Innovations

Minimizing Traffic Congestion Problems by Using IoT Technologies

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Abstract

Rapid urbanization is a challenge for organizations that manage the city's infrastructure and are responsible for comfort and safety. As the number of cars is increasing, traffic is becoming more intense, which results in traffic congestion and traffic accidents. Internet of things (IoT) is the system that is used to control the road traffic by using sensors or any cloud based algorithm. In this paper we will proposed various IoT technologies which can be used in day to day life to avoid traffic congestion problems. A review of the literature on this issue leads to some interesting conclusions.

Keywords: *Traffic Congestion, IoT, Travel Delay, Detectors, Smart Traffic Light, RFID, Drone Service, Public Transits.*

1. Introduction:

Many major cities are facing a variety of problems due to overcrowding and an unexpected increase in private transportation. Congestion is a condition characterized by slower speeds, longer travel times, and increasing traffic volumes. Congestion on city streets has increased dramatically since the 19th century. Traffic can be divided into repeat and non-repeat. During rush hour, traffic is normal as there are many vehicles. On the other hand, changing events such as rain, employment events, and special events causes traffic jams. Building new roads or widening roads is a temporarily relieve tocongestion.

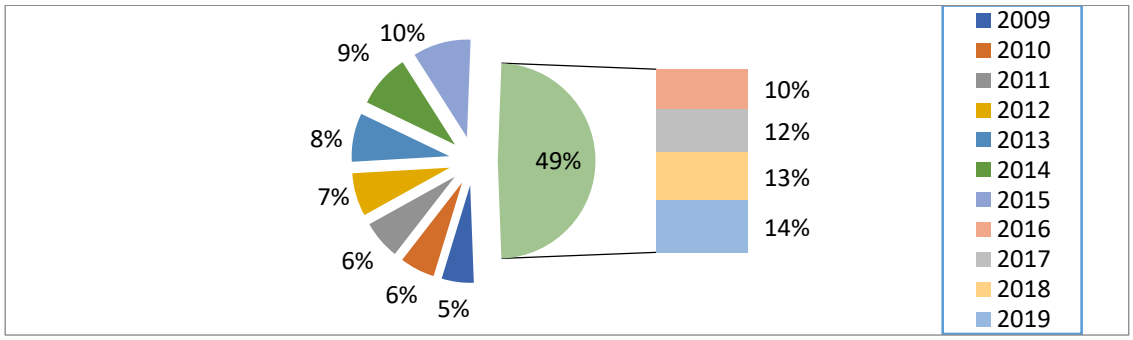

Fig-1. Registered motor vehicle in Delhi

Building new roads is not always a good thing for a variety of financial, environmental and political reasons. In fact, there is little demand for fast and smooth driving, including driving on this road.

Traffic in developing countries like India remains the same. They differ in shape and form. Two-wheelers, three-wheelers, four-wheelers and heavy vehicles such as buses and trucks travelling on the same road immingled with each other without any lane discipline. One-way driving on dirt roads and other vehicles causes traffic jams.

Meanwhile traditional traffic control system is insufficient to control congestion. Therefore cities needs some modern solution to tackle these problems by using intelligent traffic system which could be achieved by using IoT (internet of things).

Smart traffic management and information systems are needed to reduce and increase public transport demand over time amid growing traffic and traffic problems in major Indian cities.

2. Types of congestion:

1) **Repeating traffic congestion** - recurring congestion is defined as traffic resulting from the normal volume of business operating in a typical geographic area. From a layman's point of view, this could be acceptable as "driving on a normal day unless something bad happens on the road". Basically, this description is based on the concept of "expected movement ", unless an " abnormal situation" occurs. On weekdays, it is expected that the opening hours on the outskirts of the downtown expressway will be higher than in the middle of the day. Also, more traffic is expected during the day than at night. Friday mornings tend to have less traffic, and Fridays in the fall tend to be worse.

