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Energy Conservation with Smart Street Light System Using IoT

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ABSTRACT

An intelligent smart street lighting system has been aimed to develop which is equipped with vehicle detection sensors which provide a better solution for street lighting system. It targets the energy saving and autonomous operation of the street lights. The main purpose behind this is to save the power and cost. As the light goes ON and OFF as needed, it conserves energy. Bangladesh has one of the world's fastest expanding economies, and as a result, we are installing a smart technology - specifically, a smart street light system using IoT. Even when power is available, the manual streetlight system illuminates with maximum intensity from dusk to daybreak. A model of smart street lighting system that uses less energy has been created and tested. We have taken real life data from streets of Dhaka’s malibagh area and by calculating, we have found out that approximately in lanes, we got energy saving percentage 37.08% in roads 15.67% and in flyovers 13.33%.

Keywords: *Street lights, IoT, Energy saving percentage, Power, Cost*

1. INTRODUCTION

Streetlights are an essential aspect of any city since they provide for better night vision, safe roads, and access to public places, yet they consume a significant amount of electricity. Even when there is enough light available, the manual streetlight system operates at maximum intensity from sunset until daybreak. This waste of energy can be avoided by turning lights off automatically. The energy saved can be put to better use in other areas such as residential, business, and transportation. An IoT (Internet of things)-enabled streetlight management system can help with this. The goal of an IOT-based automated streetlight management system is to save energy by minimizing electrical waste while also lowering manpower. This technology can be utilized in public spaces such as hotels, industries, and other businesses because it uses less energy and saves money. It prevents current from overflowing. This system does not necessitate the use of human resources.

The street light is one of the major expenses in a city, as observed in a lot of cities. All sodium vapor lamps use more electricity due to their high cost. The money spent on the street light could be put to better use elsewhere in the country. Currently, a manual system is in use, in which the light is turned on and off manually, i.e., the light is turned.

The lights are on in the evening and off in the morning. As a result, the ON/OFF cycle wastes a lot of energy. Less power waste leads to significant cost savings, which is one of the key justifications for moving to an autonomous system. This method can be employed in public venues such as hotels, factories, and other businesses. It prevents current from overflowing. This system does not necessitate the use of human resources. This SSLS is primarily used to prevent power waste and save current in metropolitan areas and highways. Conserving energy has been a significant burden for our age, and by automating tedious processes, we may save a tremendous amount of energy. These also save time and money by reducing manpower and preventing energy waste.

By improving safety and easing traffic congestion, smart street lights make cities more livable. Costs of energy are reduced. When compared to simple LED luminaries, smart street lights manage electricity more efficiently, resulting in larger cost savings. The primary goal of street lighting is to provide nighttime visibility that is quick, accurate, and comfortable. These visibility attributes may help to protect, facilitate, and encourage vehicle and pedestrian transportation.

2. METHODOLOGY

A platform is employed in the design of an IOT-based street light management and monitoring system in order to create a versatile and dependable system that is simple to operate. The type of platforms, hardware components, and style of operation of the street light control and monitoring system were all carefully chosen for the purposes of this project.

3. OBJECTIVES OF THE STUDY

a) To create a system of intelligent street lighting with sensors for vehicle detection that can create a smart street lighting system with vehicle identification sensors that focuses energy conservation and autonomous operation on streets with low lighting costs.
Saving money and power is the major goal here. As the light goes ON and OFF as needed, it conserves energy while also reducing our workload. When a vehicle is driven by a specific IR sensor, the IR sensor sends a signal to the Arduino board, which then activates the LEDs to determine the position of the car. LDR is used to automatically turn off street lights during the day when the sun is bright by detecting the presence of ambient light.

b) The main goal is to safeguard the power efficiently and to save energy without wasting it for safe street lights and tranquil vehicle movements. When vehicles approach the street/road, the sensor will detect their motions and turn the lights on or off automatically.

4. LITERATURE REVIEW

Street lights have been a fundamental component of human society since its introduction by the Greek and Roman civilizations in the preindustrial age. They illuminate the gloomy paths at night, reducing the risk of accidents and improving pedestrian safety. Criminals are less likely to conduct crimes in the light; hence street lights help to minimize crime. Citizens benefit greatly from street lighting LEDs are already being used to replace current streetlights in most developed countries as a cost-effective alternative. As part of the "smart city" concept, modern countries are also focused on replacing old lighting with "smart" streetlights. Smart streetlights help communities save even more money by reducing maintenance expenses and electrical energy waste. In general, the market for LED and intelligent street lighting is expanding gradually.

To advance the study, previous project papers completed by several authors will be evaluated. It's a method for me to come up with new concepts and thoughts. There has been a lot of literature written on the same project earlier; certain publications are taken into consideration for the project's idea. Examining previous work and conducting research on the Street Light Control System: According to Minli Tang and Hengyu Wu's theory, the street light control system's main component is an AT89S52 single-chip microprocessor. It has a power supply, a circuit for defect detection, a circuit for infrared detection, a circuit for an LCD display, a circuit for photosensitive detection, a circuit for controlling street lights, a circuit for controlling pressed keys, and other parts. With the help of this technology, switches and lights can be turned on and off automatically in response to traffic. It expands both the associated circuit and the fault detecting circuit in size. It also incorporates a user-friendly and flexible button control circuit for on/off switching of the aforementioned functionalities. The system's operating principle is completely absent from the document, which is its fundamental problem. Additionally, it is advised that you use a fault-detecting circuit, which, if broken, results in the voltage dropping to zero and creating a problem.

Gong Siliang [1] describes a wireless sensor network-based remote streetlight monitoring system. The system can be set up to operate automatically, adjusting the brightness of streetlights and other lights using the Sunrise and Sunset Algorithm. This control can adapt fairly based on latitude, longitude, and seasonal fluctuations. This mechanism is also capable of being controlled. In this mode, we can operate streetlights via a PC monitor terminal. The system also has a digital temperature-humidity sensor, which tracks the temperature and humidity in addition to the streetlight in real-time. The system can be utilized in many different sites that need timely control, including streets, stations, mines, schools, and the electricity sector, among others. It also features a high-power relay output. However, a wireless network for streetlight remote control is covered in this paper. The uniqueness of the approach is the location knowledge of nodes that cannot self-localize. Hardware that was expensive was used to make prototypes. The cornerstone for localization, the capability of ranging measurements, includes minor defects on the order of meters. In the near future, location-aware routing algorithms will be created, increasing the street lighting system's effectiveness.

