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Intelligent Transport System - Study of Intelligent Transportation Systems for Urban Transport Planning

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Abstract: ***Transport, tourists and various site visitors' traffic jam is an internationally common hassle. Indian economy is growing very fast; the problem in transport is severely felt in almost all major cities. This is due to infrastructure growth, flood in variety of car segments, due to space and value constraints. However, traffic in India is being non-lane based and uncontrolled is basically different from the western visitors. Intelligent techniques / systems (ITS), used for efficient traffic management at developed international locations, cannot be used as it is in India.***
A case study was done on urban area of Amravati from Rajapeth to Nandgaon Peth Toll plaza of NH-6 and its detail analysis is presented in this project. The accident data was collected for last five years from 2014-2019 from police station. Data collected on traffic volume and spot speed by adopting standard survey method. The collected data was analyzed to evaluate the effect of influencing parameters on accident rate, congestion of traffic and standardize the speed of the vehicles.
Different Highways / State Highways are passing through different parts of the Amravati City. The highway MH SH 243 & NH 53 is selected. It spans a distance of 12.8 km connecting Amravati (Rajapeth) to Nandgaon Peth Toll plaza. The highway is identified on the basis of traffic flow through this route and heavy traffic congestion at morning and evening peak hour, leading to considerable amount of loss of freedom to manoevre and consequently environmental imbalance. It can be observed from above that project traffic has PCU index close to 2.0 which indicates good mix of commercial, goods traffic and passenger traffic. Increase speeding enforcement initiate traffic calming measures.
So that the use of Intelligent Transportation system can manage or minimize the road accidents and congestion in the road transport.
Keywords: Intelligent Transport System (ITS), urban transportation management, GPS, GPRS, Wi-Fi, Sensor.

I. INTRODUCTION

India is the second most populated country in the world, and a quick developing economic system, is seeing horrible road congestion troubles in its towns. Due to population growth and the emergence of economies in developing countries, and the high economic growth in developed countries, the rapid development of technology makes cities more attractive and thereby increases the growth of urbanization. Therefore, people need to satisfy their residential needs. One of these requirements are the fast and optimal transport from one place to another within the city. Therefore, urban management is seriously challenged with adoption and good management of urban transport systems. Constructing infrastructure, levying right taxes to reduce private automotive growth and enhancing public shipping facilities area unit lengthy-term answers to the current trouble. These permanent solution techniques want authority intervention. The government of India has dedicated Rs.234,000 crore[1] inside the urban infrastructure region. Bus mass rapid transit (BRT), metro rails and mono rails are being built in extraordinary cities to encourage the usage of public shipping. However still there's a steep boom Private vehicle. A few cities like urban centre, Pune, Hyderabad and Delhi-NCR, with their rapid growths inside the IT sector, even have a steep increase in population, any increasing transportation needs.
The ITS literature could be very tremendous with papers appearing in apparently unrelated venues. In this paper, the focus is given on a complete listing of ITS literature to offer an outline of all existing strategies. Also follow it up with a set of open research questions within the context of Indian roads and traffic. sooner or later, list a fixed of public and personal sector corporations and educational establishments[2], who are lively in studies or application on the area, as meaningful collaborations and generation switch should show up if research has to make any practical effect.

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A. Scope of Work

1) *Traffic Control:* It focuses mainly on prioritizing the modes of transport such as buses, cyclist, pedestrians and other emergency vehicles in order to evaluate the performance and study the reasons for traffic emissions and congestion.
2) *Disaster Management Systems:* Various technologies are used for this purpose in order to smooth the traffic flow and to provide medical and other related help in such cases.
3) *Vehicle Information and Navigation Systems:* In-vehicle information system warns drivers about adverse climate conditions, road surface conditions, traffic jams and hazards including accidents. Navigation systems offer vehicle location info in real time and route guidance for driver to require optimum route.
4) *Driver Assistance Systems:* In order to save the driver from accidents these systems have replaced some human driver decisions with machine decisions which also help to achieve smoother vehicle control.
5) *Air Pollution Control:* Road transport is the major source of air pollution which has caused impact on human health and environment quality. Various models and protocols are used in ITS to control air pollution[18, 19].

B. Objectives

1) To introduce new tools for managing urban transport and understand sustainability parameters for urban transport planning.
2) To understand safety by evaluating accident data and analysis.
3) To measure the spot speed and travel speed of vehicles and note alternative connected traffic characteristics. Calculate spot speeds and prepare tables for applied math analysis of spot speeds.
4) Determine proper speed limits.
5) To study the effect of Traffic volume, Traffic Capacity, Road feature on accident rate on road.
6) Draw conclusions and suggest directions for future work.

