INTELLIGENT PEOPLE AND VEHICLE COUNTING SYSTEM FOR SECRETARIAT CODE C PROGRAM

INTRODUCTION:

Intelligent people and vehicle counting systems are used in various settings to accurately and efficiently monitor the number of individuals and vehicles present in a specific area or location. These systems find applications in areas such as traffic management, crowd control, security surveillance, and urban planning.The underlying theory behind intelligent counting systems involves the use of advanced technologies such as computer vision, image processing, and machine learning. These technologies enable the system to analyze visual data, extract relevant information, and make intelligent decisions based on the data received.

Computer vision algorithms play a crucial role in detecting and tracking people and vehicles in images or video streams. Techniques like object detection, object recognition, and object tracking are utilized to identify and locate individuals and vehicles within the captured data. These algorithms leverage features like shape, color, texture, and motion to distinguish between different objects and track their movements.

1.project overview:

The goal of this project is to create an intelligent people and vehicle counting system using computer vision and machine learning techniques. The system will be designed to accurately detect and count individuals and vehicles in real-time, providing valuable data for applications such as traffic analysis, crowd management, and surveillance.

Key Components:

1.**Data Acquisition**:

The project will involve the use of cameras or other sensors to capture visual data from the target area. The data can be in the form of images or video streams.

2.Preprocessing:

The captured data will undergo preprocessing steps to enhance the quality and optimize it for analysis. This may involve tasks like noise reduction, image resizing, and contrast adjustment.

3.Object Detection and Tracking:

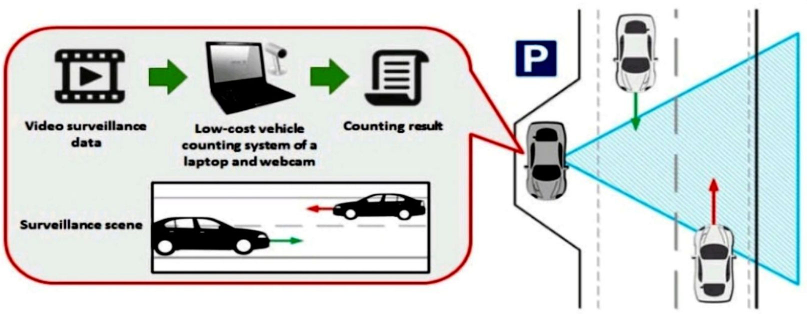
Computer vision algorithms will be employed to detect and track people and vehicles within the captured data. Object detection algorithms will identify the presence of individuals .

4.Feature Extraction:

Relevant features such as shape, color, texture, and motion will be extracted from the detected objects. These features will be used to distinguish between different individuals and vehicles, enabling accurate counting.

5.Machine Learning:

Machine learning techniques, particularly deep learning, will be employed to train models on large datasets of labeled images. These models will learn to recognize patterns and features specific to people and vehicles.



2. IDEATION & PROPOSED SOLUTION :

2.1 Problem Statement Definition :

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.

A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customers, which helps you better understand how they perceive your product or service.

Key Issues:

1. Inefficient Energy Consumption: Traditional street lighting systems operate on fixed schedules or manual controls, leading to lights being turned on even when not required. This results in unnecessary energy consumption and increased electricity costs.

2. Compromised Visibility: Different weather conditions such as rain, fog, or snow affect visibility on the roads. The lack of adaptive lighting systems results in suboptimal lighting conditions, compromising the safety of drivers, pedestrians, and cyclists.

3. Light Pollution: Uncontrolled and excessive lighting contributes to light pollution, which has adverse effects on the environment and disrupts natural ecosystems. The absence of dynamic lighting control exacerbates light pollution issues.

4. Inefficient Maintenance: Manual monitoring and maintenance processes for street lighting systems are time-consuming and costly. The lack of remote monitoring and control capabilities hinders proactive maintenance and timely detection of faults or failures, leading to increased downtime and maintenance expenses.

2.2 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

Says: "We need a street lighting system that is easy to maintain and manage."

Thinks: "How can we streamline the maintenance process and reduce manual interventions?"

Feels: Frustration when dealing with frequent maintenance issues and outdated technology.

Does: Performs routine maintenance checks, replaces faulty components, and manages the lighting system's operation.

2. User: Emergency Service Providers

Says: "We need well-lit streets to ensure efficient emergency response."

Thinks: "How can we ensure optimal visibility during emergencies, regardless of weather conditions?"

Feels: Anxious about delays caused by poor visibility or inadequate lighting.

Does: Collaborates with city officials to identify lighting needs for emergency situations, supports the implementation of adaptive lighting systems for enhanced response.

2.3 Ideation & Brainstorming :

Step-1: Team Gathering, Collaboration and Select the Problem Statement Diagram :

Template

Brainstorm & idea prioritization

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.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

