



# Sustainable Waste Segregation and Water Conservation: Strategies for Soil Moisture Enhancement and Pollution Prevention

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**Abstract :** The global challenges of water conservation and pollution prevention necessitate the adoption of sustainable practices at the household level. This paper explores the interconnected roles of waste segregation, composting, rain chains, and bio-enzymes in nurturing environmental sustainability. The research highlights effective methods for waste segregation at home, emphasizing the segregation of wet and dry waste to facilitate composting. The compost produced from wet waste not only enriches soil but also contributes to increased soil moisture, reducing the need for chemical fertilizers.

Additionally, the paper introduces the concept of creating rain chains from repurposed household materials. These rain chains not only aid in rainwater harvesting but also enhance soil moisture, making them a cost-effective solution for sustainable water management. Furthermore, the study details the simple process of producing bio-enzymes from organic waste, which can be used to clean surfaces, reduce water pollution, and conserve water resources. By integrating these practices, households can significantly contribute to environmental conservation, leading to healthier ecosystems and more resilient communities. This paper provides a practical guide for implementing these sustainable practices, demonstrating their profound impact on both local and global scales.

**Index Terms – Composting, waste, waste segregation, bio-enzyme, sustainable, rain-chains.**

## I. INTRODUCTION

Water conservation and pollution prevention are critical challenges in the modern world, with far-reaching implications for environmental sustainability, public health, and global ecosystems. Addressing these challenges requires an integrated approach that combines innovative practices with everyday household activities. This paper explores the intersection of waste management, sustainable gardening, and water conservation, focusing on how bio-enzymes, waste segregation, composting, and rain chains can collectively contribute to these goals.

Waste segregation is the first step toward sustainable waste management and environmental protection. By separating wet, dry, and hazardous waste at the source, households can ensure that waste is disposed of properly, reducing the risk of land and water pollution. Segregated wet waste, particularly organic material, can be composted at home. Composting not only reduces the volume of waste sent to landfills but also produces nutrient-rich soil that enhances land moisture, supporting healthier plant growth and reducing the need for chemical fertilizers, which often contaminate water sources.

Bio-enzymes represent another innovative solution for water conservation and pollution prevention. Made from organic kitchen waste, bio-enzymes are natural cleaners that can replace chemical detergents, which are major contributors to water pollution. By adopting bio-enzymes, households can significantly reduce harmful substances entering water systems, thereby preserving water quality, and supporting aquatic ecosystems.

Rain chains, another focal point of this study, offer a simple yet effective method for rainwater harvesting. Constructed from repurposed household materials, rain chains guide rainwater into collection containers or directly into the soil, promoting groundwater recharge and increasing soil moisture levels. By implementing rain chains, communities can reduce their dependence on external water sources and enhance their resilience to water scarcity.

Collectively, these practices—waste segregation, composting, bio-enzymes, and rain chains—provide a comprehensive strategy for water conservation and pollution prevention. They empower households to take an active role in environmental stewardship, transforming waste into resources, conserving water, and protecting natural ecosystems from pollution. This research paper aims to

raise awareness of these practices and demonstrate their practical benefits for enhancing soil moisture, reducing water pollution, and promoting sustainable living.

## II. OBJECTIVE OF STUDY

1. Promote Waste Segregation: Encourage proper separation of waste to reduce landfill burden and environmental pollution.
2. Enhance Composting Practices: Utilize organic waste for composting to improve soil moisture and reduce reliance on chemical fertilizers.
3. Advocate for Bio-Enzymes: Highlight the benefits of homemade bio-enzymes as eco-friendly cleaners to reduce water pollution.
4. Utilize Plastic Waste for Rain Chains: Develop rain chains from waste plastic bottles for rainwater harvesting and groundwater recharge.
5. Encourage Sustainable Living: Raise awareness about simple, cost-effective practices that contribute to water conservation and pollution prevention.

## III. WASTE SEGREGATION: A FOUNDATION FOR ENVIRONMENT SUSTAINABILITY

### 4.1 Introduction to Study Area

Data were collected at several locations of the roadsides in all the directions of Indira circle and were analyzed to study the speed, overtaking, flow, volume characteristics of different sides of the circle. A computer program is developed to simulate the traffic flow on a two-lane highway incorporating all these characteristics. The effect of directional split on capacity, speed, volume is evaluated.