Street lights positioned alongside loads can be controlled and monitored using a Zigbee-based street light management system, according to S.H. Jeong et al. The control command of this system switches on and off the lights. Through the communication connection, the control system keeps track of the local status data. Information about on/off status, control group status, and safety-related data, like energy-saving mode status, are all tracked. Control commands and status information are transmitted between street control terminals using a variety of communication devices and protocols. Power lines or wireless are frequently used as communication mediums. Numerous frequency bands, from tens of MHz to Rebrands, are employed for wireless cases. This street light control system can save the amount of time and money spent on maintenance while simultaneously improving safety. A comparison of three different photovoltaic (PV) street lighting systems is provided by Somchai Hiranvarodom. A high-pressure sodium lamp, a low-pressure sodium lamp, and a fluorescent light were all installed. With the same module type and wattage, all three systems were installed at different sites within the Rajamangala Institute of Technology, Thanyaburi district, Pathumthani province of Thailand. A control circuit experiment was conducted as part of this investigation. It was also suggested to use a controller to safeguard the battery from damage caused by deep depletion and overcharging. The best way for comparing three different bulbs is life cycle cost analysis (LCCA).The results of this study show that when compared to low-pressure sodium and high-pressure sodium, the average brightness of the fluorescent light at the design location, the Pathumthani region of Thailand, has the highest value. The fluorescent bulb has the shortest lifetime when compared to other types of lamps, though. However, the objective of this study is to assess the most suitable system to install in a typical rural area or rural village in Thailand, taking into account the cost of lighting, system performance, and the availability of the system's components. It is challenging to consider it in different contexts. An intelligent, energy-saving wireless street light management and monitoring system that incorporates new technology was developed by B. K. Subramanyam and colleagues. By mounting a solar panel on the lamp post and using LDR, it is possible to reduce energy and electricity use even further. A GUI program that shows the status of the lights in street or highway lighting systems allows us to monitor and control the street lights as well.

An intelligent management of the lamp posts by sending data to a central station through ZigBee wireless communication was suggested by P. Nithya et al. [2] in their work on Design of Wireless Framework for Energy Efficient Street light Automation.

Over the next decade, cities around the world will be transformed by LED and smart streetlights. When compared to traditional street lighting, LED delivers a longer lifespan, lower energy usage, and less maintenance cost. The street lighting system is inefficient, and current technology has yet to be deployed.

5. SYSTEM BLOCK DIAGRAM FOR THE PROJECT

This project involves smart street lights, which turn on as a car drives through them. In this case, IR sensors are being used to operate LEDs while simultaneously sensing the location of the car. When a certain IR sensor detects the presence of a vehicle, it determines its location and sends a signal to the

Arduino board, which activates the LEDs. In order to automatically turn off the street light throughout the day when the sun is bright, an LDRSensor is utilized to detect the presence of ambient light.

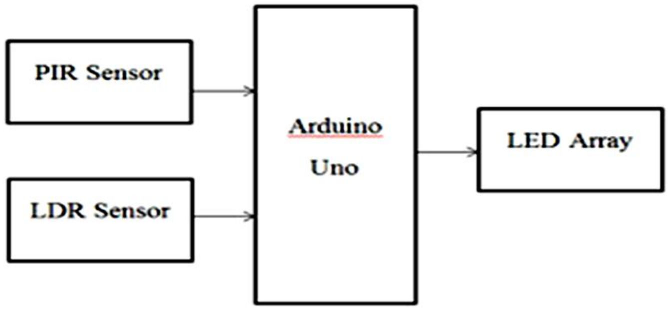


Fig 1: Block Diagram of the Proposed System

6. FLOW CHART AND DESCRIPTION OF THE CIRCUIT

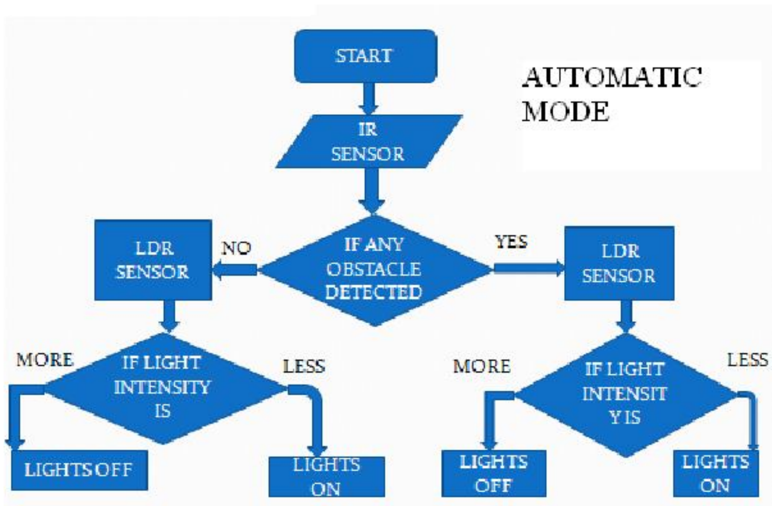


Fig 2: Flow chart of the system

LDR sensor's one pin is connected to A3 and the other is connected to 5V of the Arduino. Positive pins of the LEDs are connected to 5, 6 and 7and negatives are connected to the ground (GND). VCC of the IR sensors is connected to 5V, and middle pin is connected to the GND.

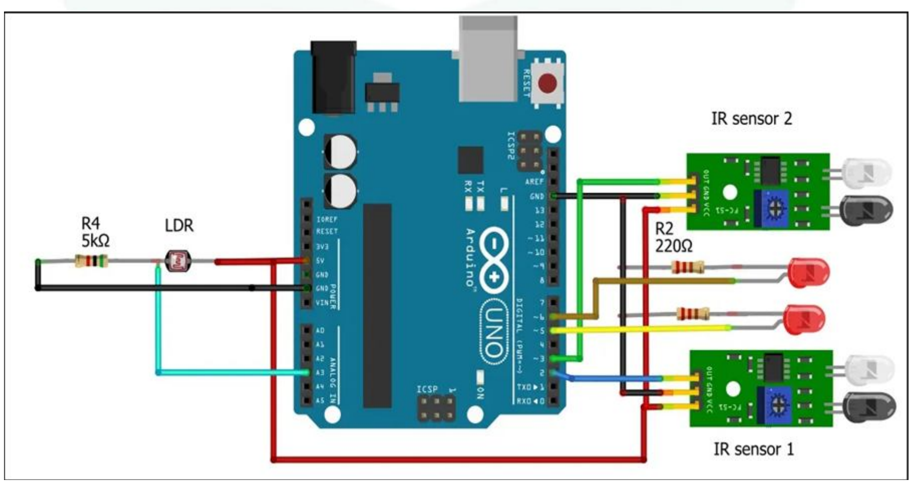


Fig 3: Circuit diagram of the project

6.1 Hardware Description

6.1.1 Arduino Uno

Based on the Microchip ATmega328P microprocessor, Arduino.cc created the open-source Arduino Uno microcontroller board. A variety of expansion boards (shields) and other circuits can be connected to the board's digital and analog input/output (I/O) pins. The board has 6 analog I/O pins, 14 digital I/O pins, six of which can be used for PWM output, and it can be programmed using the Arduino IDE using a type B USB cable. Voltages between 7 and 20 volts can be supplied via a USB cable or an external 9-volt battery. It resembles the Leonardo and Nano Arduino microcontrollers. The hardware reference design is available on the Arduino website under a Creative Commons Attribution Share-Alike 2.5 license. There are designing and manufacturing files available for several hardware versions as well.