II. INTELLIGENT TRANSPORTATION SYSTEM

Intelligent Transportation System is the integration of computers, electronics and communication technologies with proper management strategies to minimize traffic problem. The aim of it is to achieve traffic efficiency and enhancing comfort and safety to the users by using information and communication technology, which mainly consists of data collection and using the results of the analysis in the operation control and research for traffic management. Safety is one of the principle driving force behind the evolution, development, standardization and implementation of ITS. It improves the driving experience, safety and capacity of road system, reduces risks in transportation, relieves traffic congestions, improves transportation efficiency and reduces pollution. It also helps to cope up with the other modes of transportation such as air transportation, water transportation and rail transportation.

A. Components Of ITS

A Traffic Management Centre (TMC) is the hub of transport administration, where data is collected, and analyzed and combined with other operational and control concepts to manage the complex transportation network. It is the focal point for communicating transportation-related information to the media and the motoring public, a place where agencies can coordinate their responses to transportation situations and conditions. This inter dependent autonomy in operations and decision-making is essential because of the heterogeneity of demand and performance characteristics of interacting subsystems.

1) *Data Collection:* Strategic planning needs precise, extensive and prompt data collection with real-time observation. So, the data here is collected via varied hardware devices that lay the base of further ITS functions. These devices are Automatic Vehicle Identifiers; GPS based automatic vehicle locators, sensors, camera etc. The hardware mainly records the data like traffic count, surveillance, travel speed and travel time, location, vehicle weight, delays etc. These hardware devices are connected to the servers generally located at data collection centre which stores large amounts of data for further analysis.
2) *Data Transmission:* Rapid and real-time information communication is the Key to proficiency in ITS implementation so this aspect of ITS consists of the transmission of collected data from the field to TMC and then sending back that analyzed information from TMC to travellers. Traffic-related announcements are communicated to the travellers through internet, SMS or onboard units of Vehicle. Other methods of communications are dedicated short-range communications (DSRC) using radio and Continuous Air Interface Long and Medium Range (CAILM) using cellular connectivity and infra-red links.

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3) *Data Analysis:* The data that has been collected and received at TMC is processed further in various steps. These steps are error rectification, data cleaning, data synthesis, and adaptive logical analysis. Inconsistencies in data are identified with specialized software and rectified. After that data is further altered and pooled for analysis. This mended collective data is analyzed further to predict traffic scenario which is available to deliver appropriate information to users.
4) *Traveller Information:* Travel Advisory Systems (TAS) is used to inform transportation updates to the travelling user. The system delivers real-time information like travel time, travel speed, delay, accidents on roads, change in route, diversions, work zone conditions etc. This information is delivered by a wide range of electronic devices like variable message signs, highway advisory radio, internet, SMS, automated cell. With urbanization expanding with speedy stride, number of vehicles on road is also increasing. Combination of both in return puts enormous pressure on cities to maintain a better traffic system so that the city keeps on moving without any hassle. For the purpose application of Intelligent Transport System is the only solution. ITS is a win-win situation for both citizens and city administrators where it provides safety and comfort to citizens and easy maintenance and surveillance to city administrators.

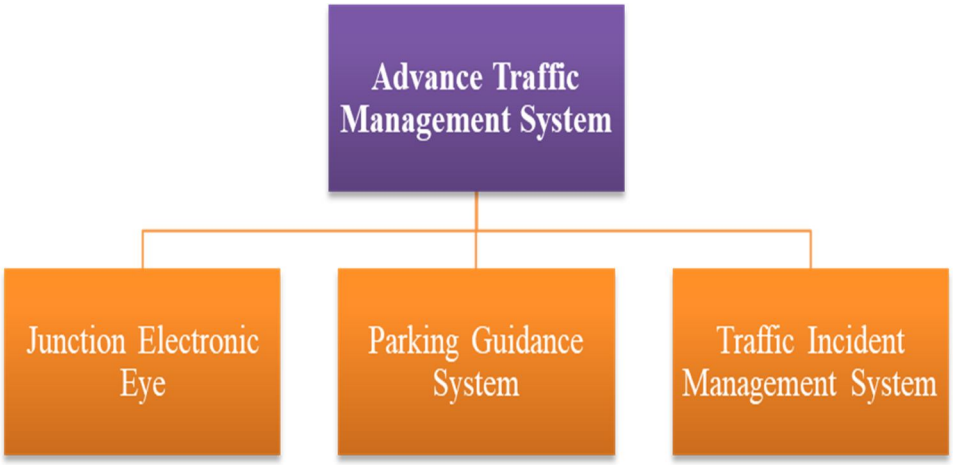


Fig.1: Components of ITS

III. ADVANCE TRAFFIC MANAGEMENT SYSTEM (ATMS)

ATMS is the subfield of Intelligent Transportation System which deals with the management of vehicular traffic and improves its safety.