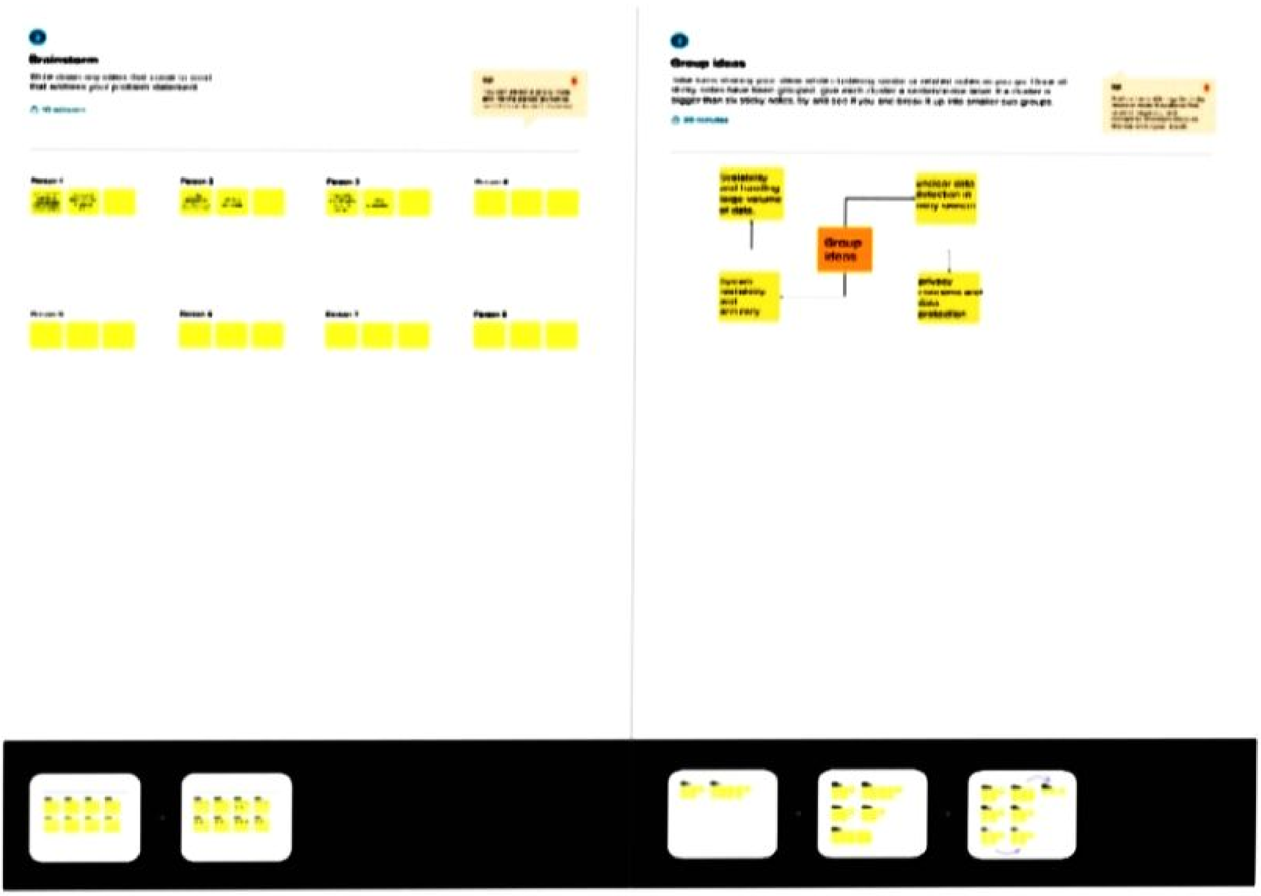
Many countries consume a large amount of electricity to light their streets. However, the energy consumed by street lights does not get efficiently used because street lights are not necessary in every street. As part of this project, we propose a system that turns off the lighting in parts of the street which are not used and turns on the lighting in parts of the street which are mostly used at night.

Key rules of brainstorming

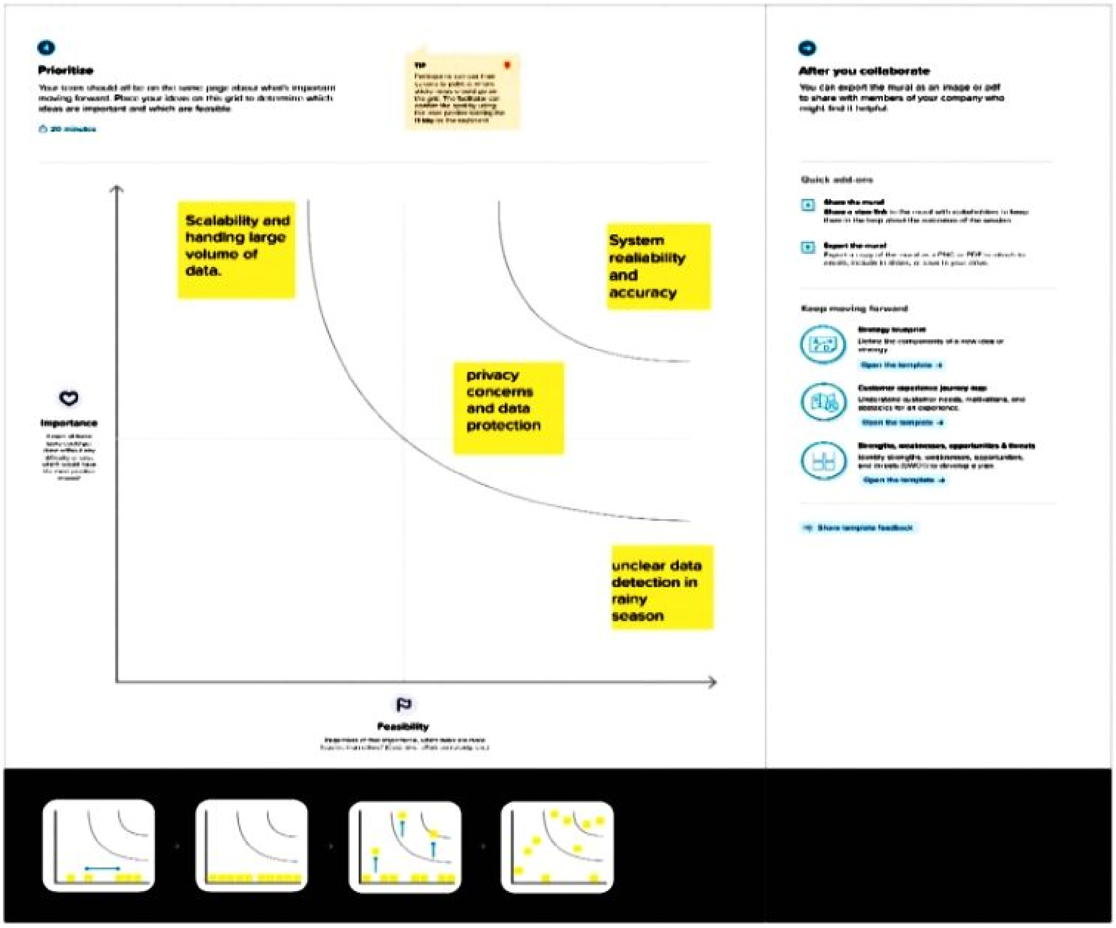
To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Step-2: Brainstorm, Idea Listing and Grouping :



Step-3: Idea Prioritization :



IDEATION :

1. Light Color Variation:

Explore the possibility of using different light colors based on weather conditions.