6.1.2 IR (Infrared) sensors

An IR sensor can monitor an object's heat while also spotting movement. These kinds of sensors are referred to as passive IR sensors since they do not emit infrared radiation; instead, they merely measure it. Typically, all items emit some kind of thermal radiation in the infrared an infrared sensor may pick up on these radiations, which are invisible to human vision. An IR LED (Light Emitting Diode) serves as the emitter, and an IR photodiode, which is sensitive to IR light of the same wavelength as that emitted by the IR LED, serves as the detector. The resistances and output voltages when IR light strikes the photodiode will vary proportionally to the intensity of the IR light received.

6.1.3 Resistors

A resistor is a passive electrical device with two terminals that creates electrical resistance to serve as a circuit element. Because they can release many watts of electrical energy as heat, high-power resistors can be used as generator test loads, power distribution systems, and motor controllers.

6.1.4 LEDs

A resistor is a passive electrical device with two terminals that creates electrical resistance to serve as a circuit element. Because they can release many watts of electrical energy as heat, high-power resistors can be used as generator test loads, power distribution systems, and motor controllers. Electrical limits to low voltage and generally to DC (not AC) power, difficulty to deliver consistent lighting from a pulsating DC or an AC electrical supply source, and lower maximum operating temperature and storage temperature are some of the downsides of LEDs.

6.1.5 Light dependent resistor sensor

Other names for an LDR also referred to as a photo resistor, photocell, or photoconductor. It is a particular kind of resistor, and the resistance changes according to the amount of light that hits its surface. The resistance alters when light strikes the resistor. In many circuits where the need to detect the presence of light exists, these resistors are frequently used. The resistance and uses of these resistors are varied. For instance, the LDR can be used to turn ON a light when it is in the dark or to turn OFF a light when it is in the light. A typical light-dependent resistor has a resistance of 1 MOhm in darkness and a resistance of a few MOhm in brightness.

6.2 Software Requirement

Software is employed in programming. The project cannot be operated if the Arduino is not programmed. We used Arduino software to program an Arduino UNO for the suggested system. With an editor, simulator, programmer, and other tools, it is a complete software development environment. The Arduino IDE has specific code organization guidelines to support the languages C and C++. Software for controlling Arduino was set up. The Arduino must then be connected to the computer's USB port. It must be connected to the computer using a USB cable.

7. Analysis and explanation of the system

In this project we have given real data and by proper calculation got the saved energy in percentage. We have calculated the energy saving in 3 possible ways in the city. We can see, in lanes energy saving percentage is higher. We have so many lanes, streets and flyovers in Dhaka city only where a lot of energy can be saved by properly implementing this work.

We have taken vehicle delay time avg. from 5pm to 5am for consecutively 3 days in lane, road and flyovers. Then we have taken the 3 days avg. energy saving percentage of lane, road and flyovers. For better understanding we have also implemented it in a chart. In lanes, we got higher energy saving percentage (37.08%) than roads (15.67%) and flyovers (13.33%). This project will help us in simultaneously reducing inefficiencies and energy waste. This project focuses on the saving of energy in power consumption.

Practical analysis of data is the act of taking raw data and turning it into information that we can use to make decisions. In this article, we have shown some practical data taken within a time limit and got final results by calculating following proper equations to understand the actual implementation of the project.

The suggested system is built in such a way that it will remain in an off state even after it is linked to the power source during the daytime when there is no requirement for street lighting.

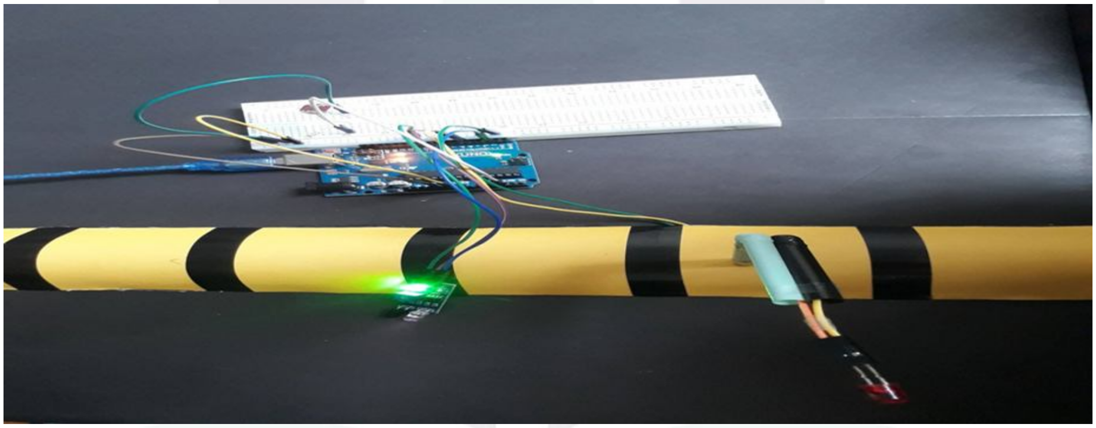


Fig 4.1: Dark outside, no object detected, LED OFF

When the sun has set and it is nighttime, the infrared sensor mounted on the road divider will detect the presence of the vehicle and send a signal to the microcontroller to turn on the street light. The LDR will then sense the intensity of light and send the signal to the microcontroller.