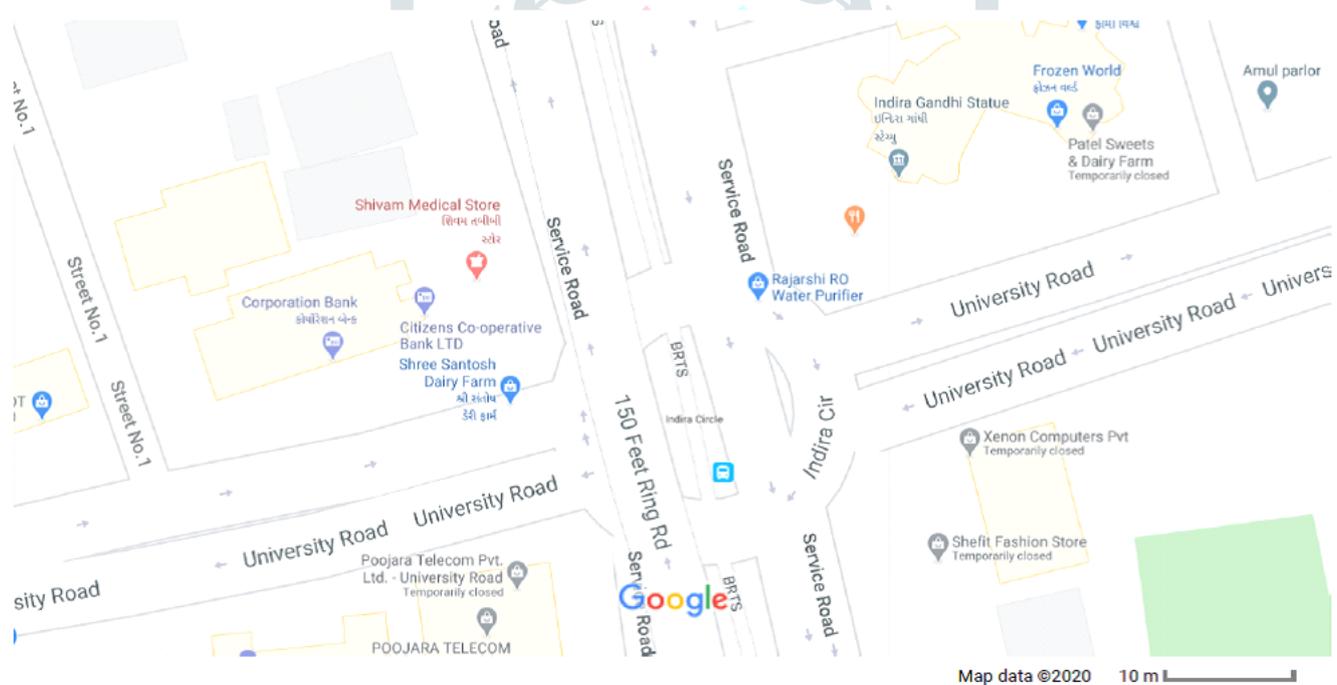


fig:1 location of indira circle intersection on map

### 4.2 Data collection

Indira circle is situated on the middle of RAJKOT city being the important part for transportation and all 4 directions are having huge traffic volume throughout the day. The area has huge commercial complex and many offices situated near it. and BRTS station is also placed besides it with the flyover passing above it. The road connects the city through 150ft ring road and university road, and it is about 100m wide and 40m long. The statue of INDIRA GANDHI is about 10 ft high which give very aesthetic look to the location and the lightings are placed very efficiently.

Due to irregular timer in the traffic signal, there is consecutive growth in a chart of traffic issues. The main victim of this is affected to many vehicles especially Ambulance, Police van and many other. Due to breaching laws, the other travellers and many others are facing problems like traffic obstruction and because it noises pollution and air pollution also takes place. Due to this kind of events the travellers are usually gets disturbed and the possibility of getting late gets high. Even mass transportation like BRTS and CITY buses gets late and need to wait for long time to pass the circle hence, due to it the people now switching to use private vehicles rather than the mass transport. The travel time to reach the destination is very much higher as there is no harmony between the signals that are connecting the roads from one starting point to another ending point. As the stops are higher harmful emission rates from the vehicles is very much higher. As the stops are higher, delay is also increasing between the starting point to the ending point.

