



Identification of Blackspots and Accidental Prediction Model by Using Multiple Regression Analysis

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ABSTRACT: The main veins for development of any country’s are Transportation system. Transportation contributes to the overall development of any country such as economic, industrial, social and cultural. The importance of roads in developing country like India can scarcely be exaggerated. The roads also have to play a vital role in the defence of our country. At least 17 deaths occurred in road accidents in 55 accidents every hour in the given time period as per the report on Road Accidents in India 2016, published by Transport Research wing under Ministry of Road Transport & Highways, Government of India. In road safety management, an accident Black spots is a place where road traffic accidents have been historically been concentrated. It may have occurred for a variety of reason, such as a sharp drop or corner in straight road, so oncoming traffic is concealed, a hidden junction on a fast road, poor or concealed warning signs at a cross roads. In past few years there is increase in causalities between the Chandani Chowk to Khadi Machine so by fixing Black Spot on this route we can reduce the causalities. Identify the accident factors based on applying a comprehensive and integrated system for making decisions by using mathematical and statistical methods in the field.

KEYWORDS: blackspot, accidental analysis, traffic, accident

I. INTRODUCTION

General:

The construction of highways reached an average of 26.93 km per day. Total length of roads constructed under Prime Minister’s Gram Sadak Yojana (PMGSY) was 47,447 km in 2017-18, the second largest road network in the world. According to official statistics 1,50,785 persons were killed and 4,80,652 accidents occurred in India in 2016. The number indicates that at least 413 people died everyday in 1,317 road accidents. (Ministry of Road Transport & Highways, Govt. of India. However, this is probably an underestimate, as not all injuries are reported to the police. The situation in India is worsening and road traffic injuries have been increasing over the past twenty years. This may be partly due to the increase in number of vehicles on the road but mainly due to the absence of coordinated evidence-based policy to control the problem. Accidents cause more deaths than any other disease in India.

Accident is an undesirable, incidental and unplanned event that could have been prevented. There are several reasons for fatalities on the roads, including Speeding, Drunk driving, Discarded for traffic rules, improper road or junction designs and mechanical defects in vehicles or ill-maintained vehicles. Driving with responsibility should become part of our culture. India is having less than 1% of the world’s vehicles, the country accounts for 6% of total road accidents across the globe and 10% of total road fatalities.

Table 1. Percentage wise distribution of road accident fatalities

Percentage wise distribution of road accident fatalities		
1.	Two Wheelers	42%
2.	Trucks	17%
3.	Hit & Run Case	10%
4.	Other	31%

Intensive social awareness, campaigns should be conducted with the help of students, NGO’s, other Government bodies like Regional Transport Office, traffic engineers and experts to reduce accidents and fatalities. So, Blackspot plays important role in reducing the road accidents. Our Union Transport Minister Mr. Nitin Gadkari spoke about Road Safety & its concerns at a two day national conference held at Vishakhapatnam during August 2016. He announced that nearly 800 BlackSpots or accident zones on national highway to be fixed soon. So we are also trying to identify the BlackSpots to reduce the accident rates. As in past few years there is an increase in casualties between Chandani Chowk to Khadi machine chowk, so by fixing black spot on this route we can reduce the casualties.

Motivation and Problem Statement:

In recent years, an increased rate of accidents has been observed in ChandaniChawk- Katraj road resulting in a high number of fatalities. Major reasons contributing to the cause are increasing number of educational institutes on this route, thereby creating traffic chaos. Under specific observation frequent accidents have been encountered in Khadi machine chowk to Katraj route. Hence, seeking my focus and motivation towards identifying accident prone areas i.e. Blackspot and suggesting preventive measures for the same.

Objective:

- ❖ Identifying BlackSpots of the roads to investigate frequency and intensity of occurred accidents.
- ❖ Identification of the accident factors based on applying a comprehensive and integrated system for making decisions by using mathematical and statistical methods in the field.
- ❖ Suggest the remedial Measures to prevent the accidents.