The Advance Traffic Management System integrates solution of multiple technologies to improve the flow of vehicle traffic improve safety and minimize the road accident on roads using some highly advance equipment. It is classified as:



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A. Junction Electronic Eye (CCTV Cameras)

The Junction Electronic Eyes (J-Eyes) is a sophisticated system which uses innovative image-processing techniques and artificial intelligence for real-time detection of congestion and incidents at traffic junctions such as heavy traffic, vehicle breakdown and road block.



Fig.2: Junction Eye

J-Eyes automatically alert the operator of any disruption to the traffic flow so that remedial actions can be taken quickly. This improves the traffic conditions and safety at the road junctions. J-Eyes provides the Operations Control Centre (OCC) with the capability to monitor traffic conditions and verify incidents in real-time. This will enable them to make informed decisions to execute appropriate and effective action plans to manage incidents, thus enhancing the travelling experience for motorists. The various components of Junction Eye are described as below:

1) *Detection System (DS):* The detection camera serves as the sensor component of the DS. The DS collects essential traffic data through video image processing of traffic scenes covered by the strategically placed detection cameras at traffic junctions. These include average speed, occupancy, and volume and queue length of each lane. The processed traffic data is then sent via leased lines to the junction control centre computer at LTA's Traffic Centre for optimum monitoring and control of the traffic junctions. Hence, the DS acts as a virtual sensor that effectively replaces the conventional inductive loops. When incidents occur (within the view of detection cameras), the DS automatically alerts the LTA operator. It can also provide playback of pre-incident video images for reviews on cause and effect.
2) *Surveillance System (SS):* This is used to monitor the traffic area that is out of the viewing range view of the detection camera. When an incident is detected, the nearest camera; Tilt, Zoom. The surveillance camera can be selected to zoom into the incident detected area for real-time incident verification and identification.
3) *Central Control and Monitoring System (CCMS):* At the CCMS, all traffic data and images can be generated and reproduced for a myriad of purposes. The electronic map also enables fast location of junctions, and addresses. The vision-based technology is also adopted in the Intelligent Expressway Monitoring and Advisory System (EMAS) to extract real-time traffic information to optimize traffic flow efficiently and safety.

B. Parking Guidance System

Car parking is becoming a challenge to the drivers in modern days. Continuous and unprecedented growth of vehicles have resulted frustration of drivers in searching for parking spaces. It is a tedious and time-consuming process to search for vacant spaces which causes in waste of fuel. This in turn is contributing to greenhouse emission.

With the evolution of present entity, the quantity of automobiles is enlarging quickly and the dissimilarity between automobiles and parking areas becomes a trouble in the congested metropolitan region. Generally parking facilities cannot satisfy expanding parking challenges, as they are unable to supervise the unoccupied parking spaces.

The only method to minimize the usage of parking space and reduce the waste of fuel and time is to install a proper parking guidance system. It recommends drivers with convenient command over parking system with fabulous characteristics and attributes. Modern parking utilizes different advance technologies to assist motorists find available and unoccupied spaces. It helps drivers diminish traffic jam linked to parking and amplify the infrastructure efficiency.

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Fig.3: Parking Guidance System

The modern-day parking systems give a unique method of vehicle detection using an ultrasonic sensor. The ability to reliably detect vehicles offers certain advantages for asset management, resource allocation, site safety and traffic control. A wireless ultrasonic sensor is often an ideal solution for indoor or outdoor parking. Sound waves, radar sensors, optical sensors etc. can be used to detect objects and presence of vehicles.

In appropriate guidance system, if the driver sees a green light, it would indicate the availability of parking space. Well timed and accurate information, will allow motorists to make informed decisions related to parking. They are easily directed to a low occupancy zone with the help of indicators.

C. Traffic Incident Management System

Traffic Incident Management is a planned and coordinated program process to detect, respond to, and remove traffic incidents and restore traffic capacity as safely and quickly as possible to reduce the impacts of incidents on safety and congestion, while protecting the safety of on-scene responders and the travelling public.

When an accident occurs congestion quickly builds up and chances of a secondary incident increases. The sooner incidents are detected, the sooner safety personnel can respond to the incident and clear it from the roads thereby allowing traffic lanes to re-open and traffic to return to normal conditions. TIM assists with creating a safe work zone with proper signage and equipment for emergency crews responding to an incident.



