a cloud-based platform for analysis. Based on this data, the system can adjust the light output of the LED street lights to provide optimal lighting for the current weather conditions.

2. **Motion Sensors**: Detecting Presence of People or Vehicles
Motion sensors are another key component of the solution architecture for a weather adaptive street light system. These sensors detect the presence of people or vehicles in the area and send this data to the cloud-based platform for analysis. Based on this data, the system can adjust the light output of the LED street lights to provide optimal lighting for the current traffic conditions.

3. **LED Street Lights**: Energy-Efficient Lighting
LED street lights are energy-efficient and can be dimmed or brightened based on the data received from the weather and motion sensors. They are powered by renewable energy sources such as solar or wind power, which are stored in batteries for use during periods of low energy production. The use of LED street lights results in significant energy savings compared to traditional street lights, reducing costs and environmental impact.

4. **Cloud-Based Platform**: Data Processing and Analysis
A cloud-based platform is used to collect and analyze data from the weather and motion sensors. The platform uses machine learning algorithms to process this data and predict future lighting needs based on historical patterns and trends. The platform also includes a dashboard that enables remote monitoring and control of the system's performance. This allows system administrators to adjust the light output of the LED street lights, monitor the system's energy consumption, and receive alerts for faults or issues with the system.

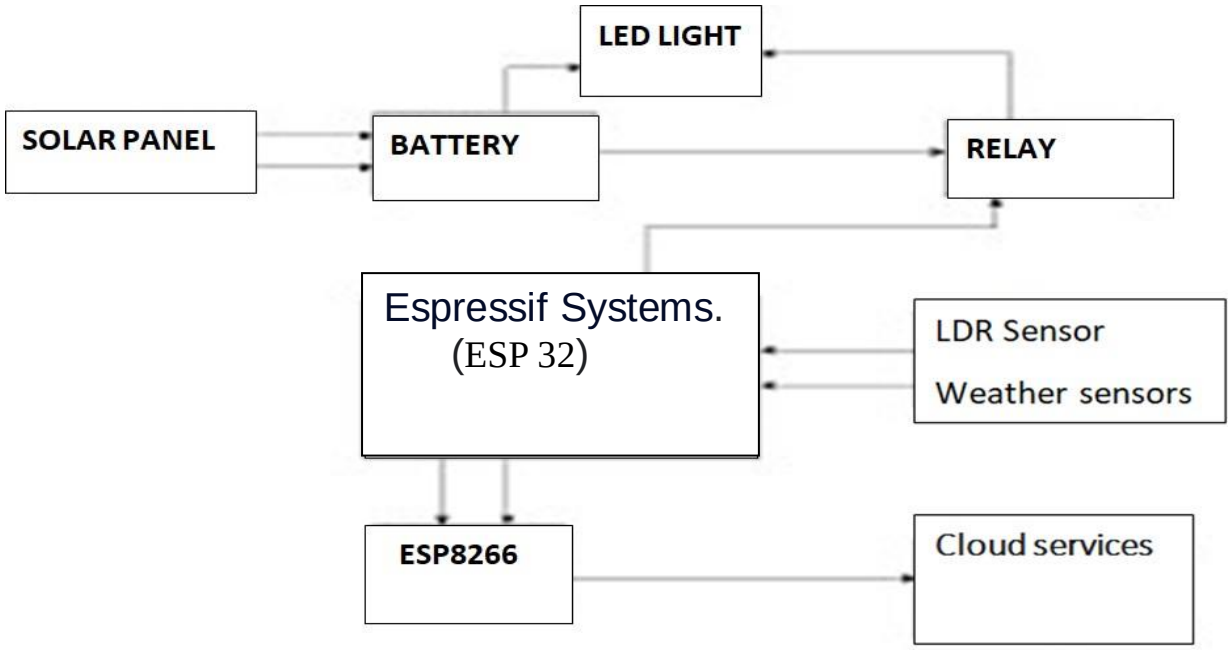
5. **Mobile App**: Reporting and Updates
A mobile app is provided for end-users, allowing them to report faults or issues with the system and receive updates on the system's performance. This provides a way for the system administrators to quickly respond to any issues or concerns raised by users, improving the overall user experience.