Study Area of Project:

Route connecting the Khadi Machine to ChandaniChawk

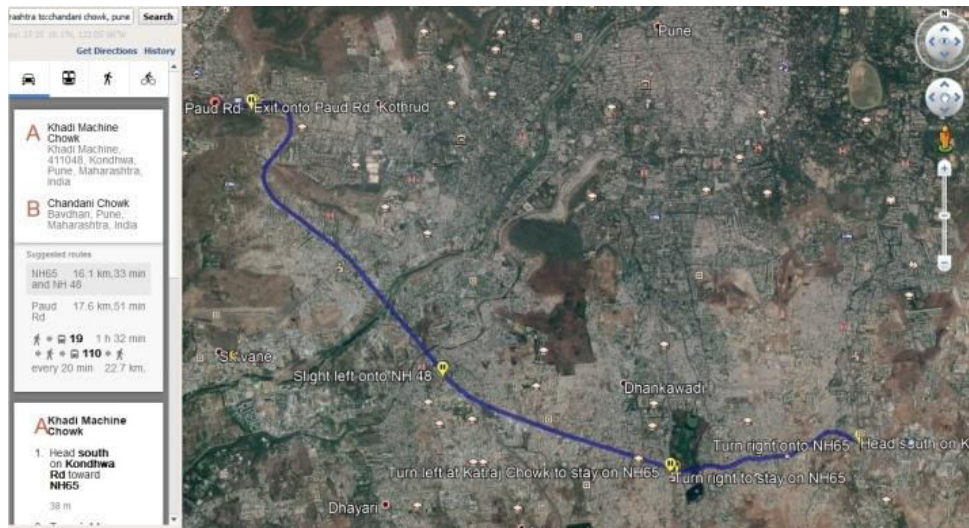


Figure 1 Satellite Imagery

The figure 1 portrays the satellite view of the selected route for the study and figure 2 displays route highlighted in blue colour.

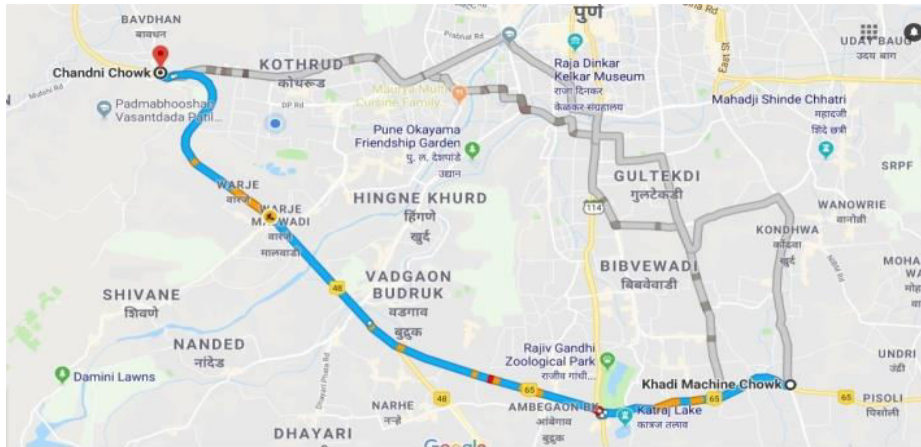


Figure 2 Route from Google Maps

II. RELATED WORK

There are many studies on the Blackspot identification in past few years. Government of India also focusing on the Blackspot identification, to reduce the accident rates. Previously it has been observed that by identifying BlackSpots there is decrease in rate of accidents upto 28%. Following are some of research papers.