Fig.4: Traffic Incident Management

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IV. METHODOLOGY

A. Identification of Location

Different Highways are passing through different parts of the urban area of Amravati City. Out of the highway MH SH 243 & NH 53 is selected for assessment of above mentioned sustainability indicators. It spans a distance of 12.8 km connecting urban area of Amravati (Rajapeth) to Nandgaon Peth Toll of NH-6.

The highway is identified on the basis of traffic flow through this route and heavy traffic congestion at morning and evening peak hour, leading to considerable amount of loss of freedom to manoevre and consequently environmental imbalance.

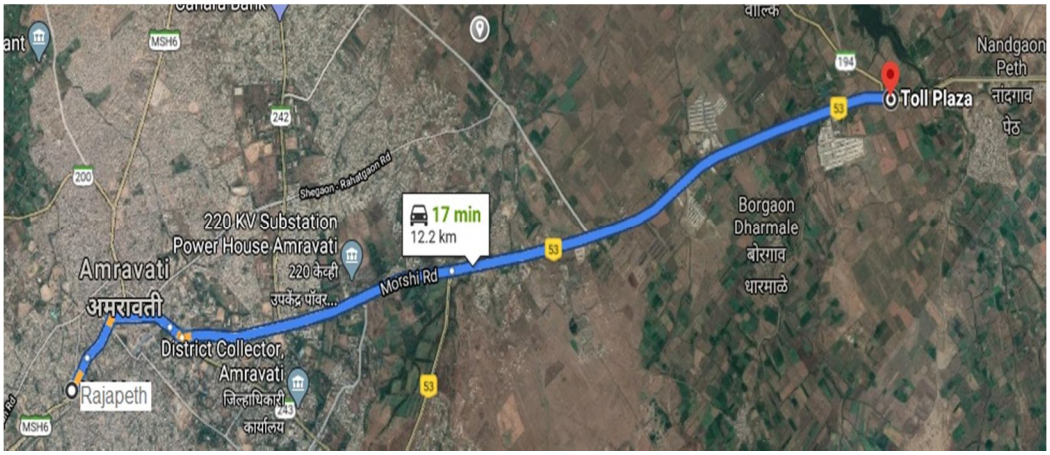


Fig.5: Rajapeth to Nandgaon Peth Highway

Data is collected for morning peak hour and evening peak hour. The data obtained by manual technique to analyzed in order to count the traffic flow. The number of vehicles of all types passing by a section count in defined hours.

B. Classified Traffic Volume Count

The objective of conducting a Classified Traffic Volume Count is to understand the traffic flow pattern including modal split on a roadway. The Classified Traffic Volume Count survey has been provided by concessionaire of project highway from actual traffic data gathered at toll plaza locations based on monthly data. The vehicles can broadly be classified into fast moving / motorized and slow moving / non-motorized vehicles, which can be further classified into specific categories of vehicles. The groupings of vehicles are further segregated to capture the toll able vehicle categories specifically and toll exempted vehicles are counted separately. The detailed vehicle classification system as per IRC: 64-1990 is given in Table:

Table 1: Vehicle Classification System

Vehicles Type	
Auto Rickshaw	
Passenger Car	Car, Jeep, Taxi & Van (Old / new technology)
Bus	Mini Bus
	Standard Bus
Truck	Light Goods Vehicle (LCV)
	2 – Axle Truck
	3 Axle Truck (HCV)
	Multi Axle Truck (4-6 Axle)
	Oversized Vehicles (7 or more axles)
Other Vehicles	Agriculture Tractor, Tractor & Trailer

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1) Summarized vehicle volume count on each leg at peak hour (Morning Volume)

Table 2: Traffic Volume Count at Peak Hour (Morning)

Square	Leg No.	Heavy vehicle	Light vehicle			Total Number of Vehicles	Total Traffic in PCU
			Car	Auto	Motorcycle		
Panchwati Square	NB	42	807	157	1525	2531	1852.5
	SB	71	793	214	1736	2814	2088
Irwin Square	EB	84	597	350	1878	2909	2129
	WB	42	438	316	2146	2942	1953
Rajkamal Square	EB	5	755	236	2015	3011	2013.5
	WB	52	543	229	2256	3080	2056
Rajapeth Square	NB	105	405	215	1371	2096	1620.5
	SB	50	363	211	1629	2253	1538.5

2) Summarized vehicle volume count on each leg at peak hour (Evening Volume)

Table 3: Traffic Volume Count at Peak Hour (Evening)

Square	Leg No.	Heavy vehicle	Light vehicle			Total Number of Vehicles	Total Traffic in PCU
			Car	Auto	Motorcycle		
Panchwati Square	EB	41	357	110	1104	1612	1142
	WB	14	370	195	1840	2419	1527
Irwin Square	NB	21	653	225	1157	2056	1546.5
Rajkamal Square	NB	62	758	480	2393	3693	2620.5
	SB	10	440	177	2823	3450	2058.5
Rajapeth Square	WB	18	249	150	1204	1621	1055

C. Traffic Characteristics

Toll revenue of the highway does not solely depend on traffic volume. There are certain characteristics of traffic which have significant potential to affect toll revenue. Component of local traffic, component of passenger and commercial traffic, portion of return journey traffic, portion of monthly pass traffic are some such characteristics of traffic.