Project Design Phase-II
Data Flow Diagram & User Stories

Date	10 May 2023
Team ID	NM2023TMID04258
Project Name	IOT Based Weather Adaptive Street Lighting System

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password.	I can access my account / dashboard	High	Jotham Isaac Jesudasan
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Jotham Isaac Jesudasan
		USN-3	As a user, I can register for the application through Whatsapp	I can register & access the dashboard with Whatsapp Login	High	Dhilli Babu
		USN-4	As a user, I can register for the application through Gmail		High	Mohammed Fawwaz
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Kannan
	Dashboard					
Customer (Web user)	Registration	USN-1	As a user, I can register for the application by entering my email, password.	I can access my account / dashboard	High	Jotham Isaac Jesudasan
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Jotham Isaac Jesudasan
		USN-3	As a user, I can register for the application through Whatsapp	I can register & access the dashboard with Whatsapp Login	High	Dhilli Babu
		USN-4	As a user, I can register for the application through Gmail		High	Mohammed Fawwaz
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Kannan
Customer Care Executive			As of user side, I could support customer technically	I deal direct conversation with the customer		Mohammed Fawwaz
Administrator			I could look after the management	I check for all the works done regularly		Kannan

Technology Stack (Architecture & Stack)

Date	14 May 2023
Team ID	NM2023TMID04258
Project Name	IOT Based Weather Adaptive Street Lighting System