[1]“Identification of Blackspots and junction improvements in Vishakhapatnam city”, studied about the city Vishakhapatnam in India in Andhra Pradesh. It is the second largest city in Andhra Pradesh with an area of 550 km², it is primarily an industrial city, apart from being a port city. The traffic volume of Visakhapatnam city is about 59% of the total traffic volume of the district (Gopala raju, 2011). The term BlackSpot is used to describe locations that have a higher average accident rate. The identification, analysis and treatment of road crash black spots are widely regarded as one of the most effective approaches to road crash prevention. Generally hazardous locations are selected on the basis of formal road safety audits.

[2]“Identification of Accident Black Spots for National Highway Using GIS”, in this they were studied about traffic in Muzaffarnagar and Meerut. Muzaffarnagar District is bounded by Meerut District to the south and Haridwar District to the north. The data were collected from police stations and survey of topographical map has been studied. After that the Ground Control Points with the help of Global Position System has been found out & then the black spots has been identified by using Critical Crash Rate Factor Method.

[3]“Black Spots Analysis On Pune - Bangalore National Highway”, identified accidental Black Spots on a section (820 km-830 km) of NH-4 by studying the accidental data provided by National Highway Authority of India (NHAI) during year 2014-2015. They used Weighted Severity Index (WSI) and Accidental Density Method (ADM) for identification of Black Spots. By considering all the parameters of Accidental Density Method (ADM) they found black spots at chainage 821.2 km, 823 km, 824.1 km, 825.3 km and 829.1 km.

[4] “Development of Traffic Accident Prediction Models Using Traffic and Road Characteristics: A Case Study from Sri Lanka”, studied that traffic accident data in developing countries are just merely statistics which will not lead to further analyses and detailed studies. A section of highway of 20.5km in western province, Sri Lanka, was subdivided into approximately 200m segments and considered for this case study. Black spots were identified using three accident indices: (i) Accident Rate, (ii) Accident Frequency and (iii) Accident Severity. The study attempted to identify the relationship among Number of accidents (Y), Average Daily Traffic Flow in thousands (X1), Commercial Land Use Area in Square kilometers (X2), Binary variable to represent the vicinity of intersection (X3; if yes:=1, else:=0). The following relationship was found: $Y = (-6.54) + 0.23X_1 + 0.94X_2 + 12.89X_3$ where $R-Sq = 52.3\%$, $R-Sq(adj) = 51.0\%$, $Std.err = 11.61$.

[5] “Road Traffic Accident Analysis and Prediction Model: A Case Study of Kashmir”, In this project they analyze road traffic accident (preliminary and micro level) and they predict model based on the parameters of vehicle ownership –population ratio.

[6] “Road Crash Prediction Models: Different Statistical modelling Approaches”, concluded that the, Traffic crash prediction models are very useful tools in road safety programs used by transportation agencies, police, health departments, education institutions that oversee road safety, vehicles, and the driver’s education. They can be used to predict both the frequency of crash occurrence and the contributing factors.

[7] “Analyzing Traffic Accidents in Gampaha District Colombo - Kandy Road”, they observed that critical combination of various factors contributes to fatal accidents and This issue should be approached on the basis of accident contributing factor and risk increasing factor when determining why and how fatal accidents

III. RESEARCH METHODOLOGY

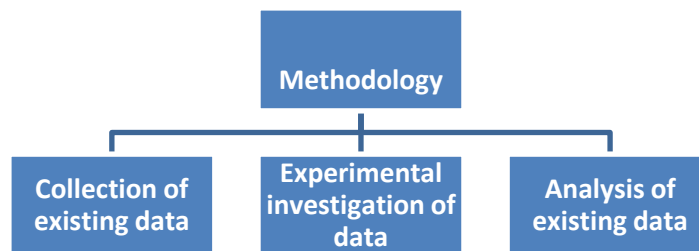


Figure 3 Process Chart for Methodology

Methodology adopted mainly includes collection of existing data, experimental investigation and analysis of existing data.

Existing Data Collection:

There are two methods to identify accident black spots. One is by conducting physical survey considering predominant causes of accidents and other is to analyse the existing accident data of a particular stretch. Methodology for this research includes identification of black spots by correlating the physical survey with existing accident data. Existing data was collected from police station.