2) **Non-repeating traffic congestion**- “Non-repeating traffic congestion” was defined for this study as “unanticipated or unusual traffic caused by an event that was unanticipated and flash relative to other analogous days”. Non-repeating traffic congestion can be caused by many factors, including

1) Lane blocking accidents and impaired vehicles.
2) Other lane blocking events (for example, ruins in the roadways).
3) Construction lane closures.

3. Impacts of congestion:

Traffic involves queues, slow speeds and long travel times, which increases cost savings and has multiple impacts on urban areas and residents. Road traffic also has many cyclical impacts, including impact of border traffic on environment and resources, impact on quality of life, stress, safety, impact on road users.The more serious social benefits of ground road transport are listed.

- Traffic means wasting precious time and wasting health. Traffic time can be effectively used for productive work.

- Traffic patterns that stop and move suddenly consume more energy in urban areas and add carbon to the area, increasing pollution levels in urban areas.

- The low speed of a vehicle at the bottleneck of a log on the road causes displacement of nitrogen oxides and some hydrocarbons, a major cause of the chemical manifestation known as printing.

- Traffic generates a lot of noise (more than 90 dB), which makes the area undesirable

Rapid urbanization has caused a number of problems, including increased traffic. Delhi's traffic is $9.6 billion, or about 12% of GDP and peak traffic is 129%. Mumbai costs $4.48 billion, 135% traffic and Bangalore $5.92 billion and 162% traffic. Kolkata had the highest peak hour traffic with 171% and the lowest costs at $1.97 billion.

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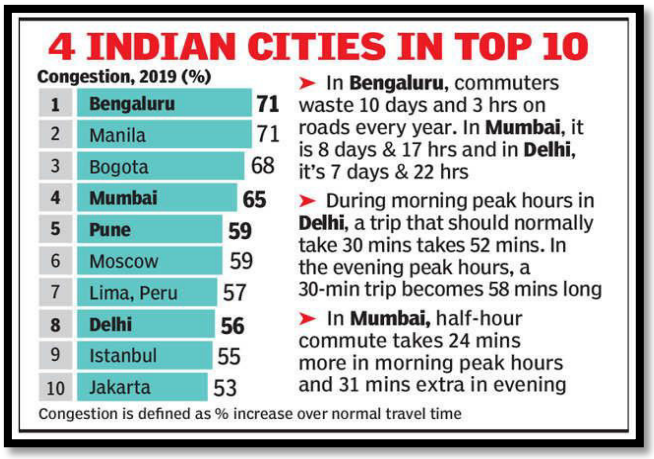

Fig.2- Congestion percentage in different cities

Congestion at intersections and highways degrades air quality and threatens public health. Automobile exports have become a major cause of air pollution in many regions, including greenhouse gases (GHGs), carbon monoxide (CO), volatile organic emulsions (VOEs), particulates matters (PMs) and hydrocarbons.

4. Factors affecting congestion:

A. Population-the increase in the number of cars on densely populated roads is one of the reasons for the increase in car traffic. Demand increases with population growth and financial growth. Some vehicles also increase the daily mobility of villagers. Thus, an increase in the number of vehicles and an increase in the output of goods are directly related.

B. Infrastructure-as the number of vehicles increases, the road does not increase. An empty street with alleys on each side can be ten times more unacceptable as the population grows. Authority always ignores double-aisle transitions.

C. Alternate path- alternate paths are also an explanation for this problem. Roads have limited extent of extension due to low cost planning and poor planning constraints. The route should follow the course you currently have. So fewer lanes contribute to more traffic.

D. Lack of public transports-the lack of public transport or the poor quality of public transport also leads to traffic problems. When means of transport such as buses and cars are increasingly scarce, people have to use their own transportation to get to work

E. Tailback-a tailback is a disturbance that limits the movement of vehicles for a period of time on the road. Traffic congestion problems are divided on the basis of different situations.