For example, use warm white lights during clear nights and cooler white lights during foggy or rainy conditions.

2. Pedestrian and Vehicle Detection:

Implement sensors or cameras to detect the presence of pedestrians or vehicles.

Increase lighting levels in areas with high pedestrian traffic or when vehicles are approaching.

3. Dynamic Light Pulsation:

Introduce pulsating light patterns during extreme weather conditions to grab attention.

This can help alert drivers and pedestrians to the presence of hazardous weather conditions.

Integration with Navigation Systems:

Collaborate with navigation or mapping applications to provide real-time lighting information.

Sync lighting adjustments with recommended routes to enhance safety and visibility.

4. Noise and Sound Detection:

Use sound sensors to detect noise levels or specific sounds (e.g., sirens, car horns) in the surroundings.

Increase lighting levels in response to high noise levels, indicating potential emergencies or disturbances.

5. User Customization:

Allow residents to customize their lighting preferences through a mobile app or web interface.

Offer adjustable brightness levels or personalization options based on individual needs.

6. Traffic Flow Optimization:

Analyze traffic patterns and adjust lighting levels accordingly to optimize traffic flow.

Increase lighting in congested areas or intersections during peak traffic hours.

7. Integration with Public Transportation Systems:

Collaborate with public transportation authorities to synchronize lighting with bus or tram schedules.

Increase lighting levels during arrival and departure times to enhance passenger safety

BRAINSTORMING :

1. Rain Sensor Integration:

Integrate rain sensors to detect rainfall intensity and adjust lighting accordingly.

Increase brightness during heavy rain to improve visibility for drivers and pedestrians.

2. Temperature Sensor Integration:

Use temperature sensors to adjust lighting levels based on temperature conditions.

Increase brightness during extremely cold weather to enhance safety on icy roads.

3. Wind Speed Detection:

Implement wind speed sensors to detect high winds and adjust lighting accordingly.

Increase brightness in windy conditions to aid navigation and alert users of potential hazards.

4. Fog and Mist Detection:

Use fog or mist sensors to detect low visibility conditions and adjust lighting levels accordingly.

Increase brightness during foggy conditions to improve visibility for drivers and pedestrians.

5. Snowfall Detection:

Integrate snowfall sensors to detect snow accumulation and adjust lighting levels accordingly.

Increase brightness during snowfall to ensure safe movement on the roads.

6. Machine Learning Algorithms:

Employ machine learning algorithms to analyze historical weather data and optimize lighting adjustments.

Continuously learn and adapt to weather patterns to make more accurate lighting predictions

2.4 Proposed Solution:

The proposed solution is to develop an IoT-based Weather Adaptive Street Lighting System that utilizes real-time weather data to dynamically adjust the lighting levels and optimize energy consumption. The system should be capable of automatically adapting to various weather conditions, ensuring optimal visibility and safety on the roads. Additionally, the system should incorporate features to reduce light pollution and enable remote monitoring and control for efficient maintenance operations.

By addressing these key issues, the IoT-based Weather Adaptive Street Lighting System will contribute to energy efficiency, enhance safety and visibility, minimize light pollution, and optimize maintenance processes.

Proposed Solution Template:

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

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	1.**Accuracy**: The system's counting accuracy may be affected by factors like lighting conditions, camera placement, occlusions, and crowded environments. Achieving high accuracy levels in real-world scenarios can be challenging and require algorithm fine-tuning and continuous monitoring. 2.**Privacy concern**: Implementing a system that counts and tracks individuals raises privacy concerns. Collecting and storing personal data must be done in a way that respects privacy rights and complies with relevant data protection regulations
2.	Idea / Solution description	**Advanced Algorithms**: Employ advanced computer vision algorithms, such as deep learning-based models, to enhance the accuracy of people and vehicle detection and tracking. **Camera Placement and Calibration**: Ensure optimal camera placement and calibration to maximize accuracy. Cameras should be strategically positioned to cover critical areas with clear visibility, minimize occlusions, and reduce the impact of challenging lighting conditions.
3.	Novelty / Uniqueness	Intelligent people and vehicle counting system lie in its ability to utilize advanced technologies and algorithms to accurately detect, track, and count individuals and vehicles within a specific environment, such as a secretariat. 1.Computer Vision and Machine Learning 2.Real-time Monitoring 3.Differentiation of People and Vehicles 4.Multi-Camera Integration
4.	Social Impact / Customer Satisfaction	**Social impact:** 1.Improved Safety and Security: Accurate counting and monitoring of people and vehicles enhance the overall safety and security of the secretariat. 2.Enhanced Traffic Management: By accurately counting vehicles and analyzing traffic patterns, the system can assist in optimizing traffic flow within the secretariat premises

		Customer satisfaction: 1.Real-Time Occupancy Information: The system provides real-time occupancy information, allowing visitors and staff to make informed decisions about the best times to visit specific areas within the secretariat 2.Reduced Waiting Times: By analyzing traffic patterns and queue lengths, the system can identify areas with high congestion or long waiting times.
5.	Business Model (Revenue Model)	a. System Sales: Generate revenue by selling the intelligent people and vehicle counting system as a product to secretariats, government organizations, or private entities. b. Installation and Integration Services: Offer installation, configuration, and integration services for the system, ensuring seamless deployment and integration with existing infrastructure. c. Maintenance and Support: Provide ongoing maintenance, software updates, and technical support services to ensure the system's optimal performance and address any issues that may arise.
6.	Scalability of the Solution	**Adding Cameras and Expansion**: The system can accommodate an increasing number of cameras as needed, allowing for expansion and coverage of larger areas within the secretariat or other locations. **Handling High Traffic**: The system can handle high volumes of people and vehicles without compromising accuracy or performance, ensuring scalability even during peak periods or events. **Cloud Infrastructure**: Leveraging cloud-based infrastructure enables easy scalability by dynamically allocating resources based on demand, accommodating fluctuations in data processing requirements.