) Data Collection:

The data which is shown below is collected from the respected police stations from their FIR (First Investigation Report). As our project area is from Chandani Chowk to Khadi Machine Chowk, Pune. The data is collected from last few years i.e 2015, 2016. The data includes number of deaths, No. of Critical Injuries, No. of Minor Injuries and Damages also. The stretch of 16 km comes under following four different police stations i.e.

- 1) Warje Police Station
- 2) Sinhagad Police Station
- 3) Bharati Vidhyapith Police Station
- 4) Kondhwa Police Station

ii) Experimental Investigation:

Selecting Parameters for Ground Survey:

There are many parameters that can cause accidents on highways but only the parameters that are more predominant in the study area had to be selected. These factors will be finalized on the basis of following factors

- (i) International Journal Papers
- (ii) Reconnaissance Survey
- (iii) Interviewing Local Commuters

iii) Analysis of Existing Data:

Existing data collected from Police station was to be correlated with the data collected from physical survey to identify accident black spots. It will be analysed by following methods.



1. Accident Density Method
2. Weighted Severity Index

IV. OBSERVATIONS AND ANALYSIS

The data collected reflects the view of the reporting Police Officer. Accidental data collected from the Police Station from their FIR (First information report). Following table (Table 1) shows the summary of the all four police station FIR reports.

Police Station	Year	Death Sheet		Critical Injured		Injured		Damage	Total
WARJE	2015	12		16		17		14	45
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
		11	1	12	4	13	4	14	
	2016	14		11		7		11	32
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
	10	4	9	2	5	2	11		
SINHGAD	2015	14		13		8		0	35
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
		11	3	11	2	8	0	0	
	2016	13		17		0		0	30
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
	9	4	14	3	0	0	0		
BHARTI VIDHYAPITH	2015	12		0		15		0	27
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
		10	2	0	0	3	2	0	
	2016	9		10		14		0	33
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
	8	1	6	4	13	1	0		
KONDHAWA	2015	5		5		0		0	10
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
		2	3	4	1	0	0	0	
	2016	4		4		0		0	8
		MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	DAMAGE	
	3	1	2	2	0	0	0		