The main congestion sequences are:

1. **Fixed congestion** - issues such as deviations, narrowing of road spans, ramps, exits and stair entrances are some of the ways.

2. **Dynamic Congestion**- the distribution of nonstop business inflows in general due to vehicle delays is defined as a dynamic congestion problem in road traffic. By way of illustration, heavy equipment is towed by a truck or a long convoy or large vehicles. Many reports indicate that tailback problems are the main cause of congestion.

5. Measures for congestion calculation:

To attack the problem of, colourful measures have been developed for the identification and quantification of traffic by colourful experimenters. These measures can be helpful for chancing the degree of business traffic and the performance of the thruway. We're grading these measures into three corridor Trip time grounded, speed-grounded, and position of service grounded.

Trip time grounded -Trip time is time required to go through a sectionof a road by a vehicle, this time used as a parameter in business traffic studies. Urban Link's performance evaluation was conducted grounded on trip time. Some measures related to trip time are listed below.

Delay	Delay is used to quantify business traffic. Delay is defined as redundant trip time to taken driving a vehicle against their prospects. Lomax etal. (1997) represented detention as the difference between free- inflow trip time (FITT) and average trip time (ATT) i.e. Therefore detention can be calculated by using equation . **Delay = ATT-FITT**
Planning time index (PTT)	PTI is the rate relation between the free- inflow trip time and the 95th percentile trip time (95TT) (1). As trip time increases, PTI also increases. Therefore, PTI should bear the minimal value for better business operation.
Congestion index (CI)	CI measure is the rate relation between the detention and FFTT. Then detention is the difference between ATT and FFTT. For better business operation, ATT for the commuters should be minimal (1).
Travel time index	TTI is the rate relation between ATT and FFTT (1). For better business performance, the TTI should be minima

Speed Grounded Speed is the most generally used measure of performance for thruway and business traffic. Speed can be calculated in several ways, first, grounded on average trip time combined with the length of the corridor understudy.

Average trip speed = length of corridor/ average trip time

Speed Reduction Index (SRI)	The speed reduction indicator is the rate of vehicle speed reduction due to traffic. This rate allows comparing the degree of business traffic for different types of transport services by using a constant as a scale to distinguish between different traffic classes at different situations. Therefore it usable to particular routes of the civic road network or individual parts of the thruway for peak or out-peak period. (1). It can be calculated by using the equation **SRI = (non peak flow speed – peak flow speed) / non peak flow speed**
Travel speed rate	TSR is the rate relation between the reduction in speed during traffic and the speed in free-inflowcondition.TSR is the rate relation between the reduction in speed during traffic and the speed in free- inflow condition.

Level of Service (LOS) - LOS has been used as a qualitative dimension that explains the operatingConditions of the traffic and perceptions of drivers and passengers. LOS is used for the identification of business performance as a threshold. Generally, LOS is distributed into six situations from A to F. (Manual, 1985). In which the free-inflow speed is represented by LOS A and traffic by LOS F (i.e. stop and go inflow). LOS may be represented in the colorful situations, where operating speed is colluded against the volume/ capacity rate for civic conditions .
Congestion severity index (CSI) - CSI is used to measure of civic areas highway detention, which calculate detention trip per million vehicle kilometre. CSI uses 1965 HCM computation and original highway business volume distribution to estimate each hour of a typical day. An analysis has been done using this indicator presented a threshold for traffic (v/ c rate of0.77 or lesser) on a different section of a highway.

6. Literature reviews:

Pavan Kumar et.al(2016)conclude on reliable traffic forecasting methods and different types of traffic control algorithms. They also offer crowd visualization technology that will assist in flexible lane selection to avoid traffic jams. This article uses three methods to describe traffic congestion: fixed, mobile, and hybrid.

Dr.Vaishali Mahavar et.al, (2018)propose that the development of smart traffic lights depends on several determinants such as real-time business status, traffic, traffic and dwell times, stone business metrics, crowded and choose from three routes. All of these variables are taken into account when improving traffic lights and are styled appropriately to avoid problems. In this article, different schemas are given for all the different cases. There is also pressure to deploy smart traffic lights in our major cities.