Figure 6: Nandgaon Peth Toll Plaza

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D. Traffic Data

The Concessionaire has provided Traffic data for base year 2015-16, 2016-17, 2017-18 and 2018-19 as under for toll plaza-

Table 4: Traffic Data of NH-6

Sr. No.	Type of Vehicles	Annual Average Daily Traffic for 2015-16	Annual Average Daily Traffic for 2016-17	Annual Average Daily Traffic for 2017-18	Annual Average Daily Traffic for 2018-19
01.	Car	5105	5825	6275	6738
02.	Minibus / LCV	1253	1374	1439	1511
03.	Truck / Bus	1238	1290	1362	1421
04.	Multi Axel	1742	1962	2233	2285
05.	Oversized vehicles	2	1	4	2
	Total	9340	10452	11313	11957

E. Analysis of Traffic Count

Understanding the character of existing traffic forms the idea of traffic forecast. The varied vehicle varieties having completely different sizes and characteristics are regenerate into one unit referred to as Passenger Car Unit (PCU). car equivalents for numerous vehicles square measure adopted supported recommendations of Indian Road Congress prescribed in "IRC-64-1990: pointers for capability of Roads in Rural areas". The adopted Passenger car unit values (PCU) square measure given in following table:

Table 5: PCU Factor Adopting For Study

Vehicle type	PCUs
Car/Van	1.0
Mini Bus	1.5
Standard Bus	3.0
LCV	1.5
2-Axel Truck	3.0
3-6 Axel Truck	4.5
Multi Axel Vehicle	4.5
Auto Rickshaw	1.0
Agriculture Tractor with Trailer	4.5
Agriculture Tractor without Trailer	1.5

Table 6: Traffic in PCU

Period	Traffic No.	PCU	PCU Index
2015-16	9340	18546.5	1.99
2016-17	10452	20590	1.97
2017-18	11313	22582	2.00
2018-19	11957	23558	1.97

It can be observed from above that project traffic has PCU index close to 2.0 which indicates good mix of commercial, goods traffic and passenger traffic.

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F. Analysis of Accident Data

Road transport is important for development because it provides quality to individuals and product. However, it conjointly exposes individuals to the danger of road accidents, injuries and fatalities. Exposure to adverse traffic surroundings is high in India attributable to the unexampled rate of motorization and growing urbanization burning by high rate of economic process. As a result, incidents of road accidents, traffic injuries and fatalities have remained intolerably high within the India.

Previous year's data of accidents on study highway as following:

1) Accident data for Year 2014 to 2019

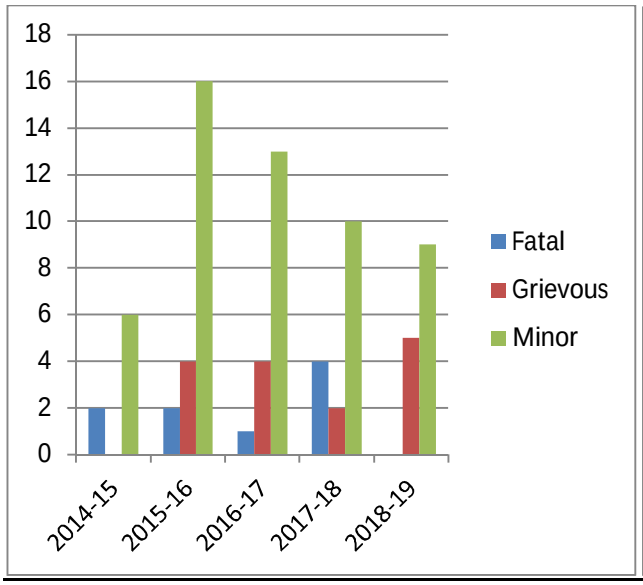
Table 7: Accident Data for Panchwati to Rajapeth

Sr. No.	Year	Fatal	Grievous	Minor	Total Accidents
01.	2014-15	02	00	06	08
02.	2015-16	02	04	16	22
03.	2016-17	01	04	13	18
04.	2017-18	04	02	10	16
05.	2018-19	00	05	09	14