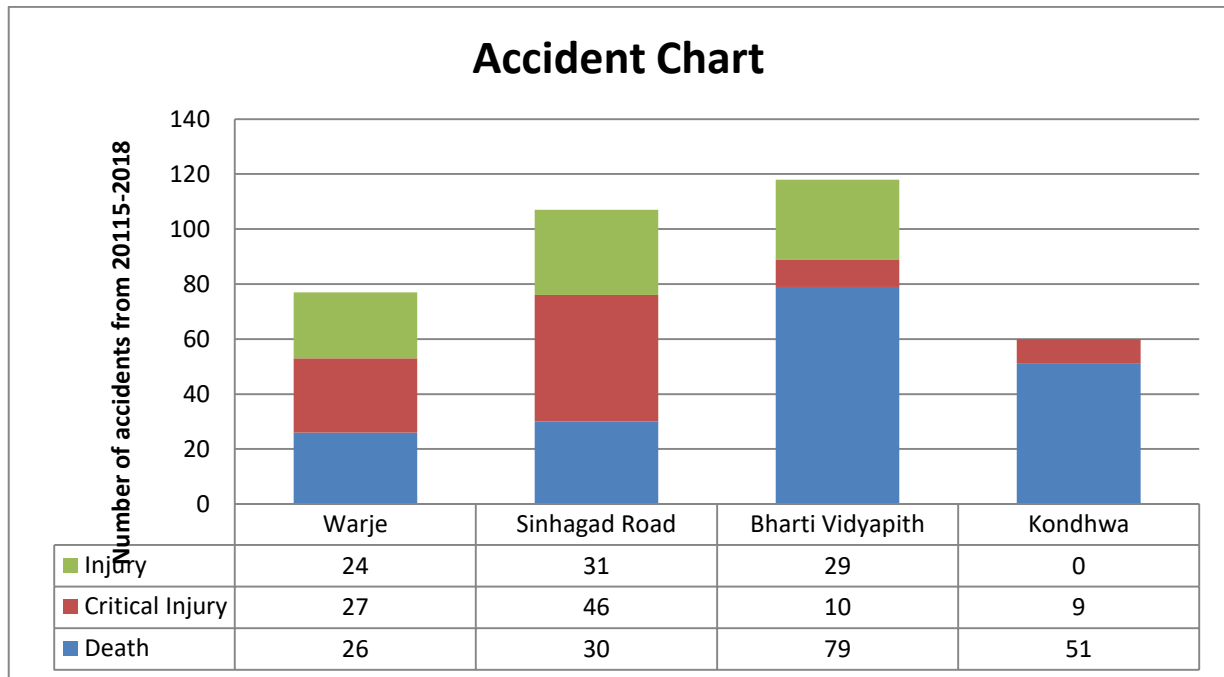


Figure 4. Distribution of accidents from police station by accident severity type

4.1 Analysis of Existing Data:

Existing data collected from Police station was to be correlated with the data collected from physical survey to identify accident black spots. It will be analysed by Accident Density Method

1) i) Accidental Density Method:

- i. The accident density is calculated from the number of accidents per unit length for a section of highway. Sections with more than a predetermined number of accidents are classified as high accident locations.
- ii. Unit length is taken as 500m.
- iii. Predetermined no. of accidents is calculated as average number of accidents that have occurred per unit length.
- iv. Average no. of accidents = (Total no. of accidents) / 16
- v. Sample calculation,

$$\text{Average no. of accidents} = (268) / (16) = 16.75$$

- vi. Every 500m length of the stretch where no. accidents is more than 5 is termed as “Accidental Blackspot”.

So, by using this method we analyses the data and identified the BlackSpots.

From Accidental Density Method 22 numbers of BlackSpots are identified. These are mentioned in following table.

Table No.2 List of BlackSpots

Sr. No.	Section	Place	No. of Accidents	Result
1	PT01-PT02	Khadi Machine	14	TRUE
2	PT02-PT03	Smashan Bhumi	7	TRUE
3	PT03-PT04	Honda Showroom	7	TRUE
4	PT04-PT05	ISKON Temple	7	TRUE
5	PT05-PT06	Gokul Nagar Bus stop	8	TRUE
6	PT06-PT07	Sai Nagar	2	FALSE
7	PT07-PT08	AK Petrol Pump	6	TRUE
8	PT08-PT09	Katraj lake Signal	5	FALSE



9	PT09-PT10	Katraj Chowk	19	TRUE
10	PT10-PT11	Wonder city	8	TRUE
11	PT11-PT12	Ambegaon Chowk	8	TRUE
12	PT12-PT13	Dattangar	12	TRUE
13	PT13-PT14	Abhinav School	4	FALSE
14	PT14-PT15	Beldare Petrol Pump	11	TRUE
15	PT15-PT16	Navale bridge	16	TRUE
16	PT16-PT17	Vadgaon Bridge	27	TRUE
17	PT17-PT18	End of Vadgaon Bridge	14	TRUE
18	PT18-PT19	MulaMutha River	14	TRUE
19	PT19-PT20	Warje Bridge	8	TRUE
20	PT20-PT21	Warje Bridge End	11	TRUE
21	PT21-PT22	Vardhaman Petrol Pump	9	TRUE
22	PT22-PT23	Popular Nagar	15	TRUE
23	PT23-PT24	Dodke Dairy	7	TRUE
24	PT24-PT25	RMD College	12	TRUE
25	PT25-PT26	Dukkarkhind	10	TRUE
26	PT26-PT27	Wonder Futura 1	4	FALSE
27	PT27-PT28	Chandani Chowk	3	FALSE