Bhaskaran Raman, (2004)proposedthat road transport systems are found in developing countries. In this issue, the author describes India's road traffic problems such as traffic jams, detours, three delays and traffic accidents, making a decisive transition and concluding that the results easily indicate the rail system, with its limited speed and highway availability by vehicle type, official means of transport.

A. Mansoori, Achar, (2018)presented the efficient use of smart roads and the use of IoT traffic systems is a unique concept that makes drivers safer than ever. The authors argue that the main purpose of smart roads is to provide safety, use less electricity and reduce traffic congestion. This can be applied using advanced technologies such as ultrasonic sensors, cameras, mobile sensors, and more. Traffic is a growing problem in India, leading to wasted energy, wasted time and pollution. This project introduces new low-cost technologies for smart roads. Various technologies have been introduced to reduce obstacles to traffic.

Chandra and Sikdar, (2006) wanted to simplify the analysis of mixed vehicles in which different types of vehicles on the same road segment are converted through passenger car units (PCUs) into first passenger cars.

Kalaga Ramachandra Rao, (2013) explains that overcrowding is one of the major problems facing most countries and, therefore, many measures have been taken to reduce congestion, making overcrowding a waste of time. time and energy, pollution and stress, which reduce output and imposes costs on society.

Prasad N.V, (2009)suggested measuring the city's traffic congestion. In this study, the authors reveal that business circulation is one of the major problems that most space politicians face, and therefore many measures have been taken to facilitate it. good for traffic. He concludes that the results readily show that business traffic wastes time and energy, and causes pollution and stress. , which reduces productivity and causes costs to society.

7. IOT technologies to tackle traffic congestions problems:

- **Detectors:**

a) Infrared detector (IRdetector)-an IR detector is a light-based detector used for colour functions such as distance and object detection. Infrared detectors are used as distance detectors on most mobile phones**[3].**

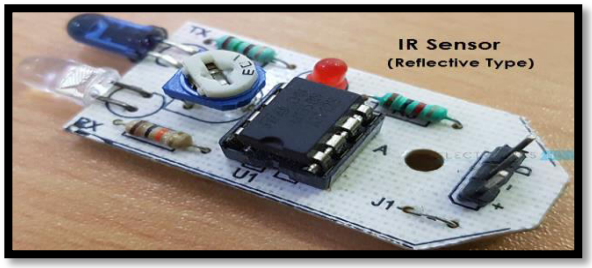

Fig.3- IR sensor

There are two types of infrared detectors: emitter and reflector. A transmitting infrared sensor has an infrared emitter (usually an IR LED) and an infrared sensor (frequency printed diode) mounted on opposite sides so that the detector detects an object as it passes between them. Another type of IR sensor is the reference IR sensor. In this case, the probe and sensor are mounted close together in the direction of the object. If an object appears in front of the detector, the detector will detect it. Different functions of IR sensors are used in mobile phones, robots, industrial assembly, automobiles, etc.

b) Aural detector- the aural detector is used to measure (sensor) space and convert this information into a digital signal that can be translated by a computer or an observer.

Fig.4- Aural detector

The movement of vehicles produces audible energy or audible sound from various sources inside the vehicle and in the trade of car tires on the surface of the road. Using a microphone system, the voice sensors are designed to pick up these sounds somewhere within the track. When the vehicle passes through the acquisition area, the signal processing algorithm detects an increase in sound power and generates a vehicle presence signal. When the vehicle leaves the acquisition area, the noise level decreases below the acquisition limit and the vehicle's presence signal disappears. Hearing sensors can be used to measure speed, volume, seating, and presence**[2].**

c) Piezoelectric detectors–"Piezoelectric detectors" convert mechanical energy into electrical energy.