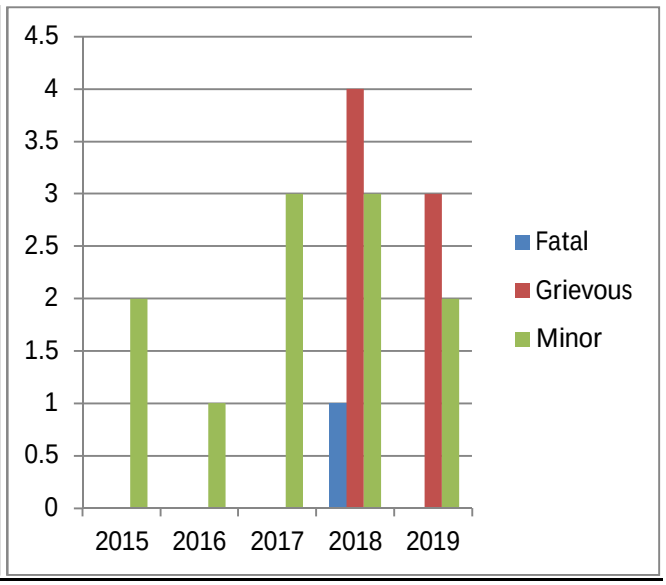
2) Accident data for Year 2015 to 2019

Table 8: Accident Data for Nandgaon Peth to Panchwati

Sr. No.	Year	Fatal	Grievous	Minor	Total Accidents
01.	2015	00	00	02	02
02.	2016	00	00	01	01
03.	2017	00	00	03	03
04.	2018	01	04	03	08
05.	2019	00	03	02	05



Graph 1: Accident Data for Panchwati to Rajapeth



Graph 2: Accident Data for Nandgaon Peth to Panchwati

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V. RESULT

A. Spot Speed Study by Stopwatch Method

The Stopwatch Method can be used to successfully complete a spot speed study using a small sample size taken over a relatively short period of time. The stopwatch method is a quick and inexpensive method for collecting speed data.

$$V = \frac{D}{T}$$

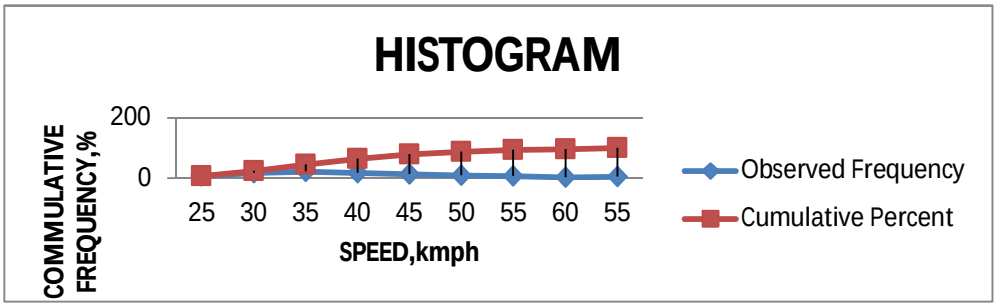
Where,

V = Spot Speed (Kmph)
D = Length (meter)
T = Elapsed time (Seconds)

1) Panchwati Square to Irwin Square

Table 9: Spot Speed Study Distribution Table

Speed (KMPH)	Observed Frequency	Cumulative Percent	Speed Percentile
25	7	7	15th
30	17	24	
35	22	46	50th
40	18	64	
45	14	78	
50	9	87	85th
55	6	93	
60	3	96	
55	4	100	



Graph 3: Cumulative Frequency Distribution and Frequency Distribution

B. Severity Ratio

$$Severity\ Ratio = \frac{Fatal + Injury\ Accidents}{Fatal + Injury\ Accident + PDO}$$

Where,

PDO = Property Damage Only (Fatal + Grievous Injury)
Injury Accident = Grievous Accident + Minor Accident

Table 10: Severity Ratio

Sr. No.	Accidents Year	Fatal	Injury Accidents	PDO	Severity Ratio
01.	2014 - 15	02	06	02	0.8
02.	2015 - 16	02	22	06	0.8
03.	2016 - 17	01	16	05	0.8
04.	2017 - 18	05	15	11	0.65
05.	2018 - 19	00	19	08	0.704

From the above table 5.2 shows that the severity ratio is about 0.6 to 0.8. That is the severity on highway study area is about 60% to 80%. It has creating the unsafe highway for transporting.