4.2 Accident Prediction Model

4.2.1 Multiple linear regression analysis

Hong et al. (2005) developed a multiple linear regression traffic accident prediction model for urban areas using the parameters of traffic volumes, intersections, connecting roads, traffic signals and existence of median barrier. Mustakim et al. (2008) carried out a study on Black spot Study and Accident Prediction Model Using Multiple Liner Regression. The study focus to develop an accident prediction model for a selected route and in the model the independent variables were number of access points per one kilometer road section, hourly traffic flow and 85th percentile speed. The regression analysis is performed using Microsoft Excel. Hong et al. (2013) also did a study to produce an application of spatial econometrics analysis for traffic accident prediction models in urban areas using multiple linear regression and the variables were based on two factors, one is socio economic factors including number of residents, number of employees in area, number of traffic volume.

A section of highway of 16 km of Chandani Chowk to Khadi machine chowk was subdivided into approximately 500m segments and considered for this case study. Black spots were identified using by using Accident Density Method. The study attempted to identify the relationship among Number of accidents (Y), Traffic Calming Agents (X1), Intersection existence (X2), Traffic Divider (X3; if yes:=1, else:=0). The following relationship was found:
 $Y=10.61-2.90X_1+1.84X_2+0.53X_3$ where $R-Sq=16.44%$, $R-Sq(adj)=5.54%$, $Std.err=5.28$.

Table 3. Description of variables in the study

Variable	Description
Y	Number of Accidents
X ₁	Traffic Calming Agents
X ₂	Intersection existence
X ₃	Traffic Divider
E	Error term



Table 4. ANOVE Table

	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	126.2487	42.08289	1.508575	0.238837
Residual	23	641.6032	27.89579		
Total	26	767.8519			

Table 5. Table of Co-efficient

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	10.619022	2.8239046	3.760404	0.001018	4.777331	16.460714	4.7773307	16.460714
A	-2.9096433	1.4448453	-2.01381	0.055873	-5.89853	0.0792469	-5.8985336	0.0792469
B	1.8406869	2.0078444	0.916748	0.368788	-2.31286	5.9942295	-2.3128557	5.9942295
C	0.539498	2.70391	0.199525	0.843606	-5.05397	6.132962	-5.0539659	6.132962

SUMMARY OUTPUT	
<i>Regression Statistics</i>	
Multiple R	0.405485
R Square	0.164418
Adjusted R Square	0.055429
Standard Error	5.281647
Observations	27

V. RESULTS AND CONCLUSION

The main focus of this project is accident analysis and identification of BlackSpots on the route of Chandani Chowk to Khadi Machine Chowk, Pune. This route is having 16.0 KM length. This route includes Mumbai-Bangalore Highway (NH-48), Pune-Machilipatanam (NH-65) Highway. Number of educational institutes, temples, stops for construction workers are also exists on this route. We had collected accidental data from police stations for last Four years and by using Accidental Density Method. After analysing this data by this method we find out 22 BlackSpots.

These are the following:

- | | |
|-------------------------|---------------------------|
| 1) Khadi Machine | 12) Navale Bridge |
| 2) Smashan Bhumi | 13) Vadgaon Bridge |
| 3) Honda Showroom | 14) End of Vadgaon Bridge |
| 4) ISKON Temple | 15) MulaMutha River |
| 5) Gokul Nagar Bus Stop | 16) Warje Bridge |
| 6) AK Petrol Pump | 17) Warje Bridge End |
| 7) Katraj Chowk | 18) Vardhaman Petrol Pump |
| 8) Wonder City | 19) Popular Nagar |
| 9) Ambegaon Chowk | 20) Dodke Dairy |
| 10) Datta Nagar | 21) RMD College |
| 11) Beldare Petrol Pump | 22) Dukkarkhind |