For the better output of people & better utilization of expected outcome, we had followed some important surveys whose results would directly or indirectly helps us to change the current scenario.

The surveys are: -

1. Preliminary Survey
2. Locational Survey
3. Traffic Survey
4. Other Surveys (interviews)
5. Results of Traffic Surveys

#### 4.2.1 Preliminary Survey

It is also known as primary survey which includes the data collection of all the areas of the city that is under the condition of high traffic and signal problem.

This survey must be carried out for two periods:

- a) For normal days
- b) For weekends

For normal days = Tuesday, Wednesday, Thursday

For weekends = Saturday, Sunday

This survey had been carried out by us for TWO WEEKS consecutively.

#### 4.2.2 Location Survey

This survey includes the data collection of the location of areas that is under the influence of high traffic problem. Selection of any location across selected area. And it is the further process of primary survey. Further process is like above preliminary survey and is to be carried out for ONE WEEK. In this survey measurement of the length of the roads ,width of the roads no. of traffic signals requirement of the police staff etc. was calculated.



fig:2 location of Indira circle

#### 4.2.3 Traffic Survey

Traffic survey has been carried out in TWO sections - Morning Peak Hour and Evening Peak Hour

For normal days = Tuesday, Wednesday, Thursday

For Weekends = Saturday, Sunday

This survey has been carried out on 8.00am to 12.00 noon in morning and 4.00pm to 8.00pm evening in afternoon.

We have conducted at:

- A. Two- lane
- B. Intersection

Like above mentioned surveys, this survey is also accomplished in TWO WEEKS. By taking the AVERAGE value of two sections, the final figure is obtained.

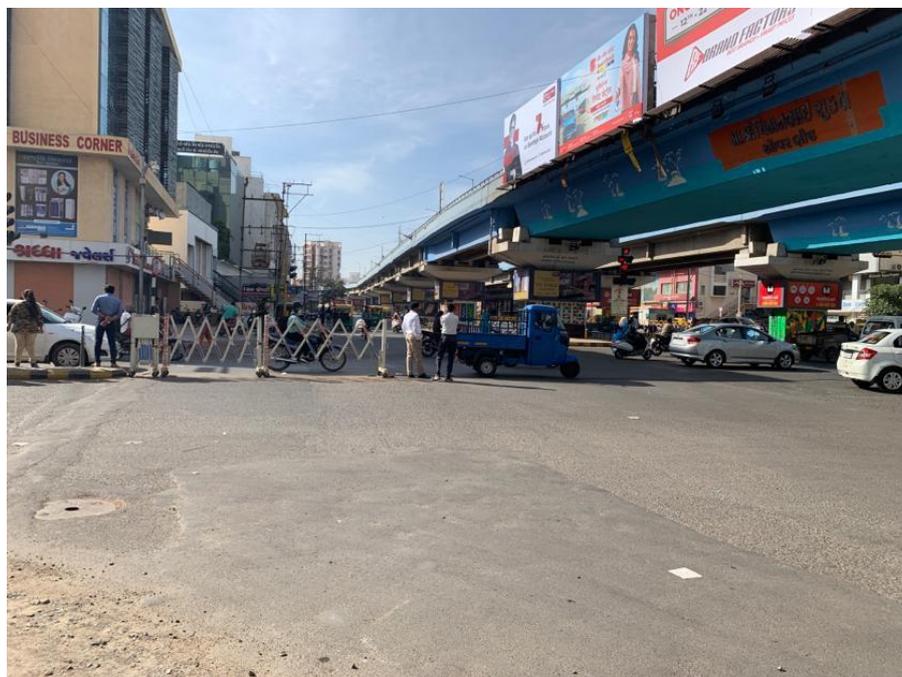


Fig 3: morning traffic



Fig 4 peak hours traffic situation



fig:5 morning traffic

#### 4.2.4 OTHER SURVEYS (INTERVIEWS)

1. Shopkeeper's Interview – It includes that what and which type of Problems they are facing off due to traffic and signal crises near their shops.
2. Public Interview – It satisfies the people by hearing their problems regarding traffic which consumes lot of time and thus results into decreasing in rush towards that area.
3. Police Interview – It includes asking questions to the police about the working of the traffic signals and the accidents occurring on the road.