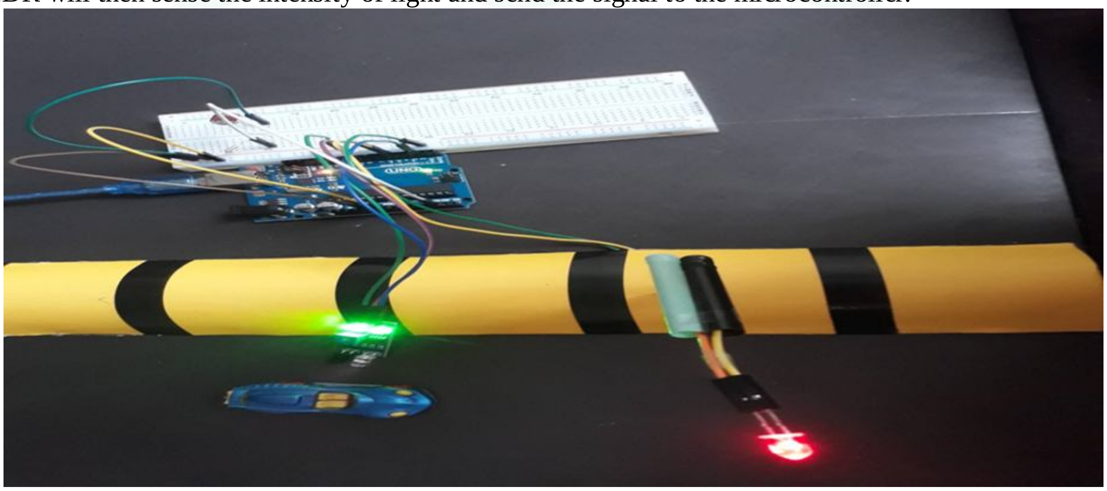


Fig 4.2: Dark outside, object detected, LED ON

Two different types of sensors, each with a particular function, are primarily used in this system. The first is the Light Dependent Resistor (LDR), which is used to turn on or off the LEDs during the day and at night by sensing the brightness of the light.

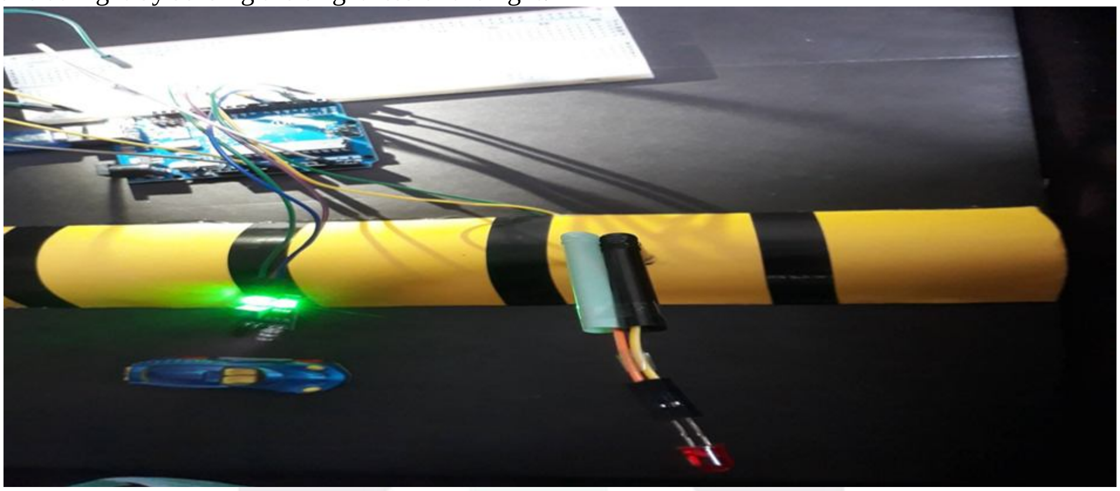
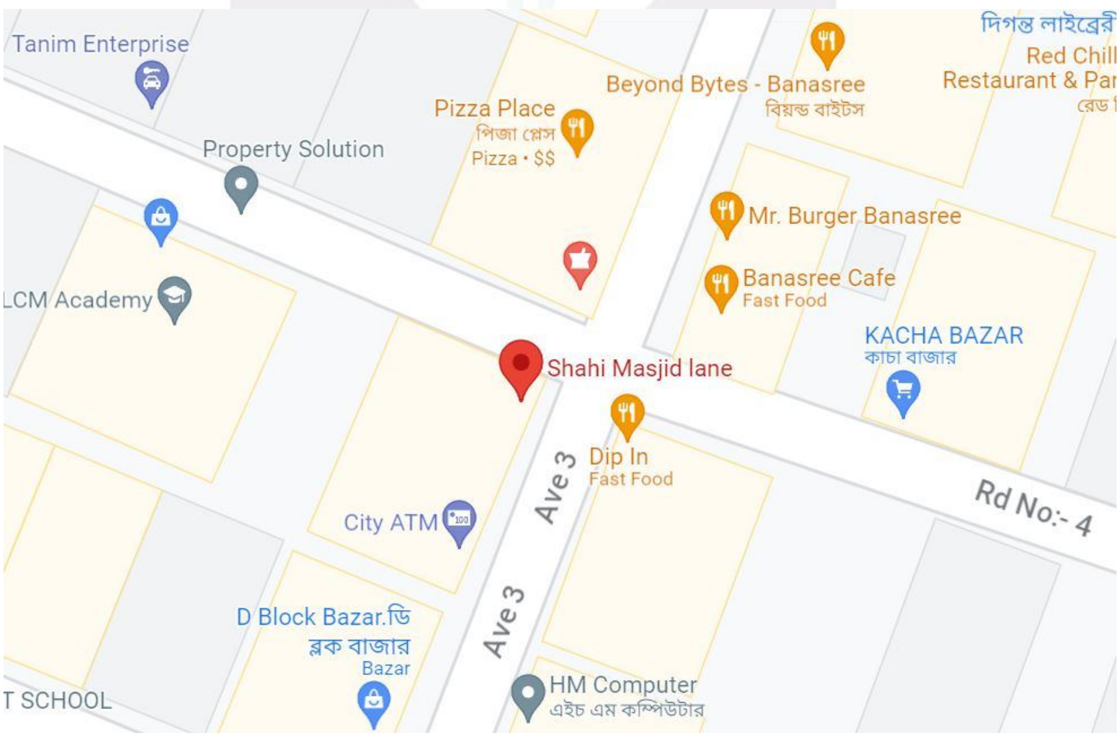


Fig 4.3: Light outside, object detected, LED OFF

The other one which is used in this project is the Infrared sensor. The presence of any vehicle passing the street can be detected secondarily using the IR sensor.

Here the locations from where the data are taken have been attached for better understanding and clear view of the project.