Technical Architecture:
The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

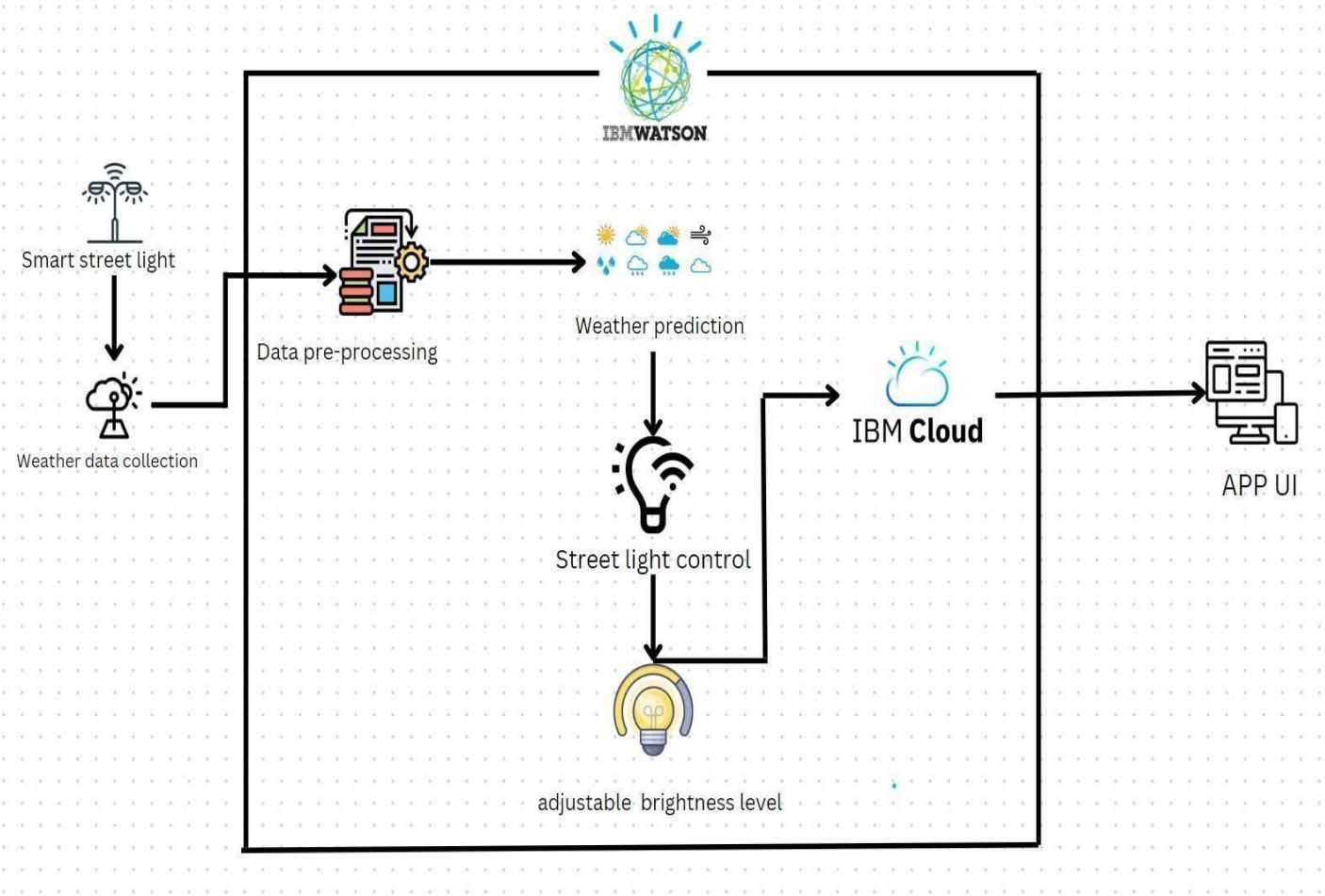


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	HTML, CSS, JavaScript / Angular Js / React Js etc.	Web UI, Mobile App
2.	Application Logic-1	IoT sensors to measure weather conditions in real-time, such as temperature, humidity, and precipitation. Microcontrollers such as Arduino or Raspberry Pi to control thestreet lights and adjust their brightness.	Basic Weather Monitoring
3.	Application Logic-2	Machine learning algorithms such as decision trees, random forests, or neural networks to predict future weather conditions. Cloud services such as IBM or Google Cloud Platform to store andprocess large amounts of data.	Advanced Weather Predictionand Light Control
4.	Application Logic-3	Mobile applications to communicate with emergency services andcity officials.	Emergency Response
5.	Database	Relational databases are suitable for structured data that requirecomplex queries and transactions. NoSQL databases are suitable for unstructured or semi-structured data that require high scalability and availability.	MySQL, NoSQL, etc.
6.	Cloud Database	IBM also offers various database management tools and services, such as IBM Data Management Console for managing databases on IBM Cloud, IBM Cloud Pak for Data for data analytics and AI, and IBMWatson Studio for building and deploying machine learning models.	IBM DB2, IBM Cloudant etc.
7.	File Storage	You can store files on the local system of the device running the street light system. This can be a simple and low-cost option, but itmay not be scalable and can pose a risk of data loss if the device fails. A NAS is a dedicated storage device that can be attached to the street light system over a network. NAS devices provide higher scalability and reliability than local file storage and can be accessedby multiple devices.	Network-attached storage (NAS)Local file storage Cloud storage
8.	External API-1	this API provides current and historical weather data, as well as 15-day weather forecasts. You can use this API to retrieve weather data for street light system and adjust the light settings accordingly. The API can also provide information about severe weather conditions and alerts, which can be used for emergency response.	IBMWeather API, etc.

9.	External API-2	This API allows you to connect and manage IoT devices, such as your street lights, and collect and analyze the data they generate. With the IoT Platform, you can set up rules and alerts based on sensor data, and trigger actions such as adjusting the light settingsor sending notifications. You can also use the platform to visualize the data and monitor the performance of your street light system.	IBM IoT Platform
10.	Machine Learning Model	By training a machine learning model on historical weather data and other factors such as location, time of day, and season, you can predict the likely weather conditions for a given time and location. This information can be used to adjust the light settings,for example, to increase brightness in case of rain or fog. By training a machine learning model on images or video feeds from the street light system, you can recognize objects such as vehicles, pedestrians, or animals. This information can be used toadjust the light settings, for example, to increase brightness in areas with high pedestrian traffic or to dim the lights in areas withlow activity.	Object Recognition Model, Weather prediction ,etc.

Table-2: Application Characteristics:

S. No	Characteristics	Description	Technology
1.	Open-Source Frameworks	TensorFlow can be used for a variety of machine learning tasks, including weather prediction and object recognition. TensorFlow canrun on a variety of platforms, including IBM's PowerAI platform, which is optimized for deep learning workloads. This is an open-source framework for deploying and managing machine learning workflows on Kubernetes, a popular container orchestration platform. This is an open-source computer vision library that can be used fortasks such as object detection, tracking, and recognition.	TensorFlow,KubeFlow, OpenCV.
2.	Security Implementations	Encrypting the data in transit and at rest can prevent unauthorized access and data breaches. You can use encryption protocols such as SSL/TLS for data in transit and AES encryption for data at rest. Implementing access control measures such as user authentication, authorization, and role-based access control can ensure that onlyauthorized personnel have access to the system and its data.	Encryptions, AcessControls, etc.
3.	Scalable Architecture	These tools can help you deploy and manage your application across multiple nodes, and scale up or down as needed. Another way to achieve scalability is by using cloud-based services such as IBM's Cloud Functions, which allows you to run serverless functionsthat can automatically scale up or down based on demand.	IBM's Cloud Functions, Docker and Kubernetes.
4.	Availability	Load balancing can distribute incoming traffic across multiple servers, while failover can automatically switch to a backup server in case of a failure. Disaster recovery can help you recover from catastrophic events such as natural disasters or cyber-attacks. IBM's Cloud Load Balancer and Cloud Resiliency Orchestration are sometools that can help you achieve high availability.	Loadbalancing,disaste rrecovery.
5.	Performance	Caching can store frequently accessed data in memory, which can reduce the response time and improve performance. Indexing can optimize database queries by creating indexes on frequently accessed columns, while compression can reduce the size of data intransit and at rest, which can improve network and storage performance.	caching, indexing, and compression.

CODING & SOLUTIONS:

```
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#include "DHT.h"// Library for dht11
#define DHTPIN 32     // what pin we're connected to
#define DHTTYPE DHT22   // define type of sensor DHT 11
const int ldrpin =34;
#define Pir 2
const float gama = 0.7;
const float rl10 = 50;
int led = 4;
int LED=15;
int amber=23;
int statusPir = 0;

DHT dht (DHTPIN, DHTTYPE);
void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);

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

#define ORG "etuanl"//IBM ORGANITION ID
#define DEVICE_TYPE "streetlight"//Device type mentioned in ibm watson IOT Platform
#define DEVICE_ID "22123"//Device ID mentioned in ibm watson IOT Platform
#define TOKEN "22122322"//Token
String data3;
float h, t;


//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of event perform
and format in which data to be send
char subscribetopic[] = "iot-2/cmd/command/fmt/String";// cmd  REPRESENT command type
AND COMMAND IS TEST OF FORMAT STRING
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id


//-----------------------------------------
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient); //calling the predefined client
id by passing parameter like server id,portand wificredential


void setup()// configureing the ESP32
{
 Serial.begin(115200);
  pinMode(Pir, INPUT);
  pinMode(ldrpin, INPUT);
```

```
  pinMode(led, OUTPUT);
  pinMode(LED, OUTPUT);
  pinMode(amber, OUTPUT);
  dht.begin();
  wificonnect();
  mqttconnect();
}



void loop()// Recursive Function
{

  delay(10);
  h = dht.readHumidity();
  t = dht.readTemperature();
  Serial.print("temp:");
  Serial.println(t);
  Serial.print("Humid:");
  Serial.println(h);
  statusPir = digitalRead(Pir);
  int analogvalue = analogRead(ldrpin);
  analogvalue = map(analogvalue, 4095, 0, 1024, 0);
  float voltage = analogvalue / 1024.*5;
  float resistance = 2000 * voltage / (1-voltage/5);
  float luxv = pow(50*1e3*pow(10,0.7)/resistance,(1/0.7));
  delay(10);
  Serial.print("lux = ");
  Serial.println(luxv);
  if(statusPir==HIGH)
  {
    if(h<=70)
  {


  if(luxv<400)
  {
    digitalWrite(4, HIGH);
    digitalWrite(15, HIGH);
    delay(6000);
    digitalWrite(4, LOW);
    digitalWrite(15, LOW);

  }
  else if((luxv>400)&&(luxv<=1600))
  {
    digitalWrite(15, HIGH);
    delay(6000);
    digitalWrite(15, LOW);
  }
  }
  else{
    digitalWrite(23, HIGH);
    delay(6000);
```

```
    digitalWrite(23, LOW);
  }
  }

  PublishData(t,h,luxv);

  delay(1000);
  if (!client.loop()) {
    mqttconnect();
  }
}


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

void PublishData(float temp, float humid,float lux) {
  mqttconnect();//function call for connecting to ibm
  /*
     creating the String in in form JSon to update the data to ibm cloud
  */
  String payload = "{\"temp\":";
  payload += temp;
  payload += "," "\"Humid\":";
  payload += humid;
  payload += "," "\"luminance\":";
  payload += lux;
  payload += "}";


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


  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish ok");// if it sucessfully upload data on the cloud then it
will print publish ok in Serial monitor or else it will print publish failed
  } 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() //function defination for wificonnect
{
  Serial.println();
  Serial.print("Connecting to ");

  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish the
connection
  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++) {
    //Serial.print((char)payload[i]);
    data3 += (char)payload[i];
  }
  Serial.println("data: "+ data3);
  if(data3=="lighton")
  {
Serial.println(data3);

  }
  else
  {
Serial.println(data3);
  }
data3="";
}
```