Some of the questions asked to the people

- ❖ How much traffic has increased after the installation of the Traffic signal?
- ❖ Are you happy with the installation of the traffic signal?
- ❖ Are there any casualties or any kind of accidents occurring due to the installation of traffic signal?
- ❖ Has it affected your business in any form?
- ❖ Has your journey time increased or decreased due to installation of traffic signal?
- ❖ If yes than how much?
- ❖ Due to traffic do the ambulance gets its way or it must find a new way?
- ❖ Would you give some suggestion about the traffic signal?

4.2.5 Result of Traffic Survey Data

Table 1 Morning Traffic Analysis

Type of Vehicles	Number of Vehicles
Car	790
2-Wheeler	1745
3-Wheeler	265
Bus	42
Cycle	53
Other	17

Table 2 Evening Traffic Analysis

Type of Vehicles	Number of Vehicles
Car	1180
2-Wheeler	2644
3-Wheeler	471
Bus	35
Cycle	92
Other	7

Table 3 Total Traffic Analysis

Type of Vehicles	Number of Vehicles
Car	1969
2-Wheeler	4389
3-Wheeler	736
Bus	77
Cycle	145
Other	24

4.3 Growth of Vehicles

The vehicle growth of Rajkot city is shown in Table and graphically in Fig and Total vehicles in Rajkot city is continuously increasing. It is a surprising fact that in the last two-year vehicle growth is decreasing in the city. Almost two-wheeler and four-wheeler having a greater composition in the share of total vehicle. Following figure represents the vehicular growth of Rajkot city. (Source: Status and challenges of public transportation of Rajkot, Chirag Pandya, City Engineer, RMC)

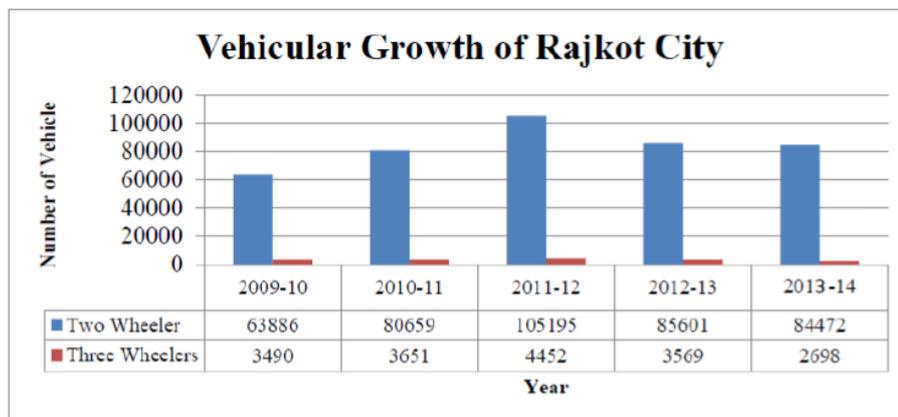


fig:6 chart of vehicular growth of Rajkot city

Table 4 vehicular growth of Rajkot city

Type of Vehicles	2009-10	2010-11	2011-12	2012-13	2013-14
2-Wheeler	63886	80559 (26%)	105195 (30%)	85601 (-19%)	84472 (-1%)
3-Wheeler	3490	3651 (5%)	4452 (22%)	3569 (-18%)	2698 (-24%)
4-Wheeler	9027	15821 (75%)	19525 (23%)	16020 (-17%)	14430 (-10%)

V. DEVELOPMENT OF SOFTWARE

As the calculation is very hard and lengthy a software is developed for the calculation of the simplex method for linear programming method. It is known as MMO Software.



fig:7 opening window of software



fig:8 main menu of MMO

Maximize  $z = 2x_1 + 3x_2$   
 Subject to  $x_1 \leq 5$   
 $x_1 - 2x_2 \geq -5$   
 $x_1 + x_2 \leq 6$   
 $x_1, x_2 \geq 0$