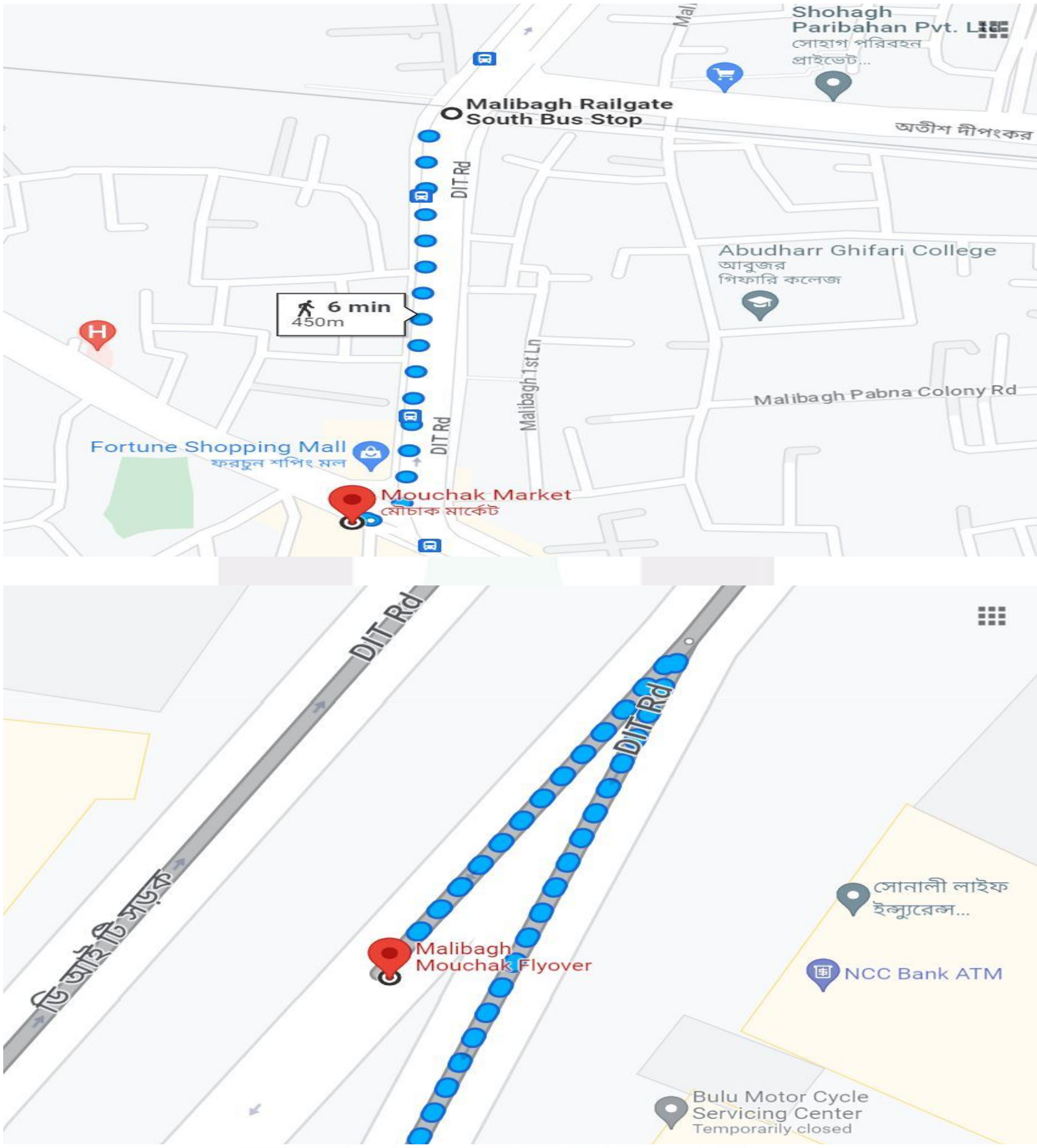


Fig 5: Routes on map.

8. RESULTS AND DISCUSSION

Data tables and calculation of the system are given below which finally the outcome which is given in chart.

8.1 Data tables and calculations

Table 1: Malibagh Shahi Masjid Adjacent Lane (0.2 km), Day 01

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg 4.38 Hrs)
1	5pm-6 pm	30	ON	13 Min Off Condition	250 Watt	
2	6pm-7 pm	20	ON	15 Min Off Condition	250 Watt	
3	7pm-8 pm	35	ON	16 Min Off Condition	250 Watt	

4	8pm-9 pm	15	ON	23 Min Off Condition	250 Watt	**8001 Taka**
5	9pm-10 pm	15	ON	17 Min Off Condition	250 Watt	
6	10pm-11pm	11	ON	30 Min Off Condition	250 Watt	
7	11pm-12pm	9	ON	27 Min Off Condition	250 Watt	
8	12am-1 am	9	ON	25 min off condition	250 watt	
9	1 am-2 am	3	ON	32 min Off Condition	250 Watt	
10	2 am-3 am	2	ON	35 min Off Condition	250 Watt	
11	3 am-4 am	0	ON	0 min Off Condition	250 Watt	
12	4 am-5 am	2	ON	30 min Off Condition	250 Watt	

Total Energy Calculation for 30 Days:

0.2 kilometer=656.168 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 20 pcs
Total Power =250x20=5000 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x5000x30/1000
=1800 Unit
30 Days Total Cost = 1800x7 taka/Per Unit
=12,600 Taka

Energy Saving Calculation for 30 Days:

0.2 kilometer=656.168 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 20 pcs
Total Power =250x20=5000 Watt
Total delay time=4.38 hours
30 Days Energy Saving Calculation= 4.38 hrs. X 5000x30/1000 =657 Unit

30 Days Energy Saving Cost= 657x7/per unit
=4599 Taka

Reduced saving cost: 12,600-4599 Taka
= 8001 Taka

Energy saving in percentage: (4599/12600) x 100 = 36.5 %

Table 2: Malibagh South Bus Stop to Mouchak Market road (0.5 km), Day 01

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg 1.92 Hrs)
1	5.00pm-6pm	80	ON	4 Min Off Condition	250 Watt	**26,460 Taka**
2	6pm-7pm	92	ON	3 Min Off Condition	250 Watt	
3	7pm-8pm	98	ON	2 Min Off Condition	250 Watt	
4	8pm-9pm	64	ON	6 Min Off Condition	250 Watt	
5	9pm-10pm	55	ON	2 Min Off Condition	250 Watt	
6	10pm-11pm	28	ON	8 Min Off Condition	250 Watt	
7	11pm-12pm	7	ON	7 Min Off Condition	250 Watt	
8	12am-1am	5	ON	7 min off condition	250 watt	
9	1 am-2 am	6	ON	10 min Off Condition	250 Watt	
10	2 am-3 am	2	ON	25 min Off Condition	250 Watt	
11	3 am-4 am	5	ON	15 min Off Condition	250 Watt	
12	4 am-5am	3	ON	25 min Off Condition	250 Watt	

Total Energy Calculation For 30 Days :

0.5 kilometer=1640.42 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 50 pcs
Total Power =250x50=12500 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x12500x30/1000
=4500 Unit
30 Days Total Cost = 4500x7 taka/Per Unit
=31,500 Taka

Energy Saving Calculation for 30 Days:

0.5 kilometer=1640.42 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 50 pcs
Total Power =250x50=12500 Watt
Total delay time=115 minutes/1.92 hrs.
30 Days Energy Saving Calculation= 1.92 hrs. X12500x30/1000 =720 Unit

30 Days Energy Saving Cost= 720x7/per unit
=5040 Taka
Reduced saving cost: 31,500-5040 Taka
= 26,460 Taka

Energy saving in percentage: (5040/31500) x 100 = 16 %

Data table 3: Malibagh – Mouchak Flyover (1 km), Day 01

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 1.6 Hrs.)
1	5pm-6 pm	102	ON	2 Min Off Condition	250 Watt	**54,600 Taka**
2	6pm-7 pm	90	ON	2 Min Off Condition	250 Watt	
3	7pm-8 pm	92	ON	5 Min Off Condition	250 Watt	
4	8pm-9 pm	100	ON	3 Min Off Condition	250 Watt	
5	9pm-10 pm	88	ON	1 Min Off Condition	250 Watt	
6	10pm-11pm	73	ON	6 Min Off Condition	250 Watt	
7	11pm-12pm	65	ON	6 Min Off Condition	250 Watt	
8	12am-1 am	51	ON	9 min off Condition	250 watt	
9	1 am-2 am	44	ON	13 min Off Condition	250 Watt	
10	2 am-3 am	29	ON	9 min Off Condition	250 Watt	
11	3 am-4 am	20	ON	15 min Off Condition	250 Watt	
12	4 am-5 am	16	ON	25 min Off Condition	250 Watt	

Total Energy Calculation for 30 Days:
1 kilometer=3280.84 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 100 pcs
Total Power =250x100=25000 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x25000x30/1000
=9000 Unit
30 Days Total Cost = 9000x7 taka/Per Unit
=63,000 Taka

Energy Saving Calculation for 30 Days:

1 kilometer=3280.84 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 100 pcs
Total Power =250x100=25000 Watt
Total delay time= 96 minutes/1.6 hours
30 Days Energy Saving Calculation= 1.6 hrs. X 25000x30/1000 = 1200 Unit

30 Days Energy Saving Cost= 1200x7/per unit
=8400 Taka

Reduced saving cost: 63,000-8400 Taka
= 54,600 Taka

Energy saving in percentage: (8400/63000) x 100 = 13.33%

Average Calculation:

LANE

Vehicle delay time (Avg.)
Day 01 - 4.38 hours
Day 02 – 5.16 hours
Day 03 - 3.82 hours

3 days Avg. Delay Time of Lane = 4.38 + 5.16 + 3.82/3 = 4.45 hours
Energy Saving Calculation Avg. = 4.45 hrs. X 50000 X 30/1000 = 667.5 Unit
30 Days Avg. Energy Saving Cost= 667.5x7/per unit
= 4672.5 Taka

Reduced saving cost: 12,600-4672.5 Taka
= 7927.5 Taka
Energy saving in percentage: (4672.5/12600) x 100 = 37.08%

ROAD

Vehicle delay time (Avg.)
Day 01 – 1.92 hours
Day 02 – 1.88 hours
Day 03 – 1.83 hours

3 days Avg. Delay Time of Lane = 1.92 + 1.88 + 1.83/3 = 1.88 hours
Energy Saving Calculation Avg. = 1.88 hrs. X 12500 X 30/1000 = 705 Unit
30 Days Avg. Energy Saving Cost= 705x7/per unit
= 4935 Taka

Reduced saving cost: 31500-4935Taka
= 26,565 Taka
Energy saving in percentage: (4935/31500) x 100 = 15.67%

FLYOVER

Vehicle delay time (Avg.)
Day 01 – 1.6 hours
Day 02 – 1.45 hours
Day 03 – 1.75 hours

3 days Avg. Delay Time of Lane = 1.6 + 1.45 + 1.75/3 = 1.6 hours
Energy Saving Calculation Avg. = 1.6 hrs. X 25000 X 30/1000 = 1200 Unit
30 Days Avg. Energy Saving Cost= 1200x7/per unit
= 8400 Taka

Reduced saving cost: 63000-8400 Taka
= 54600 Taka
Energy saving in percentage: (8400/63000) x 100 = 13.33%

8.2 Graphic Outline of the System

We have shown the data tables with calculations. Now according to those calculations we have drawn a chart to show energy conservation percentage in adjacent lanes, roads and flyovers.

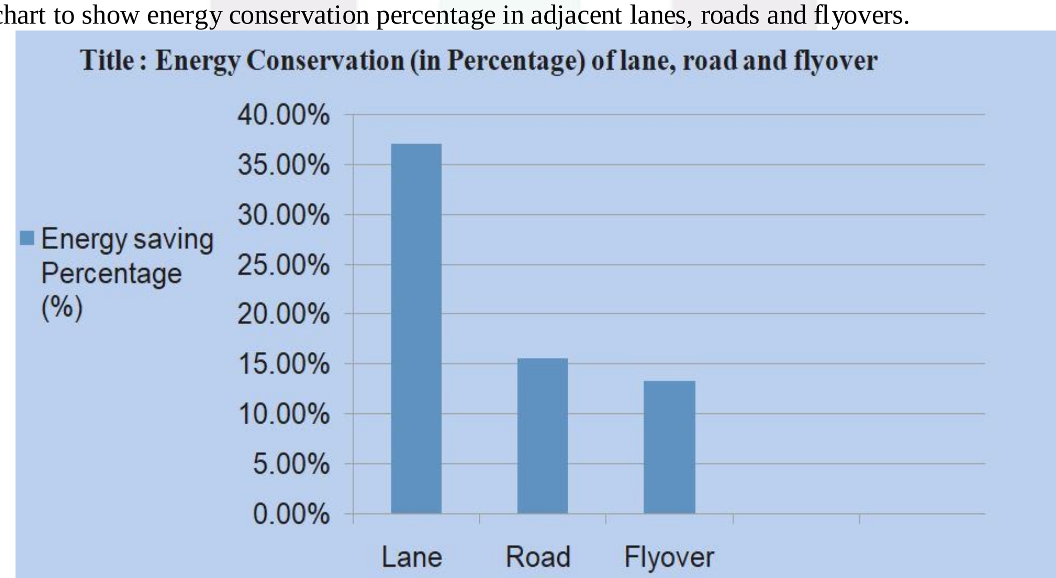


Fig 6: Graphic Outline of the Project.

Discussion

A smart street lighting system that uses less energy has been created, tested, and successfully applied in a real-world setting. We have given real data and by proper calculation got the saved energy in percentage. The street lights are turned on and at the perfect level only when necessary thanks to the combined use of two types of sensors. Charts are given to understand the energy saving between 3 possible ways in the city. We can see, in lanes energy saving percentage is higher. We have so many lanes, streets and flyovers in Dhaka city only where a lot of energy can be saved by properly implementing this work.