3. REQUIREMENT ANALYSIS :

Main Factors in the Street Lighting Design Scheme

- Luminance Level Should be Proper. ...
- Luminance Uniformity must be Achieved. ...
- Degree of Glare Llimitation is always taken into Design Scheme. ...
- Lamp Spectra for Visual Sharpness depends on the Proper Luminaries. ...
- Effectiveness of Visual Guidance is also an important factor.

3.1 Functional requirement :

1. Weather Data Integration: The system should integrate with reliable weather data sources to receive real-time updates on weather conditions.

2. Sensor Integration: The system should incorporate various sensors to detect weather parameters such as rain, fog, snow, temperature, wind speed, and humidity.

3. Adaptive Lighting Control: The system should adjust the brightness levels of street lights based on detected weather conditions.

*It should dynamically increase or decrease lighting intensity to optimize visibility and energy efficiency.

4. Communication and Connectivity: The system should establish reliable connectivity to receive weather data and transmit control signals to the street lights.

It should support communication protocols that enable seamless integration with other devices and systems.

5. Real-time Data Processing: The system should process weather data in real-time to ensure timely adjustments to lighting levels.

It should analyze data efficiently and make accurate decisions for adaptive lighting control.

6. Energy Optimization: The system should optimize energy usage by adjusting lighting levels based on weather conditions and occupancy.

It should incorporate energy-saving technologies, such as LED lights and motion sensors, to minimize energy consumption

7. User Interface: The system should provide a user-friendly interface for city officials to monitor and control the lighting system.

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Intelligent people counting	The system should accurately count the number of people entering and exiting the secretariat area.
FR-2	Intelligent vehicle counting:	The system should accurately count the number of vehicles entering and exiting the secretariat area
FR-3	Real-time monitoring	The system should provide real-time monitoring of the people and vehicle counts.
FR-4	Data storage	The system should store the count data for future analysis and reporting.
FR-5	Alerts and notifications	The system should generate alerts or notifications when the count exceeds a certain threshold or when anomalies are detected
FR-6	Integration with existing infrastructure:	The system should be able to integrate with existing security or surveillance systems within the secretariat area.

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The counting system should have a high level of accuracy in counting both people and vehicles
NFR-2	**Security**	The system should ensure the security and confidentiality of the count data, preventing unauthorized access or tampering.
NFR-3	**Reliability**	The system should be reliable and available for operation during the designated working hours
NFR-4	**Performance**	The system should seamlessly integrate with the secretariat's existing infrastructure, such as access control systems or video surveillance systems.

It should display real-time weather information, lighting status, and allow manual overrides if necessary.

8. Maintenance and Diagnostics: The system should include features for remote monitoring and diagnostics of street lights.

It should detect and report faults or performance issues to enable timely maintenance and minimize downtime.

9. Security and Privacy: The system should ensure the security of data transmission and protect user privacy.

It should implement encryption protocols and access controls to prevent unauthorized access to the system.

10. Integration with Emergency Services: The system should integrate with emergency services to prioritize lighting during emergencies.

It should enable seamless coordination with emergency response systems for optimal lighting adjustments.

3.2 Non-Functional requirements:

1.Reliability:

The system should operate reliably under varying weather conditions, ensuring consistent performance and accurate lighting adjustments.

2. Scalability:

The system should be scalable to accommodate a large number of street lights and handle increasing data volumes as the city expands.

3. Availability:

The system should have high availability, minimizing downtime and ensuring that the lighting system is operational at all times.

4. Performance:

The system should respond quickly to changes in weather conditions and adjust lighting levels in a timely manner.

It should process data efficiently, ensuring minimal latency and optimal system performance.

5. Security:

The system should implement robust security measures to protect against unauthorized access, data breaches, and cyber threats.

It should ensure the integrity and confidentiality of data transmitted and stored within the system.

6. Privacy:

The system should respect user privacy by securely handling personal data and adhering to applicable privacy regulations.

7. Interoperability:

The system should support interoperability with existing infrastructure, devices, and systems to facilitate seamless integration.

8. Usability:

The system should have a user-friendly interface that is intuitive and easy to navigate for city officials and maintenance personnel.

It should provide clear and meaningful visualizations of data and allow for efficient configuration and monitoring.

9. Maintainability:

The system should be designed for ease of maintenance, allowing for efficient troubleshooting, repairs, and upgrades.

It should have proper documentation and provide diagnostic tools to aid maintenance personnel.

10. Compliance:

The system should comply with relevant standards, regulations, and industry best practices related to lighting, energy efficiency, and IoT.

4. PROJECT DESIGN :

1. System Architecture:

The IoT-based weather adaptive street lighting system consists of the following components:

a. Sensors: Weather sensors such as temperature, humidity, rainfall, and ambient light sensors will be deployed at strategic locations along the street. These sensors will collect real-time weather data.

b. IoT Gateway: An IoT gateway device will be responsible for collecting data from the weather sensors and transmitting it to the cloud platform securely. It will also receive control commands from the cloud platform to adjust street lighting levels.

c. Cloud Platform: A cloud-based platform will receive and process the weather data from the IoT gateway. It will analyze the data and send appropriate control commands to the IoT gateway for adjusting street lighting levels.

d. Street Lighting Controllers: Each street lighting pole will be equipped with a lighting controller that receives control commands from the IoT gateway. The controllers will adjust the brightness levels of the street lights based on the received commands.