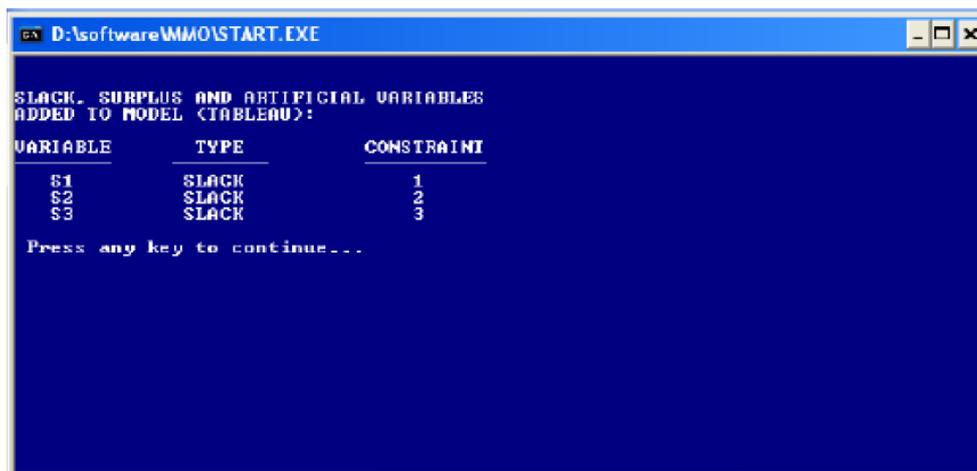


fig:9 list of slack surplus and artificial values

It will show three different options:

1. No Tableau: Shows direct solutions
2. All Tableau: Shows all simplex tableau one by one
3. Final Tableau: Shows only the final simplex tableau directly



fig:10 different options for simplex methods

Final simplex tableau for the present problem is shown in and the final solution is obtained as: Optimal  $Z = 15.667$ , with  $x_1 = 2.333$  and  $x_2 = 3.667$

C(j)	BASIC	VAR	X1	X2	S1	S2	S3	RHS
0	S1		0	0	1	-.333	-.667	2.667
3	X2		0	1	0	.333	.333	3.667
2	X1		1	0	0	-.333	.667	2.333
Z			2	3	0	-.333	2.333	15.667
C-Z			0	0	0	-.333	-2.333	0

fig:10 final simplex table

### 5.1 Proposed System Design

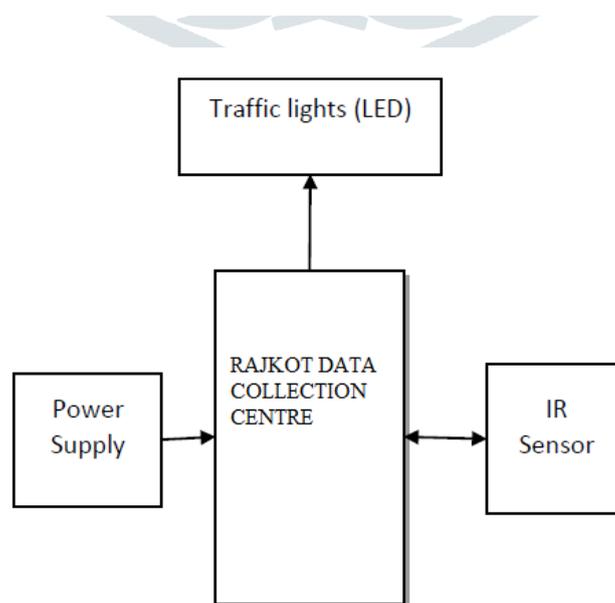


fig:10 block diagram of proposed system

1. Microcontroller Based on ATmega -2560

It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

## 2. IR SENSOR

An Infrared (IR) sensor is an electronic instrument that is used to sense the presence of objects which is at a distance greater than 20-30 cm. IR sensor changes its state from HIGH to LOW upon detecting the object. This is called as state change detection.

## 3. LED

The LED is a PN-junction diode which emits light when an electric current passes through it in the forward direction. In the LED, the recombination of charge carrier takes place. The electron from the N-side and the hole from the P-side are combined and gives the energy in the form of heat and light. The LED is made of semiconductor material which is colourless, and the light is radiated through the junction of the diode.

### 5.3 Software system design

The coding language that this software uses is same as the C++, which is used by the all the computers in day-to-day life for the coding. A code which is intended for the software, hardware can be written using any programming language with compilers that produce binary machine code for the target processor.