The street lights across the entire nation will be greatly benefitted by this smart effort on street lighting. The project is incredibly simple to utilize and put into practice. It will help us in simultaneously reducing inefficiencies and energy waste. This project focuses on the energy saving in power consumption. It has been showed practically by taking data from the roads and the energy which can be saved is derived from the calculation is given in percentage.

9. CONCLUSION

The prototype for the automatic switching street light circuit has been successfully put into use. Basically, the suggested system uses two sensors: an infrared sensor and a light-dependent resistor sensor. In order to automatically turn off the street light throughout the day when the sun is bright, an LDR sensor is utilized to detect the presence of ambient light. The LDR signals the microcontroller to turn on the street light at night when there is no light. The IR sensor adjusts the street light's brightness after the light turns on.

This project will have a significant positive impact on lowering the amount of labor required to maintain the street lights along highways. It will become a cost-effective project if the number of people employed there can be transferred to another location, which will lower the cost of the overall system. We have taken real life data and by calculating, we have found out that approximately in lanes, we got higher energy saving percentage (37.08%) than roads (15.67%) and flyovers (13.33%). With greater maintenance, this project will likely survive longer than the conventional system. It will also digitalize the entire system, making it simple for a person to handle when necessary without being physically there. If this system is properly used, despite its seeming low cost, it will function more effectively than other systems.

The project can be expanded to predict the vehicle's speed. When we recognize the number plate, we may also identify when accidents occur on the roadways, etc. Instead of employing a sensor, such as an LDR sensor, to measure the system's light intensity, we can establish a constant timer to turn the lights ON and OFF. We are able to create a solar street light system with an automatic controller. A battery that can be charged during the day by capturing solar energy using a solar cell can power the system.

10. APPENDIX

Data Tables and Calculations

Data table 1: Malibagh Shahi Masjid Adjacent Lane (0.2 km), Day 02

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 5.16 Hrs.)
1	5pm-6 pm	20	ON	17 Min Off Condition	250 Watt	**7175 Taka**
2	6pm-7 pm	21	ON	15 Min Off Condition	250 Watt	
3	7pm-8 pm	27	ON	20 Min Off Condition	250 Watt	
4	8pm-9 pm	31	ON	23 Min Off Condition	250 Watt	
5	9pm-10 pm	15	ON	20 Min Off Condition	250 Watt	
6	10pm-11pm	7	ON	25 Min Off Condition	250 Watt	
7	11pm-12pm	5	ON	27 Min Off Condition	250 Watt	
8	12am-1 am	3	ON	33 min off Condition	250 watt	
9	1 am-2 am	3	ON	33 min Off Condition	250 Watt	
10	2 am-3 am	2	ON	30 min Off Condition	250 Watt	
11	3 am-4 am	2	ON	35 min Off Condition	250 Watt	
12	4 am-5 am	3	ON	32 min Off Condition	250 Watt	

<u>Total Energy Calculation For 30 Days :</u>

0.2 kilometer= 656.168 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 20 pcs
Total Power =250x20=5000 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x5000x30/1000
=1800 Unit
30 Days Total Cost = 1800x7 taka/Per Unit
=12,600 Taka

Energy Saving Calculation for 30 Days:

0.2 kilometer=656.168 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 20 pcs
Total Power =250x20=5000 Watt
Total delay time=5.16 hrs.
30 Days Energy Saving Calculation= 5.16 hrs. X5000x30/1000 =775 Unit

30 Days Energy Saving Cost= 775x7/per unit
=5425 Taka

Reduced saving cost: 12,600-5425 Taka = 7175 Taka
Energy saving in percentage: (5425/12,600) x 100 = 43.06 %

Data table 2: Malibagh Shahi Masjid Adjacent Lane (0.2 km), Day 03

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 5.16 Hrs.)
1	5pm-6 pm	25	ON	15 Min Off Condition	250 Watt	**8589 Taka**
2	6pm-7 pm	35	ON	13 Min Off Condition	250 Watt	
3	7pm-8 pm	39	ON	17 Min Off Condition	250 Watt	
4	8pm-9 pm	20	ON	20 Min Off Condition	250 Watt	
5	9pm-10 pm	17	ON	16 Min Off Condition	250 Watt	
6	10pm-11pm	10	ON	29 Min Off Condition	250 Watt	
7	11pm-12pm	11	ON	26 Min Off Condition	250 Watt	
8	12am-1 am	6	ON	30 min off Condition	250 watt	
9	1 am-2 am	5	ON	33 min Off Condition	250 Watt	
10	2 am-3 am	0	ON	0 min Off Condition	250 Watt	
11	3 am-4 am	0	ON	0 min Off Condition	250 Watt	
12	4 am-5 am	2	ON	30 min Off Condition	250 Watt	

Total Energy Calculation For 30 Days :

0.2 kilometer= 656.168 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 20 pcs
Total Power =250x20=5000 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x5000x30/1000
=1800 Unit
30 Days Total Cost = 1800x7 taka/Per Unit
=12,600 Taka

Energy Saving Calculation for 30 Days:

0.2 kilometer=656.168 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 20 pcs
Total Power =250x20=5000 Watt
Total delay time=3.82 hrs.
30 Days Energy Saving Calculation= 3.82 hrs. X5000x30/1000 =573 Unit

30 Days Energy Saving Cost= 573x7/per unit
=4011 Taka
Reduced saving cost: 12,600-4011 Taka = 8589 Taka
Energy saving in percentage: (4011/12,600) x 100 = 31.83 %

Data table 3: Malibagh South Bus Stop to Mouchak Market road (0.5 km), Day 02

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 5.16 Hrs.)
1	5pm-6 pm	90	ON	3 Min Off Condition	250 Watt	26,565 taka
2	6pm-7 pm	95	ON	5 Min Off Condition	250 Watt	
3	7pm-8 pm	80	ON	3 Min Off Condition	250 Watt	
4	8pm-9 pm	71	ON	6 Min Off Condition	250 Watt	
5	9pm-10 pm	59	ON	2 Min Off Condition	250 Watt	
6	10pm-11pm	30	ON	7 Min Off Condition	250 Watt	
7	11pm-12pm	6	ON	9 Min Off Condition	250 Watt	
8	12am-1 am	3	ON	6 min off Condition	250 watt	
9	1 am-2 am	9	ON	7 min Off Condition	250 Watt	
10	2 am-3 am	2	ON	23 min Off Condition	250 Watt	
11	3 am-4 am	2	ON	27 min Off Condition	250 Watt	
12	4 am-5 am	3	ON	15 min Off Condition	250 Watt	

Total Energy Calculation For 30 Days :