2. System Workflow:

a. Data Collection: The weather sensors placed along the street will continuously collect weather data such as temperature, humidity, rainfall, and ambient light levels.

b. Data Transmission: The IoT gateway will securely transmit the collected weather data to the cloud platform for analysis.

c. Data Analysis: The cloud platform will analyze the weather data to determine the appropriate lighting levels based on predefined rules and algorithms. Factors like rain, fog, or low light conditions may trigger different lighting levels.

d. Control Command Generation: The cloud platform will generate control commands based on the analysis results. These commands will be sent to the IoT gateway.

e. Lighting Adjustment: The IoT gateway will receive the control commands and transmit them to the respective street lighting controllers. The controllers will adjust the brightness levels of the street lights accordingly.

3. Key Features and Functionalities:

a. Adaptive Lighting: The system will dynamically adjust the street lighting levels based on realtime weather conditions. It will automatically increase or decrease the brightness of street lights as per the analyzed data.

b. Energy Efficiency: By adapting lighting levels based on weather conditions, the system will optimize energy consumption. It will reduce unnecessary lighting during favorable weather conditions and increase lighting during adverse weather conditions.

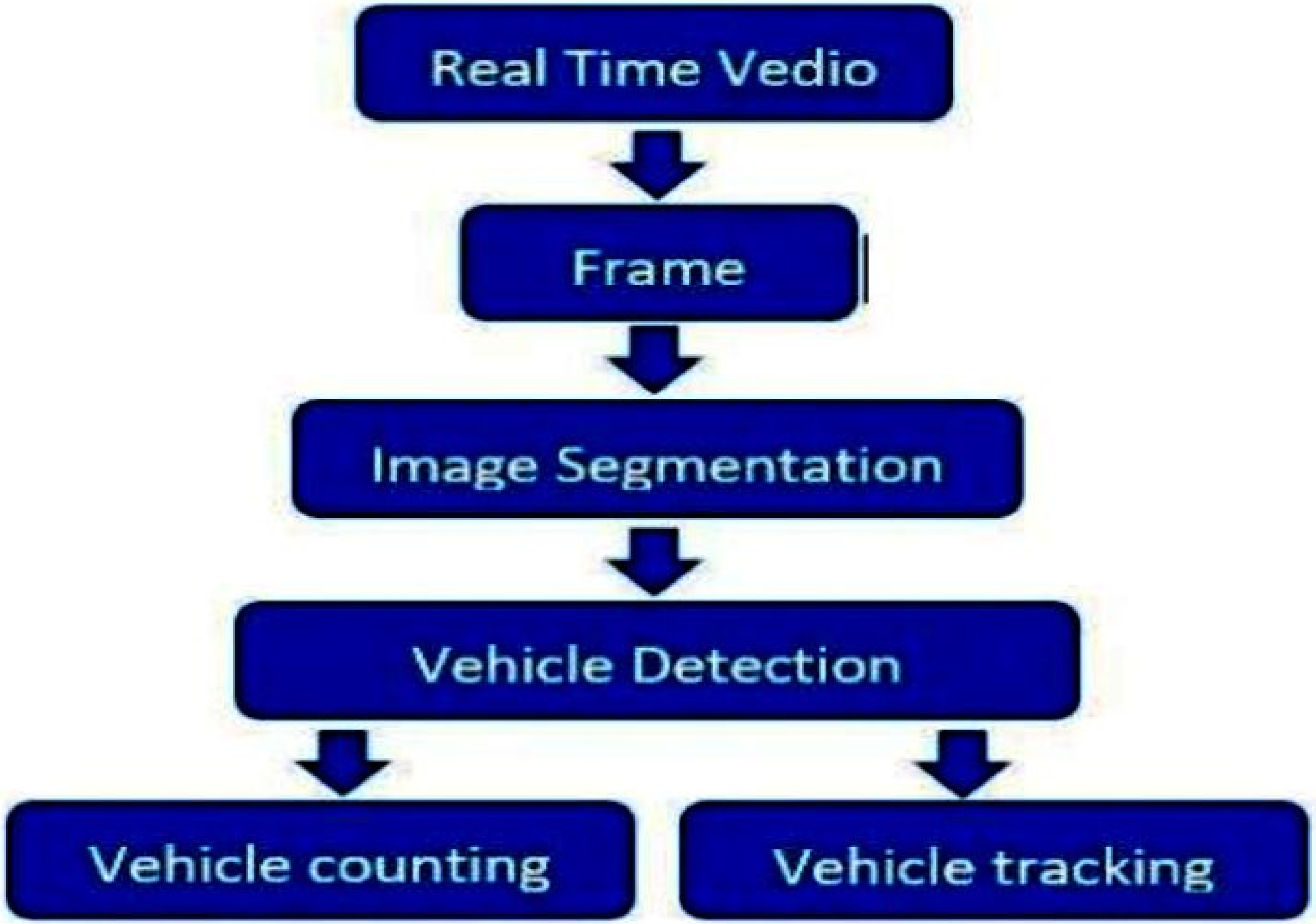
c. Safety Enhancement: The system will improve safety by ensuring appropriate lighting levels in different weather conditions. It will provide better visibility for pedestrians and drivers, reducing the risk of accidents.