Fig.5- Piezoelectric detectors

When used for vehicle counting, the detector is placed in a trench dug in the pavement. When the car passes a piezoelectric sensor, it squeezes and activates a clear electrical signal-an electrical signal. The signal size can be measured by distortion. When the car is off, the voltage drops. This voltage variation can be used to describe and calculate a vehicle. Computer devices connected to icons are mounted squarely along the road

d) Inductive loop sensors (ILS)– "Inductive loop sensors"are currently the most widely used for vehicle detection. Its main application is in bends involving advanced signal monitoring systems as well as on highways for traffic monitoring and accident detection.

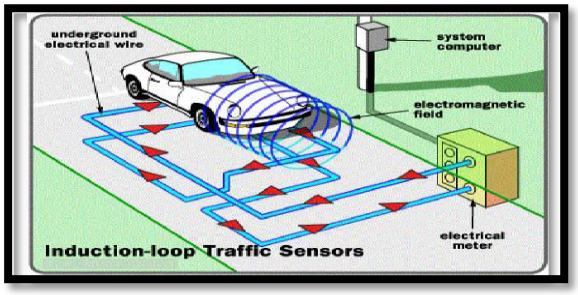

Fig.6- Inductive loop sensor

ILS usually takes the form of one or more irregular lines drawn over a paved area. The circuit is connected to a sensor element that records the change in circular inductance (the change in the detector's magnification field) as the vehicle passes it. ILS can be used to describe the presence or passage of a vehicle. It can also be used to measure speed (using two wheels for short distances) and assist vehicles**[2].**

- **(RFID):**

Radio Frequency Identification (RFID) uses an electromagnetic field to automatically detect and track signals attached to an object. An RFID system consists of a bit radio transponder, a radio receiver and a transmitter. When an electromagnetic test is initiated from a nearby RFID receiver, the tag transmits digital data (usually a set of forces involved) to the receiver. This number can be used to track energy assets **[2].**

Fig.7- (RFID) Technology

RFID markers are used in numerous diligence. For illustration, an RFID label attached to an machine during product can be used to track its progress through the assembly line, RFID-tagged medicinal can be tracked through storages, and implanting RFID microchips in livestock's and speed enables positive identification of vehicles.

- **Drone services**:

  This is one of the best business traffic reduction ideas using smart metro technology. With the rise of IoT-enabled drones, the great jobs needed by inspectors, large delivery specialists or city officials in the cockpit can now be done with cameras. Driverless. Smart cities perform small tasks and experimental tasks that drones cannot handle. This quickly reduces the number of vehicles on the road, especially

during rush hour.

Fig.8– Drone services

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- **Smart traffic lights:**

  Smart traffic light or smart traffic light is a transportation business management system that combines traditional traffic lights with sensors and artificial intelligence to intelligently route vehicles and vehicles. They could be part of a larger intelligent transportation system. Smart traffic lights use data from detectors, cameras, GPS and other devices to understand traffic patterns and the number of vehicles, hikers and pedestrians approaching the intersection**[3].**

Fig.9 – Smart traffic light

By reacting quickly to situations in real time, traffic lights can efficiently navigate city centres, shorten travel times, reduce traffic, reduce carbon emissions, and improve improved safety for drivers, hikers and cyclists. Smart traffic lights can prioritize cars and buses, helping to reduce traffic congestion by encouraging people to use public transport.

- **Public transit:**

Public Transit is a locally available form of travel that allows others to travel together along designated routes. Good examples of public transits modes include shared taxis, trains, buses, bullet trains, airlines, and coaches that dominate inter-urban public transport. The scope of benefits that public transits offers is not limited to only reducing traffic, but many other factors are improved by combining this system. Here are some:

(i) Public health
(ii) Sustainability
(iii) Mobility and accessibility to megacities
(iv) Profit growth
(v) Community participation

Public transits generates significantly less air pollution per passenger than a motor vehicle. In addition to reducing air pollution, public transport is also more energy-efficient for each remote passenger, contributing to a reduction in the total amount of energy required for transport. APTA says public transportation in the United States is responsible for saving 4.2 billion gallons of gas each time. Public transits can accommodate more people in a much smaller space than private vehicles, which reduces business vehicle traffic, reduces air pollution from pedestrians, and helps drivers avoid stress.