0.5 kilometer= 1640.42 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 50 pcs
Total Power =250x50=12500 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x12500x30/1000
=4500 Unit
30 Days Total Cost = 4500x7 taka/Per Unit
=31,500 Taka

Energy Saving Calculation for 30 Days:

0.5 kilometer= 1640.42 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 50 pcs
Total Power =250x50=12500 Watt
Total delay time=1.88 hrs.
30 Days Energy Saving Calculation= 1.88 hrs. X12500x30/1000 =705 Unit

30 Days Energy Saving Cost= 705x7/per unit
=4935 Taka

Reduced saving cost: 31,500-4935 Taka = 26,565 Taka
Energy saving in percentage: (4935/31,500) x 100 = 15.67 %

Data table 4: Malibagh South Bus Stop to Mouchak Market road (0.5 km), Day 03

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 5.16 Hrs.)
1	5pm-6 pm	70	ON	6 Min Off Condition	250 Watt	26,696.25 taka
2	6pm-7 pm	95	ON	2 Min Off Condition	250 Watt	
3	7pm-8 pm	99	ON	2 Min Off Condition	250 Watt	
4	8pm-9 pm	60	ON	5 Min Off Condition	250 Watt	
5	9pm-10 pm	75	ON	3 Min Off Condition	250 Watt	
6	10pm-11pm	30	ON	10 Min Off Condition	250 Watt	
7	11pm-12pm	10	ON	6 Min Off Condition	250 Watt	
8	12am-1 am	3	ON	7 min off Condition	250 watt	

9	1 am-2 am	3	ON	12 min Off Condition	250 Watt	
10	2 am-3 am	2	ON	20 min Off Condition	250 Watt	
11	3 am-4 am	6	ON	15 min Off Condition	250 Watt	
12	4 am-5 am	2	ON	22 min Off Condition	250 Watt	

Total Energy Calculation For 30 Days:

0.5 kilometer= 1640.42 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 50 pcs
Total Power =250x50=12500 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x12500x30/1000
=4500 Unit
30 Days Total Cost = 4500x7 taka/Per Unit
=31,500 Taka

Energy Saving Calculation for 30 Days:

0.5 kilometer= 1640.42 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 50 pcs
Total Power =250x50=12500 Watt
Total delay time=1.83 hrs.
30 Days Energy Saving Calculation= 1.83 hrs. X12500x30/1000 =686.25 Unit

30 Days Energy Saving Cost= 686.25x7/per unit
=4803.75 Taka

Reduced saving cost: 31,500-4803.75 Taka
=26,696.25 Taka

Energy saving in percentage: **(4803.75/31500) x 100 = 15.25 %**

Data table 5: Malibagh – Mouchak Flyover (1 km), Day 02

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 5.16 Hrs.)
1	5pm-6 pm	105	ON	3 Min Off Condition	250 Watt	**55,387.5 Taka**
2	6pm-7 pm	100	ON	2 Min Off Condition	250 Watt	
3	7pm-8 pm	95	ON	3 Min Off Condition	250 Watt	
4	8pm-9 pm	100	ON	6 Min Off Condition	250 Watt	
5	9pm-10 pm	102	ON	3 Min Off Condition	250 Watt	
6	10pm-11pm	87	ON	1 Min Off Condition	250 Watt	
7	11pm-12pm	75	ON	5 Min Off Condition	250 Watt	
8	12am-1 am	69	ON	9 min off Condition	250 watt	
9	1 am-2 am	52	ON	10 min Off Condition	250 Watt	
10	2 am-3 am	41	ON	9 min Off Condition	250 Watt	
11	3 am-4 am	30	ON	16 min Off Condition	250 Watt	
12	4 am-5 am	22	ON	21 min Off Condition	250 Watt	

Total Energy Calculation For 30 Days:

1 kilometer=3280.84 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 100 pcs
Total Power =250x100=25000 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x25000x30/1000
=9000 Unit
30 Days Total Cost = 9000x7 taka/Per Unit
=63,000 Taka

Energy Saving Calculation for 30 Days:

1 kilometer=3280.84 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 100 pcs
Total Power =250x100=25000 Watt
Total delay time=1.45 hrs.
30 Days Energy Saving Calculation= 1.45 hrs. X25000x30/1000 =1087.5 Unit
30 Days Energy Saving Cost= 1087.5x7/per unit
=7612.5 Taka

Reduced saving cost: 63,000-7612.5 Taka
= 55,387.5 Taka

Energy saving in percentage: **(7612.5/63000) x 100 = 12.08 %**

Data table 6: Malibagh – Mouchak Flyover (1 km), Day 03

Sl No	Time (Min)	Vehicle Count (Qty)	Lamp Condition	Vehicle Delay Time (Avg.)	Lamp Power (Watt)	Energy Saving (Avg. 5.16 Hrs.)
1	5pm-6 pm	100	ON	1 Min Off Condition	250 Watt	53,812.5 Taka
2	6pm-7 pm	85	ON	3 Min Off Condition	250 Watt	
3	7pm-8 pm	97	ON	5 Min Off Condition	250 Watt	
4	8pm-9 pm	99	ON	2 Min Off Condition	250 Watt	
5	9pm-10 pm	83	ON	3 Min Off Condition	250 Watt	
6	10pm-11pm	77	ON	7 Min Off Condition	250 Watt	
7	11pm-12pm	61	ON	9 Min Off Condition	250 Watt	
8	12am-1 am	62	ON	9 min off Condition	250 watt	
9	1 am-2 am	51	ON	11 min Off Condition	250 Watt	
10	2 am-3 am	39	ON	13 min Off Condition	250 Watt	
11	3 am-4 am	27	ON	17 min Off Condition	250 Watt	
12	4 am-5 am	19	ON	25 min Off Condition	250 Watt	

Total Energy Calculation For 30 Days :

1 kilometer=3280.84 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 100 pcs
Total Power =250x100=25000 Watt
Lamp on Condition on =12 hrs.
30 Days Energy Calculation = 12x25000x30/1000
=9000 Unit
30 Days Total Cost = 9000x7 taka/Per Unit
=63,000 Taka

Energy Saving Calculation for 30 Days:

1 kilometer=3280.84 ft.
Lamp Power: 250 Watt
Total Lamp Calculation: 100 pcs
Total Power =250x100=25000 Watt
Total delay time=1.75 hrs.
30 Days Energy Saving Calculation= 1.75 hrs. X 25000x30/1000 = 1312.5 Unit
30 Days Energy Saving Cost= 1312.5x7/per unit
=9187.5 Taka
Reduced saving cost: 63,000-9187.5 Taka
= 53,812.5 Taka
Energy saving in percentage: **(9187.5/63000) x 100 = 14.58 %**

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