### 5.4 Model



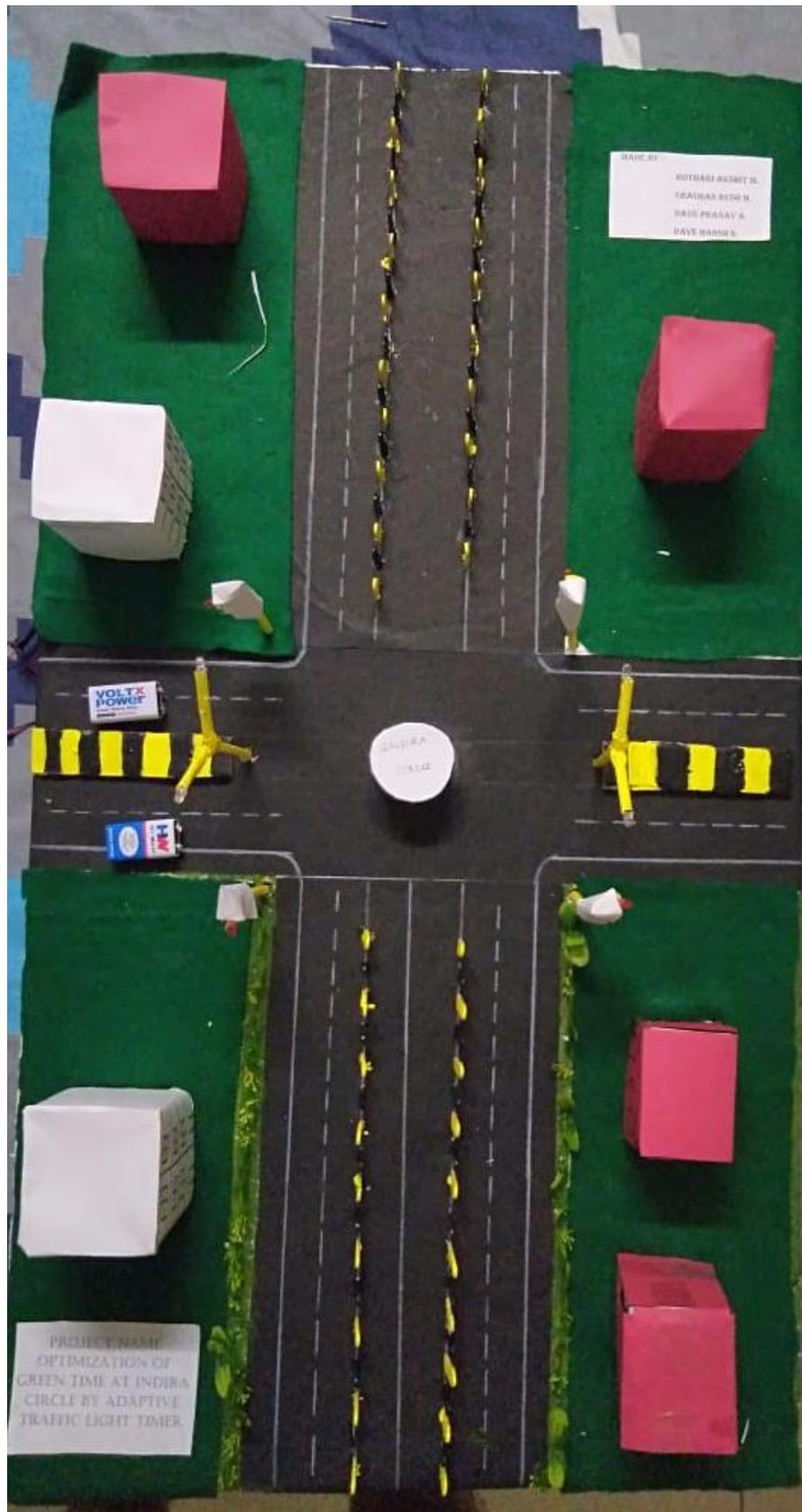


fig:11 prototype 1(a)