8. Result and Discussion:

1. Result:

Table 1: Traffic/Vehicular Volume

S.No.	Location	Duration	Traffic Volume	Traffic Consumption			
				Cars	Autos	2-Wheelers	Buses
1.	Barakhambha Road	4 Hours	820	326	186	230	78
2.	Janpath	4 Hours	465	465	173	220	29
3.	Outer Circle (Connaught Place)	4 Hours	386	386	223	264	62
4.	SansadMarg	4 Hours	703	246	116	232	109

Table 2:congestion level during peak hours

S.No.	Location	Traffic Volume(V)	Capacity(C)	V/C ratio	Congestion Level
1.	Barakhambha Road	820	1064.93	0.77	Heavy
2.	Janpath	887	1304.41	0.68	Moderate
3.	Outer Circle (Connaught Place)	935	1508.06	0.62	Moderate
4.	SansadMarg	703	1464.58	0.48	Low

volume to capacity:
The V/C ratio makes it possible to estimate the relative level of congestion on a segment of roadways. Traffic engineer have developed the following categories:

V/C ratio > 1 = **Severe Congestion**V/C ratio 0.5 to 0.74 = **Moderate Congestion**
V/C ratio 0.75 to 1 = **Heavy Congestion**V/C ratio < 0.5 = **Low or No Congestion**

Table 3: Speed Reduction Index during free flow and congestion

S.No.	Location	Average speed during free flow	Average Speed during Congestion	Speed Reduction Index
1.	Barakhambha Road	60 km/h	36 km/h	0.4
2.	Janpath	60 km/h	24 km/h	0.6
3.	Outer Circle (Connaught Place)	65 km/h	34 km/h	0.48
4.	SansadMarg	67 km/h	30 km/h	0.553

Formula used:
Speed Index = (1-(Avg. Speed during free flow / Avg. Speed during Congestion))
The SRI ratio is multiplied by 10 to keep the value between 0 to10.

2. Discussion:
The main emphasis of this study is to incorporate various technological devices in order to eradicate the existing of congestion level on selected areas of New Delhi. We took the initiative to go to the mentioned locations and extensively carried out three experiment and on the basis of the proposed data we framed out the level of congestion and the significance factor responsible for it cause. Traffic Volume, Vehicular Speed and capacity of a road were the chief factors in assessment. We were able to extract the following details from the given location

- **Barakhambha Road –**Heavily Congested during Peak Hours
- **Janpath -** Moderate Congested during Peak Hours
- **Outer Circle (Connaught Place) -** Moderate Congested during Peak Hours
- **Sansad Marg**– Low Congested during Peak Hours

9. Summary & Conclusion:

- Congestion reduction measures affect the entire transport system, with the rise of major cities around the world becoming a major cause of air pollution. It is expected that measures aimed at reducing traffic congestion will also have an impact on air traffic pollution.

- In this paper, we have proposed the effectiveness of hitting a traffic problem with minimal mortality. The proposed paper focuses on using of IoT techniques in our day to day life to minimize congestion problem. In this paper we have proposed the IoT technologies such as Detectors, Rfid, Drone services, Smart commercial lights and Public transport, which will eliminate and eliminate system degradation like mining cost, dependence on environment, etc. These technologies are sustainable in nature as they need to be installed one time and later on they need to be updated. In this way we can use the hard earned taxpayer's money in different field rather than using it in minimizing congestion problem. Using IoT technologies not only saves money but it also reduces manpower in field as everything is connected to the traffic management centre.

- If we use the above solutions, we cannot only reduce congestion level in metropolitan cities but make our cities more accessible and smarter.

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