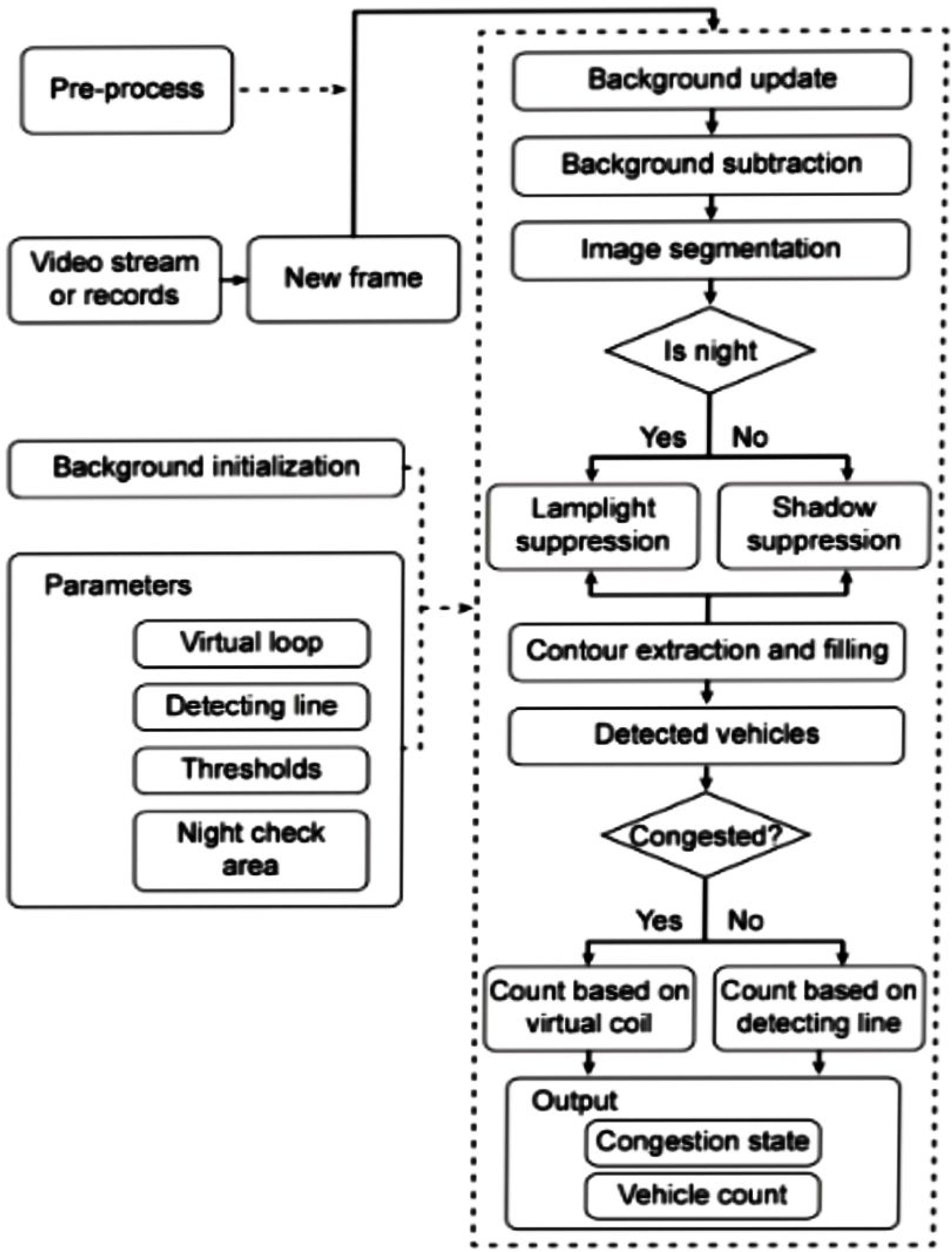
d. Remote Monitoring and Control: The cloud platform will enable remote monitoring of the street lighting system. It will provide real-time updates on weather conditions, lighting status, and energy consumption. Authorized personnel will have the ability to remotely adjust lighting settings if required.

e. Data Analytics and Insights: The system will gather and analyze historical data to generate insights about energy consumption patterns, weather trends, and system performance. This information can be used for further optimization and decision-making.

4.1 Data Flow Diagrams :

Figure 1.


Real Time Vedio
Frame
Image Segmentation
Vehicle Detection
Vehicle counting
Vehicle tracking



Pre-process
Video stream or records
New frame
Background initialization
Parameters
Virtual loop
Detecting line
Thresholds
Night check area
Background update
Background subtraction
Image segmentation
Is night
Yes
No
Lamplight suppression
Shadow suppression
Contour extraction and filling
Detected vehicles
Congested?
Yes
No
Count based on virtual coil
Count based on detecting line
Output
Congestion state
Vehicle count

User Stories:

Use the below template to list all the user stories for the product.

User type	Functional requirements(Epic)	User story number	User Story/Task	Acceptance Criteria	Priority
Customer (Online user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / Dashboard	High
		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
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low
		USN-4	As a user, I can register for the application through Gmail		Medium
	Login	USN-5	As a user, I can log into the application by entering email & password	I can login & access the dashboard	High
	Dashboard	USN-6	As a user, I can access my dashboard for booking, cancelling and billing with respect to my details	I can access my account / Dashboard	High
		USN-7	As a customer, I want to receive details	No malfunctions may occur	High

	Accuracy	USN-8	As a customer, I want the people and vehicle counting system to provide a self-service portal where I can access my datas, view stored data to ensure accuracy .	The customer can see the acurate details.	High
	Scalability and reliability	USN-8	As a customer, I want the counting system to provide scalability and reliability.	The customer can see more reliable.	High
Customer (Offline User)	**To moniter the people and vehicle entry and exit**	USN-9	As a customer, I want to moniter the people and vehicle entry and exit	A customer can purchase their required data	High
People and vehicle counting	**Install sensors or cameras**	USN-11	As a water supplier, I want to Install appropriate sensors or cameras	Install appropriate sensors or cameras at the identified counting locations. For people counting, options can include infrared sensors, thermal cameras, or video analytics software. For vehicle counting, options can include loop detectors, laser sensors, or license plate recognition cameras. Install sensors or cameras	High

	Configure counting parameter	USN-12	As a water supplier, I want to Set up the counting system to define the counting parameters, such as the direction of movement (inward or outward), counting sensitivity, and counting zones. This ensures that the system accurately distinguishes between people and vehicles and counts them correctly.	Set up the counting system to define the counting parameters	High
	Connect to a central monitoring system	USN-13	As a water supplier, I want to [illegible]	Establish a connection between the counting system and a central monitoring system. This allows real-time data transmission and enables continuous monitoring of the people and vehicle counts	High