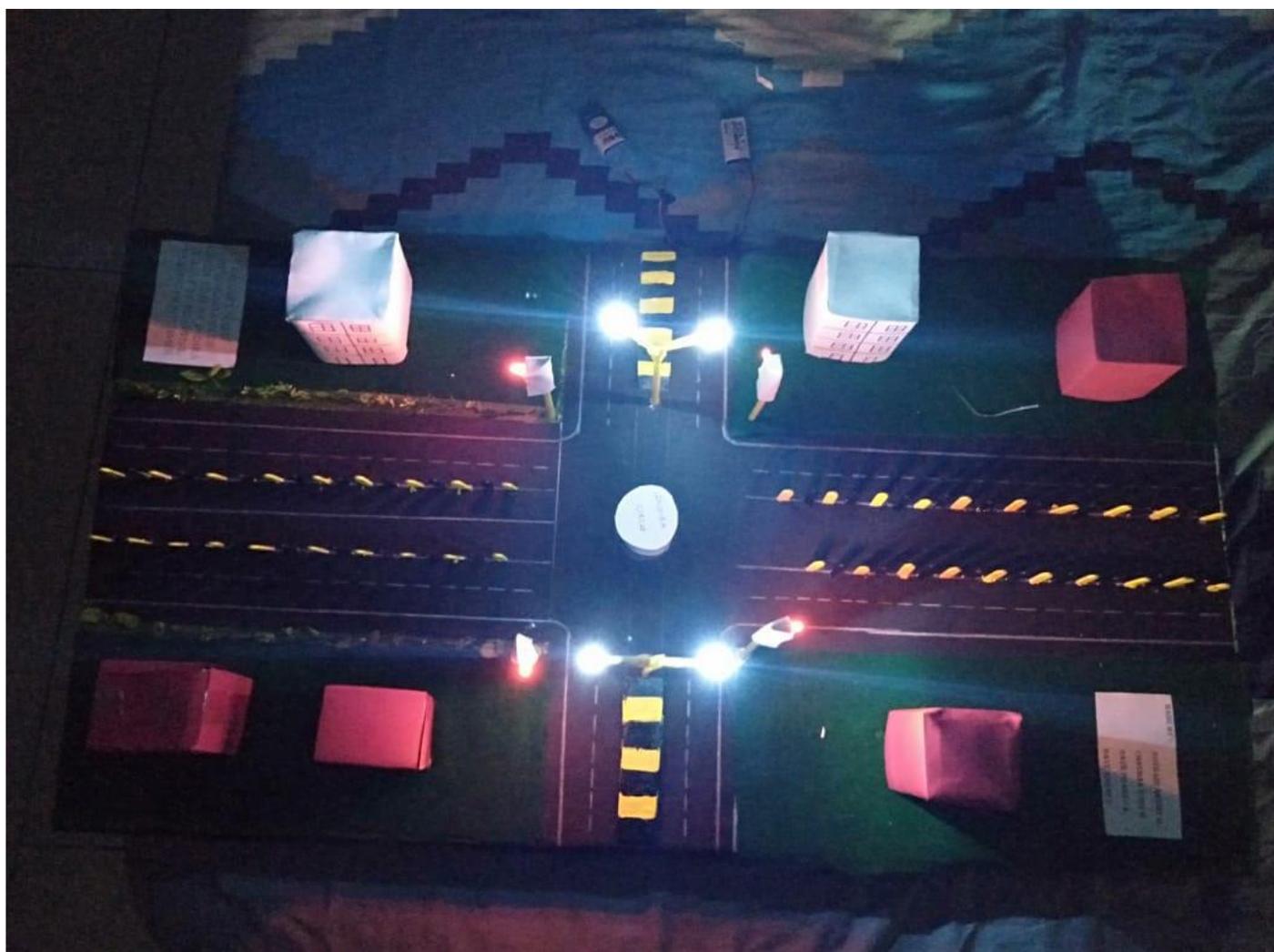


fig:12 prototype 1(b)

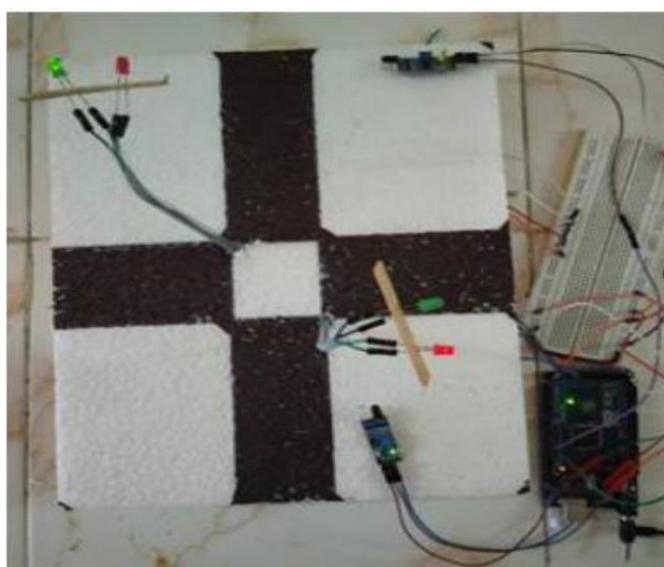


fig:13 prototype 2(a)

The above figure illustrates that the lane 1 has more usage scenario hence green signal is given to that lane.