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C. Accident Rate by Frequency Method

On this basis the overall accident hazard is expressed because the range of accidents all types per km of every road and street classification.

$$R = \frac{A}{L}$$

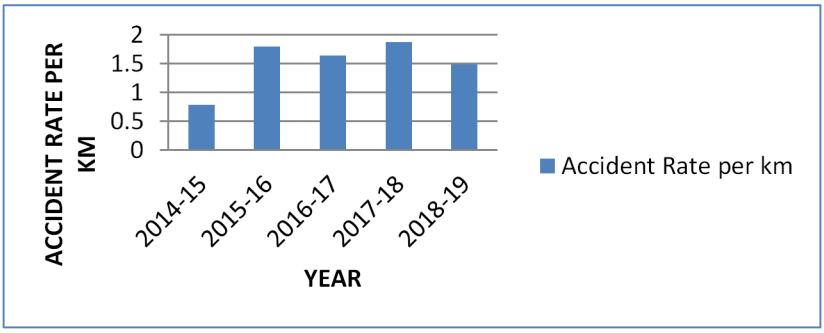
Where,

R = total accident rate per km for one year,
A = total number of accident occurring in one year,
L = length of control section in km.

1) Accident rate 2014 to 2019 Including all Accidents

Table 11: Total Accident Rate for Nandgaon Peth to Rajapeth

Years	Length (Km)	Total No. of Accidents	Accident Rate per km
2014-15	12.8	10	0.781
2015-16	12.8	23	1.797
2016-17	12.8	21	1.641
2017-18	12.8	24	1.875
2018-19	12.8	19	1.484

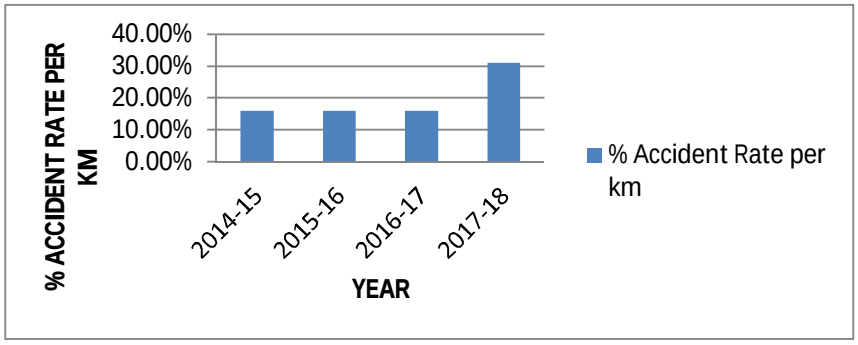


Graph 4: Total Accident Rate per Km

2) Accident rate 2014 to 2019 for Fatal

Table 12: Total Accident Rate of Fatal for Nandgaon Peth to Rajapeth

Years	Length (Km)	Total No. of Accidents	Accident Rate per km	% Accident Rate per km
2014-15	12.8	02	0.16	16.00%
2015-16	12.8	02	0.16	16.00%
2016-17	12.8	02	0.16	16.00%
2017-18	12.8	04	0.31	31.00%



Graph 5: Total Accident Rate of Fatal

From the fatal data of accident state that 15 to 31 person's fatal out off 100 persons is to be dangerous for road user and vehicle user.

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D. Accident Prediction Method by Poisson distribution Accident Analysis

$$P(r) = \frac{e^{-m}m^{r}}{r!}$$

Where,

P(r) = Probability of Occurrence of (r) event.

m = Average rate of occurrence of event.

e = Base of Naperian Logarithms.

The above formula is used to determine the probability of accident occurring in a given time span.

Table 13: Accident on Study Stretch

Year	Fatal Accidents
2014 - 15	10
2015 - 16	23
2016 - 17	21
2017 - 18	24
2018 - 19	19

Accident prediction model by Poisson distribution accident rate analytical value is to be 0.09.

E. Accident Prediction Method by Chi Square Analysis

Accident/km-year = $1.21 + 4 \times 10^{-6}$(AADT) - 0.183(CR)

It is found that estimated accident rate from accident prediction model by analytical method 0.71.

VI. CONCLUSION

A. Introduce new tools like sensor, infrastructure information, traffic information that managing the urban transport and introduce innovative system.

B. Comparison of rate of accident with IRC 27 is gives the highway rate of accident is more than the given rate. It reduces by the proper maintenance of the roadway.

C. For Panchwati square, Irwin square, Rajkamal square and Rajapeth square the peak hour volume is 1652, 1357, 2187 and 4214 and peak hour factor is 0.722, 0.796, 0.802 and 0.778 respectively.