	Implement data storage and analysis	USN-14	As a customer, I want to set up a database or storage system to store the count data collected by the system. Develop analysis tools or integrate with existing analytics platforms to extract valuable insights from the data, such as peak traffic times or patterns.	set up a database or storage system to store the count data collected by the system	High	
	Utilize the offline customer efficiently	USN-15	As a designer, I want to efficiently utilize the customer those who are not have a knowledge about internet access.		High	
Customer Care executive	**Work of customer careexecutive**	USN-16	As a customer care execute, I want the smart billing system to handle billing disputes efficiently, providing a	If any errors may occur in water billing software or any doubts/ issues regarding to access the software, the executive should	Medium	

5. CODING & SOLUTIONING :

5.1 Feature 1:

Adaptive Lighting Control:
Use the weather data to determine the appropriate lighting level based on specific weather conditions.
Implement a function to adjust the brightness of street lights accordingly.

```
def adjust_lighting(weather_data):
  brightness = 0

  if weather_data["weather"][0]["main"] == "Rain":
brightness = 70    elif
weather_data["weather"][0]["main"] == "Fog":
brightness = 50    elif
weather_data["weather"][0]["main"] == "Snow":
    brightness = 60
else:
    brightness = 100

  # Code to adjust the brightness of street lights based on the calculated brightness level

  return brightness.
```

2.Weather Monitoring: The system can gather real-time weather data from sensors or weather APIs to adjust the street lighting accordingly. For example, during rainy or foggy weather, the lighting intensity can be increased for better visibility import requests

PYTHON CODE :

```
# Function to fetch weather data from an API def get_weather_data():    api_key =
'your_api_key'    url =
'https://api.weather.com/data/2.5/weather?q=city_name&appid=' + api_key
response = requests.get(url)    data = response.json()    return data

# Example function to adjust lighting based on weather conditions def
adjust_lighting_based_on_weather(weather_data):
  if 'rain' in weather_data['weather']:
```

```python
import cv2
import numpy as np


# Web camera
cap = cv2.VideoCapture('video.mp4')

count_line_postion= 550
# Initialize Substructor
algo = cv2.bgsegm.createBackgroundSubtractorMOG()


while True:
    ret,frame1= cap.read()
    grey = cv2.cvtColor(frame1,cv2.COLOR_BGR2GRAY)
    blur = cv2.GaussianBlur(grey,(3,3),5)
    # applying on each frame
    img_sub = algo.apply(blur)
    dilat = cv2.dilate(img_sub,np.ones((5,5)))
    kernel = cv2.getStructuringElement(cv2.MORPH_ELLIPSE,(5,5))
    dilatada = cv2.morphologyEx(dilat, cv2.MORPH_CLOSE, kernel)
    dilatada = cv2.morphologyEx(dilatada, cv2.MORPH_CLOSE, kernel)
    counterSahpe = cv2.findContours(dilatada, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
```

```python
while True:
    ret,frame1= cap.read()
    grey = cv2.cvtColor(frame1,cv2.COLOR_BGR2GRAY)
    blur = cv2.GaussianBlur(grey,(3,3),5)
    # applying on each frame
    img_sub = algo.apply(blur)
    dilat = cv2.dilate(img_sub,np.ones((5,5)))
    kernel = cv2.getStructuringElement(cv2.MORPH_ELLIPSE,(5,5))
    dilatada = cv2.morphologyEx(dilat, cv2.MORPH_CLOSE, kernel)
    dilatada = cv2.morphologyEx(dilatada, cv2.MORPH_CLOSE, kernel)
    counterSahpe = cv2.findContours(dilatada, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)


 cv2.rectangle(frame1,(x,y),(x+w,y+h),(0,255,0),2)

 center= center_handle(x,y,w,h)
 detect.append(center)
 cv2.circle(frame1,center,4, (0,0,255),-1)


 for (x,y) in detect:
     if  x<(count_line_postion+offset) and y<(count_line_postion+offset):
         counter+=1
     cv2.line(frame1,(25,count_line_postion),(1200,count_line_postion),(0,127,255),3)
```

```
validate_counter = (w>= min_width_react) and (h>= min_hieght_react)
if not validate_counter:
    continue

cv2.rectangle(frame1,(x,y),(x+w,y+h),(0,255,0),2)

center= center_handle(x,y,w,h)
detect.append(center)
cv2.circle(frame1,center,4, (0,0,255),-1)


for (x,y) in detect:
    if  x<(count_line_postion+offset) and y<(count_line_postion+offset):
        counter+=1
    cv2.line(frame1,(25,count_line_postion),(1200,count_line_postion),(0,127,255),3)
    detect.remove(x,y)
    print("Vehicle Counter:"+str(counter))
```

6. RESULTS :

Huge reduction of energy and maintenance cost. increased public safety from improved lighting. safer traffic due to increased visibility of hazards; measurable environmental impact due to reduced energy consumption

6.1 Performance Metrics :

1. Energy Efficiency: This metric evaluates how effectively the system utilizes energy resources. It can be measured by monitoring the energy consumption of the street lighting system under different weather conditions and comparing it to a baseline scenario without adaptive lighting. The energy efficiency can be quantified in terms of energy savings achieved.

2. Lighting Intensity Control: This metric assesses the accuracy and responsiveness of the system in adjusting the lighting intensity based on weather conditions. It can be evaluated by comparing the actual lighting intensity with the desired intensity set by the system based on real-time weather data. The system should be able to achieve the desired lighting levels consistently and promptly.

3. Adaptability to Weather Changes: This metric measures how well the system adapts to rapid weather changes. It evaluates the system's ability to quickly detect and respond to changes in weather conditions, such as sudden rainfall or fog. The system should be able to adjust the lighting settings accordingly in a timely manner to maintain optimal visibility and safety.