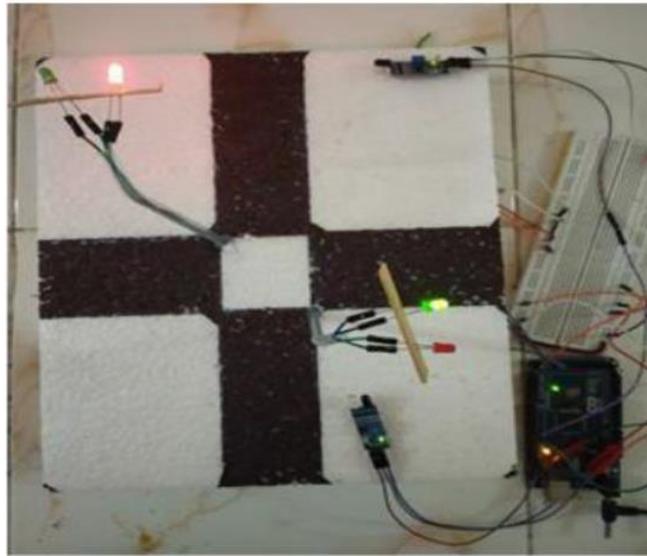


fig:14 prototype 2(b)

The above figure illustrates that the usage scenario in lane- 2 is more as compared to the lane -1 hence red light is given to the lane-1 and green light is given to lane-2.

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COM9
AUTOMATIC TRAFFIC LIGHTS BASED ON TRAFFIC DENSITY
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 2
LANE 2 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 1
LANE 1 IS ACTIVE
TRAFFIC DENSITY IS HIGH IN LANE 2
LANE 2 IS ACTIVE
  
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fig:15 output of two-lane road proposed by the software

## VI. RESULTS & DISCUSSION

(1) travel time

Get people to their destinations 20% faster by eliminating stops, reducing wait time, and increasing travel speeds.

(2) delay

Spend over 40% less time waiting at intersections.

(3) stops

Make 30-40% fewer stop, decreasing wear on the road and tires and resulting in a cost saving for drivers and cities

(4) emissions

Produce 20% fewer harmful emissions and improve air quality by reducing stops and idling.



fig:15 picture of work after completion

## VII. CONCLUSION

The project focuses on the reduction of the journey time or the travel time by reducing the unwanted delays caused at the road intersections. There is unwanted traffic congestion occurring at or near the road intersections due to a greater number of vehicles floating on the road during the prime hour (i.e.) during morning and the late evening hours. This is reduced by counting number of vehicles at each lane and giving priority to the lane which has a greater number of vehicles.

In future we can provide sound sensors in place of only object sensing device to hear the frequency of the Ambulance heading towards the traffic signal. It can be assigned highest priority irrespective of traffic density residing in lanes. This can save lives of human who are in urgent need of medication.

## VIII. REFERENCES

1. Y. N. Udoakah1, and I. G. Okure, "Design and Implementation of a Density-Based Traffic Light Control with Surveillance System", Nigerian Journal of Technology (Nijotech), Vol. 36, No. 4, October 2017, Pp. 1239 – 1248.
2. Vaishali B1\* And Jeyapriya A2, "Density Based Traffic System and Collision Alert at Intersection of Roads", Journal of Electrical & Electronic Systems, J Electr Electron Syst 2017, 6:2 doi: 10.4172/2332-0796.1000229
3. Y M Jagadeesh, G. Merlin Suba, S Karthik, And K Yokesh, "Smart Autonomous Traffic Light Switching by Traffic Density Measurement Through Sensors", Ieee Xplore, Doi: 10.1109/Ccoms.2015.7562885
4. Siddharth Srivastava, Subhadeep Chakraborty, Raj Kamal, Rahil, Minocha, "Adaptive Traffic Light Timer Control", IIT Khanpur's Nerd Magazine, March 2016.