Most common reasons observed by physically are following:

- 1) Most common reason was observed rear-end accidents at intersections. Reasons for this rear end accidents was improper signal system, poor vehicle management at intersections and instant apply of break, etc
- 2) Second common reason was observed the pedestrian accidents. The reasons were irregular pedestrian movements and heavy vehicle movement, insufficient use of traffic calming agents, insufficient space for pedestrians, poor signage, etc.
- 3) People are not following the traffic rules.
- 4) Faulty Road Geometric design such as improper super elevation, horizontal curve design etc.
- 5) Rash Driving of heavy vehicles.

In the following image (figure 5) we had marked the BlackSpots by blue pins.

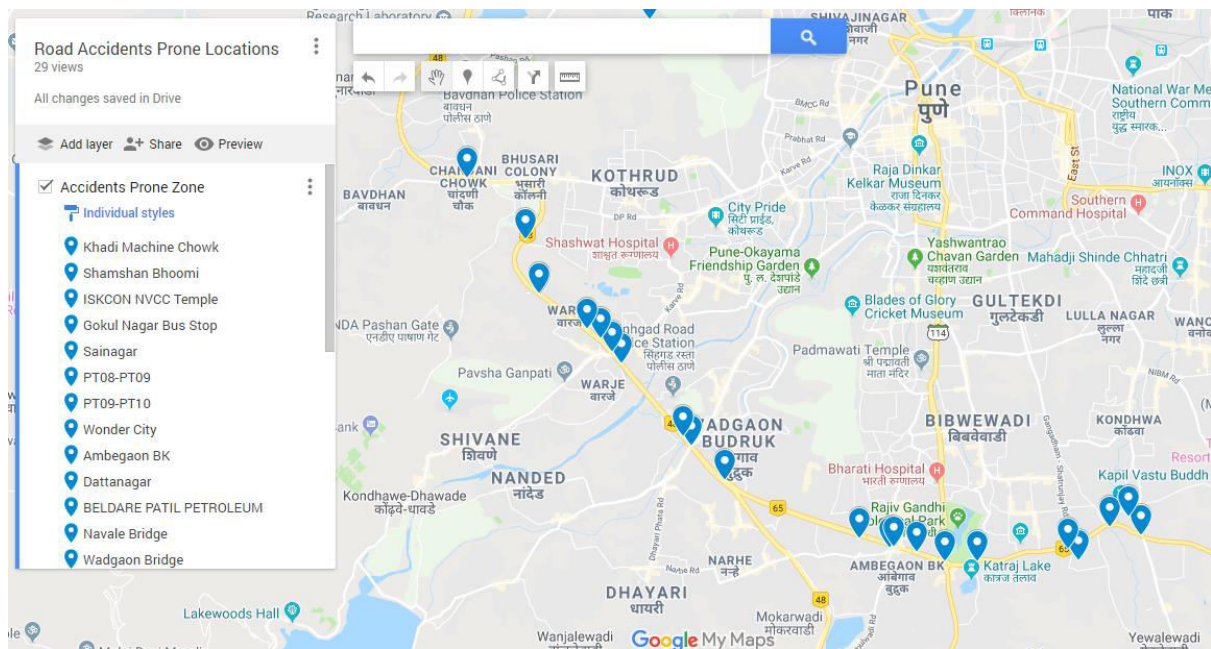


Figure 5. Location of BlackSpots

VII. FUTURE SCOPES

With the advent of technology and advanced algorithms to manage the traffic flows and integrate the analysis of the work it is possible. It would be possible to apply machine learning algorithms to determine the most probable black spots by analyzing the real-time traffic conditions and provide the safest and most comfortable traffic environment. As the population is rising, there will be a corresponding rise in the traffic related issues, to counter the evil effects of the black spots. The currently used traffic calming agents could be modified to suit the real-time analysis of black-spots.

VIII. ACKNOWLEDGEMENT

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