4. Accuracy of Weather Data: This metric assesses the accuracy and reliability of the weather data used by the system. It can be evaluated by comparing the weather data collected by the system with data from reputable weather sources or weather stations. The system should have a low margin of error in weather data collection to ensure accurate lighting adjustments.

5. System Reliability: This metric measures the reliability and uptime of the street lighting system. It evaluates the system's ability to function consistently and without disruptions. Reliability can be measured by monitoring the occurrence of system failures, downtime, or malfunctions and assessing the system's availability over a specific period.

6. User Experience: This metric focuses on user satisfaction and ease of use. It can be evaluated through user surveys or feedback regarding the convenience, intuitiveness, and effectiveness of the remote monitoring and control functionalities. User experience metrics can help identify areas for improvement and enhance the overall usability of the system.

7. Maintenance and Cost Efficiency: This metric assesses the ease of maintenance and costeffectiveness of the system. It can be evaluated by analyzing the frequency and cost of maintenance activities required for the street lighting system. A well-designed system should minimize the need for frequent maintenance, reduce maintenance costs, and ensure long-term sustainability

7. ADVANTAGES & DISADVANTAGES :

ADVANTAGES :

1. Energy Efficiency:
By dynamically adjusting the lighting intensity based on real-time weather conditions, the system can significantly improve energy efficiency. It reduces energy waste by lowering lighting intensity during periods of sufficient natural light and increasing it when visibility is compromised due to rain, fog, or other weather conditions. This results in substantial energy savings and contributes to sustainability efforts.

2. Cost Savings: The energy efficiency achieved by the IoT-based system translates into cost savings. By reducing energy consumption, municipalities and organizations can lower their electricity bills associated with street lighting. The system's adaptive capabilities help optimize resource allocation, ensuring that lighting is used only when necessary, reducing unnecessary costs.

3.Improved Visibility and Safety: The system enhances visibility on the streets by automatically adjusting the lighting based on weather conditions. During inclement weather like rain or fog, the lighting intensity is increased, enhancing visibility for pedestrians and drivers. This improves safety by reducing accidents and increasing overall security in public spaces.

4. Environmental Impact: The energy-saving features of the IoT-based system contribute to a reduced carbon footprint and environmental impact. By optimizing energy consumption, the system helps in reducing greenhouse gas emissions associated with electricity generation. This aligns with sustainability goals and promotes environmentally responsible practices.

5. Flexibility and Adaptability: The system offers flexibility and adaptability to changing weather conditions. It can quickly and automatically adjust the lighting settings based on realtime data, ensuring that the lighting is always optimized for the prevailing conditions. This flexibility allows the system to cater to different climates and weather patterns, making it suitable for various geographic locations.

6.Remote Monitoring and Control: The IoT capabilities of the system enable remote monitoring and control functionalities. Administrators and operators can monitor the system's performance, receive alerts or notifications for maintenance or faults, and remotely control the lighting settings. This improves operational efficiency, reduces the need for manual interventions, and facilitates proactive maintenance.

7. Data-Driven Insights: The system generates valuable data on weather patterns, energy consumption, and lighting performance. This data can be analyzed to gain insights into energy usage patterns, identify trends, and optimize system performance further. Data-driven insights enable evidence-based decision-making for maintenance planning, infrastructure improvements, and energy management.

8. Scalability and Expandability: The IoT-based system is highly scalable and expandable. It can be easily integrated with additional sensors, devices, or smart city infrastructure as needed. This scalability allows for future enhancements and the integration of emerging technologies, making it a future-proof solution.

DISADVANTAGES :

1.Initial Setup and Infrastructure Costs: Implementing an IoT-based system requires upfront investment in infrastructure, including sensors, communication devices, and network infrastructure. The initial setup costs can be higher compared to traditional street lighting systems. Additionally, ongoing maintenance and upgrades may be necessary, adding to the overall expenses.

2. Reliance on Technology and Connectivity: The IoT-based system heavily relies on technology and connectivity. If there are issues with the network or communication infrastructure, such as power outages or connectivity disruptions, it may affect the system's functionality. Dependence on technology introduces a certain level of vulnerability and the need for backup systems or contingency plans.

3. Data Security and Privacy Concerns: IoT systems generate and process a significant amount of data. This data may include sensitive information about weather conditions, lighting patterns, and even user behavior. Ensuring data security and protecting user privacy becomes crucial. Adequate measures must be implemented to safeguard data, prevent unauthorized access, and comply with privacy regulations.

4. Complexity and Technical Expertise: Developing and managing an IoT-based system requires technical expertise and knowledge. It involves understanding various technologies, programming, data analysis, and integration of different components. Organizations may need to invest in training or hire skilled personnel to handle the complexity of the system effectively.

5. Compatibility and Interoperability Challenges: Integrating an IoT-based street lighting system with existing infrastructure or legacy systems can be challenging. Compatibility issues may arise due to different communication protocols, hardware dependencies, or system architectures. Ensuring seamless interoperability with other smart city components may require additional effort and customization.

6. Environmental Factors and Limitations: Despite the system's adaptability, certain environmental factors can still pose challenges. For example, heavy rainfall or extreme weather conditions might affect the reliability and accuracy of sensors, leading to incorrect lighting adjustments. External factors like obstructions or reflections may impact the sensor readings, affecting the system's performance.

7. Learning Curve and User Acceptance: Introducing a new technology like IoT-based street lighting may involve a learning curve for users and stakeholders. It may take time for operators, maintenance personnel, and administrators to become familiar with the system's functionalities and adapt to new processes. Ensuring user acceptance and providing proper training and support are essential.

(This disadvantages are Possibilities to implemented and Changed to Disadvantage to advantage)

GitHub:

https://github.com/naanmudhalvan-SI/PBL-NT-GP--4343-1680763063/invitations

Thanks you