D. The speed limit of 85th percentile is 49 KMPH and 50th percentile is 36 KMPH. In this case, the 85th percentile of speed was 5 Kmph above the posted speed limit, so speeding may not have been an issue.

E. The severity on highway study area is about 60% to 80%. It has creating the unsafe highway for transporting.

F. The fatal data of accident state that 15 to 31 person's fatal out off 100 persons is to be dangerous for road user and vehicle user.

G. Accident prediction model by Poisson distribution accident rate analytical value is to be 0.09. Estimated accident rate from accident prediction model of Chi Square is 0.71

H. Collecting traffic data observed that the rate of traffic volume capacity and spot speed data is increases rapidly also increases the rate of accident.

I. Facilities must be provided for road users such as exclusive bicycle track, raised platforms, exclusive parking spaces on all urban arterial roads and traffic calming techniques on all roads.

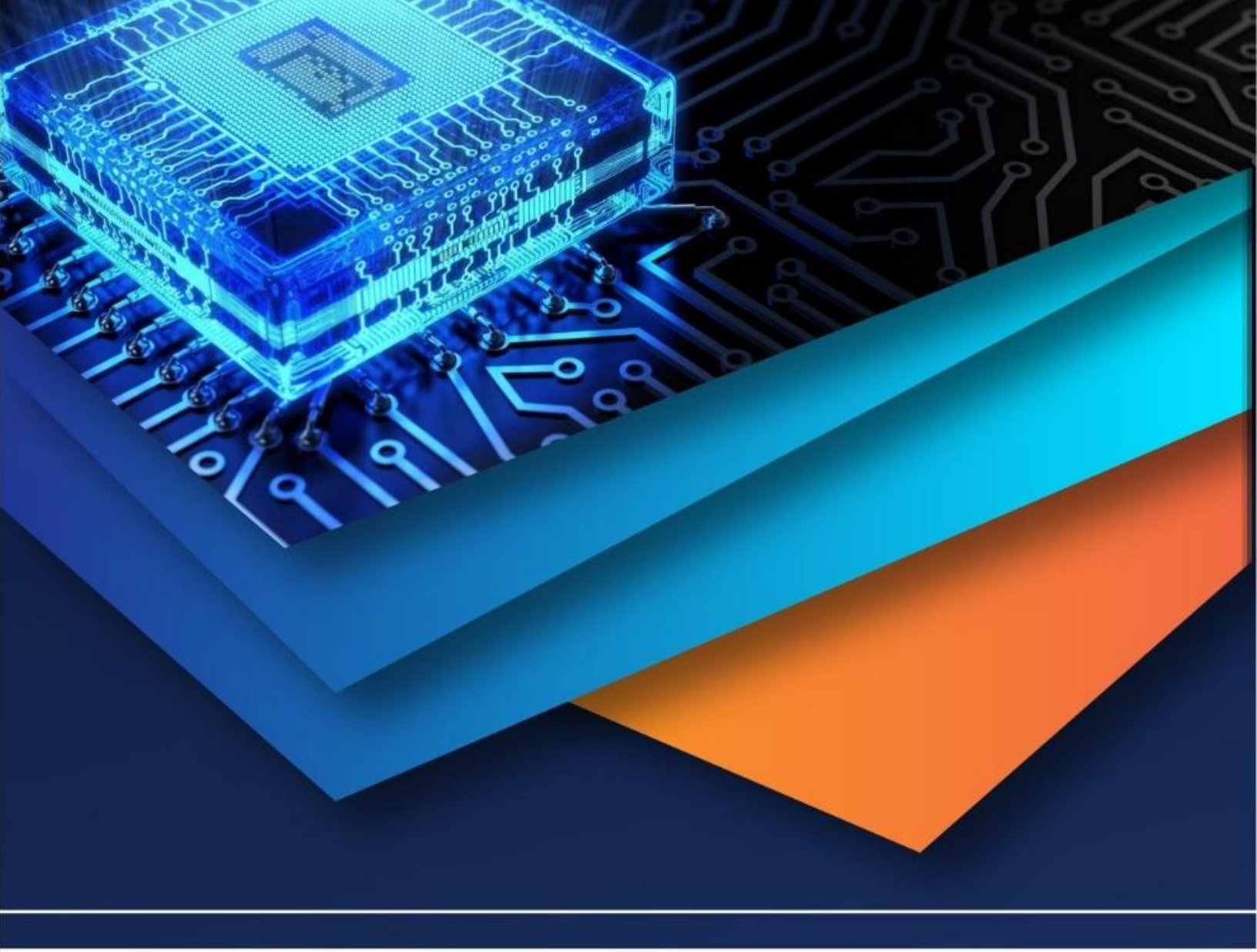
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