FEATURES ADDED:

WiFi Connectivity:

The code enables the ESP32 device to connect to a WiFi network, allowing it to access the internet and communicate with remote servers. This feature is important as it provides connectivity for the device to transmit and receive data wirelessly.

MQTT Communication:

The code utilizes the MQTT protocol to establish a communication channel between the ESP32 device and the IBM Watson IoT platform. MQTT is a lightweight messaging protocol commonly used in IoT applications. It enables the device to publish sensor data to the platform and subscribe to command messages from the platform.

DHT Sensor:

The code incorporates a DHT22 sensor, which is capable of measuring temperature and humidity. By using the appropriate library and functions, the code can read data from the DHT sensor, allowing it to monitor and report temperature and humidity values in real-time.

Sensor Data Processing:

The code leverages various sensors, including a PIR sensor for motion detection and an LDR (Light Dependent Resistor) for measuring light intensity. By collecting data from these sensors, the code can make intelligent decisions based on the surrounding environment. For example, it can adjust the brightness of the LED street lights based on the presence of motion or the ambient light level.

JSON Data Format:

The code utilizes JSON (JavaScript Object Notation) format to structure and organize the sensor data before sending it to the IBM Watson IoT platform. JSON provides a standardized and human-readable format for representing data, making it easier for both the device and the platform to understand and process the information.

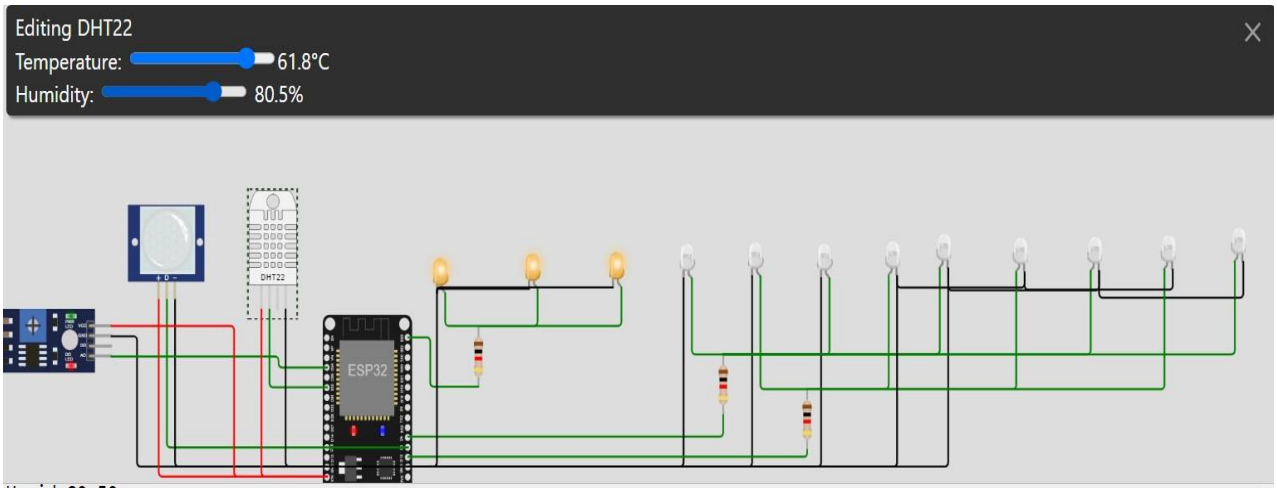
IBM Watson:

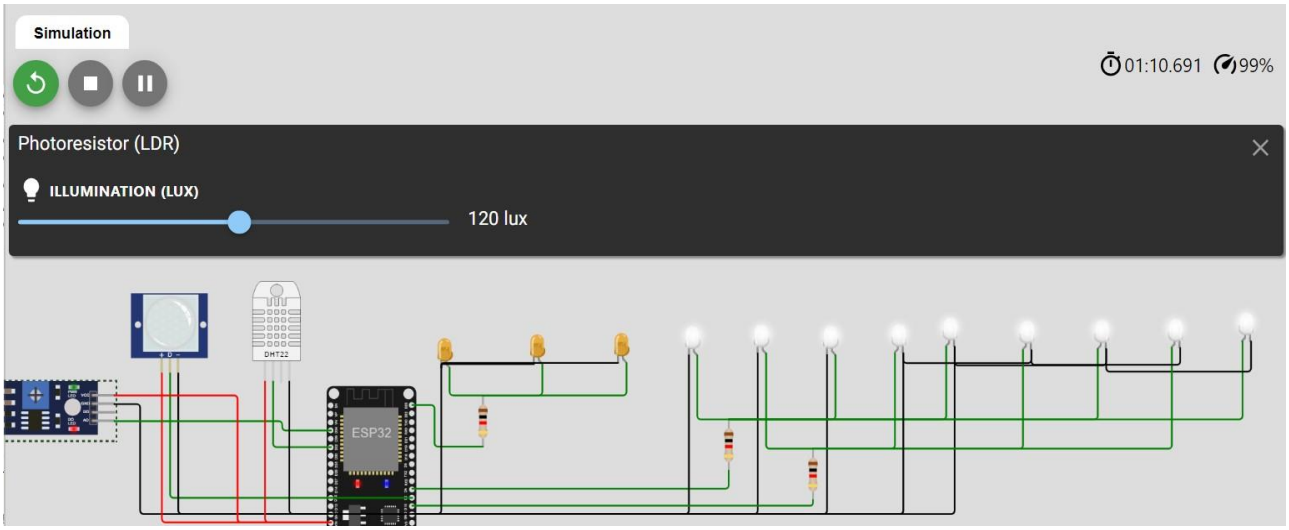
IoT Platform Integration: The code integrates with the IBM Watson IoT platform, allowing the device to securely connect to the platform and exchange data. It utilizes authentication credentials provided by the platform to establish a connection. By publishing the formatted sensor data to the platform, the code enables centralized monitoring and analysis of the street light system.

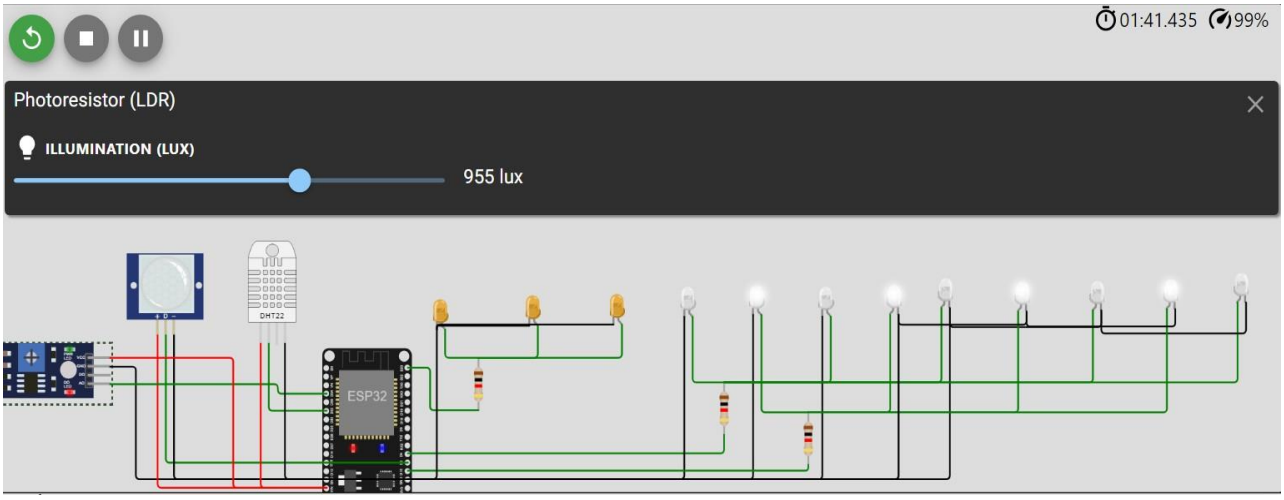
RESULT:

PERFORMANCE METRICS :

The performance testing tools used in this project is wokwi







ADVANTAGES & DISADVANTAGES

Advantages:

Adaptive street lights, also known as smart street lights, are an innovative approach to lighting public spaces. Here aresome advantages of adaptive street lights:

Energy efficiency:

Adaptive street lights use LED technology and have built-in sensors that adjust the light output based on the presence or absence of pedestrians, vehicles, and natural light. This means that they use less energy than traditional street lights, leading to lower electricity bills and a reduced carbon footprint**.**

Cost savings:

With their ability to adjust light output based on need, adaptive street lights can help reduce overall maintenance and operational costs. Additionally, they can be remotely monitored and controlled, which can reduce the need for physical maintenance and improve response time for issues that do arise.

Improved safety:

Adaptive street lights can help improve safety by providing appropriate lighting levels for pedestrians and vehicles in different areas and at different times of day. For example, brighter lighting may be needed in high-traffic areas during rush hour, while dimmer lighting may be sufficient for residential areas late at night.

Reduced light pollution:

Adaptive street lights can reduce light pollution by only providing the necessary amount of light in a specific area. Thiscan help preserve the night sky and reduce the impact of artificial lighting on wildlife.

Increased sustainability:

By using less energy, reducing maintenance needs, and reducing light pollution, adaptive street lights can help promotesustainable urban development and reduce the environmental impact of cities.

Disadvantage

Cost:

Adaptive street lights can be more expensive to install than traditional street lights, as they require additional sensors an d control systems.Additionally, ongoing maintenance costs may also be higher due to the complexity of the system.

Technical complexity:

Adaptive street lights require complex control systems that can be prone to malfunctions and require regular maintenance. If the system fails, itcan cause inconvenience and even safety issues for pedestrians and drivers.

Privacy concerns:

The sensors used to detect pedestrians and vehicles may also collect data about people's movements and activities, raising privacy concerns. This data could be used for surveillance purposes, or could be at risk of being hacked or accessed by unauthorized parties.

Maintenance:

With additional technology comes additional maintenance requirements. Adaptive street lights require regular maintenance toensure that their sensors and controls are functioning properly, which can be time-consuming and costly.

CONCLUSION

In conclusion, adaptive street lights have the potential to revolutionize the way we light our cities and towns. By using sensors, controls, and other technologies, adaptive street lights can adjust their brightness based on various factors, resulting in more efficient and sustainable lighting solutions. While there are some disadvantages to this technology, such as cost and maintenance requirements, the potential benefits far outweigh the drawbacks. As the technology behind adaptive street lights continues to develop, there is an opportunity to further enhance their performance and functionality, such as with the integration of AI algorithms, solar power, advanced sensors, and smart grid integration. The future of adaptive street lights is bright, and it has the potential to create safer, more efficient, and more sustainable urban environments for generations to come...

FUTURE SCOPE

Adaptive street lights have already brought many benefits to our cities, but there are still many ways in which they can be further enhanced to improve their performance and functionality. Here are some possible ways to enhance adaptive street lights:

Artificial Intelligence (AI):

By integrating AI algorithms, adaptive street lights can learn from their environment and adapt to changing conditions in real-time. AI can help optimize the performance of the lights, such as adjusting the brightness based on the presence of people or vehicles, or predicting traffic patterns to improve safety and reduce congestion.

Interconnectivity:

Integrating adaptive street lights with other smart city technologies, such as traffic sensors, environmental sensors, and surveillance cameras, could help cities and towns better manage their infrastructure. Interconnectivity can enable real-time data collection and analysis, helping city planners make more informed decisions.

Modular Design:

Modular design can enable easier installation and maintenance of adaptive street lights. By using modular components, the lights can be easily assembled and disassembled, allowing for quick replacement of individual components if needed.

Smart Grid Integration:

Integration with a smart grid can enable adaptive street lights to communicate with power providers and adjust their energy consumptionin real-time based on the demand for electricity. This can help reduce energy costs for cities and towns

APPENDIX SOURCE CODE

Demo Video link:
https://drive.google.com/drive/folders/1LfBPCZzZ94mM0gGiSoG0K4P7lVF0I5R