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An analysis of gis and gps-enabled traffic violation management in bengaluru city traffic police, karnataka, india.

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ABSTRACT

The twenty-first century has also been dubbed the "technological era" because everything is powered by technology and even humans live with it. Geographical Information Systems (GIS)[1] and Global Positioning Systems (GPS)[1], which we use in our daily lives, plays a crucial role in the maintained order in the society, so making this the Police Department is the primary institution for maintaining order in society. And the police department has two major actions includes pre-action and post-action in the response to any violations, issues, public nuisance, anti-social behavior, and crime, among others. So with this in mind traffic management is also one of the phenomena under social order; a lack of attention to traffic management may lead to road accidents and other issues. Management of traffic violations is a tough task for the police officials to tackle and trace out manually, but at present the Karnataka State Police Department is fully fledged with technology, as a result of which the department now has E-Policing under the Karnataka Police-IT, with this discipline of geography as a professional discipline, by using GIS and GPS applications in traffic policing to prevent potential traffic violations and to tackle and trace out these issues.

KEY WORDS: E-Policing, Police-IT, Pre- action, Post-action, E- Challan, GPS, GIS.

1. INTRODUCTION

"Geo-Informatics is the application of Science and Technology that develops and uses information in Science and Infrastructure to identify the problems of Geography, Cartography, Geo-science, and related branches of science and engineering"[2].

Geo-Informatics is defined as the science and technology concerned with the structure and characteristics of spatial information which includes capture, classification, storage, processing, portrayal, and dissemination.etc.

Geo-Informatics consists of various kinds like GIS (Geographic Information System), GPS (Google Positioning System), Cartography, Photogrammetry, Remote sensing, Web-mapping, Web-servers, LEDAR, etc. Out of all these, “GIS” and “GPS” are the most trending and useful applications in the entire world, which we are using everywhere in the present era.

Geographic Information System (GIS) is a computer technology that captures, stores, verifies displays, and projects the positions of data on the surface of the Earth. And GIS acts like a multidisciplinary and interdisciplinary application that relates to health and medicine, transportation, agriculture, government projects, security and defense, etc.

GIS/GPS Evolution in India: Once sighted on,

1. It was adopted in the late 1980s in planning systems like the Natural Resource Data Management System (NRDMS), the National Natural Resource Management System (NNRMS), and the Urban Mapping Scheme (UMS)[10]
2. GIS was partially implemented in all government projects between 1990 and 1999.
3. When it comes to 2000-2005, it was an essential part of all prominent governance schemes like the Digital India Land Record Modernization Program (DILRMP), the National Record Modernization Program (NLRMP), the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), the Integrated Watershed Management Program (IWMP) [10]etc.
4. In 2010, we entered the "decade of many adoptions with GIS/GPS," and its use is spreading across the country's various economic activities such as infrastructure, water

resource management, rural development, urban development, public safety and health care, agriculture, defense, security, and disaster management, among others [10].

GIS/GPS applications were initiated in the law enforcement sector as a part of security management. As we have law enforcement agency is maintained by the police, this includes crime prevention, Detection, Maintaining Law & Order, and Traffic management. It relates to mobile or stationary vehicles, highway maintenance, route planning, and accident analysis. With this, one of the primary responsibilities of police officers is to reduce traffic violations, which result in road accidents, which result in non-fatal injuries, disability, and economic losses to the individual and their family.

According to the WHO, approximately 1.3 million people die each year as a result of road traffic accidents, with pedestrians, cyclists, and motorcyclists accounting for more than a quarter of all road accidents[9]

Traffic management is required to avoid these socioeconomic issues, and GIS/GPS enabled management produces better results and is more effective in reducing road accidents.

Which is indirectly controlled through traffic management and with this GIS/GPS enabled traffic management, identifying traffic violations is critical.

2. Objectives Of The Study

1. To elaborate on the mechanisms of GIS and GPS in monitoring and tracking traffic-offending vehicles.
2. To evaluate the relationship between the e-challan system and the rate of traffic violations.

Limitations of the Study

1. The current study only looks at a subset of the most common traffic incidents.
2. This study to cover the violations of only two-wheelers instead of all vehicles.

3. METHODOLOGY

Research design

The current study employs a descriptive research design and an analytical research method to develop and evaluate the GIS/GPS enabled traffic management used by the Bangalore City Traffic Police.

Research area
Chosen Bengaluru, Karnataka, to complete this study.

Data Collection
Secondary data with qualitative and quantitative components was collected from various sources to complete this study.
Data Interpretation
The data collected were Tabulated, Analyzed, Interpreted, and Summarized using inferential statistics by **t-test** to test the collected data.

4. DATA ANALYSIS AND DISCUSSION

To develop GIS/GPS mechanisms for monitoring and tracking traffic-violated vehicles.

The Karnataka State Police Wide Area Network (KSPWAN) was created specifically to support the Karnataka State Police's e-policing program. Under this program, all the digital policing is working.

Bangaluru is known as the country's "Silicon Valley," but it is also notorious for its traffic. With this, Bangaluru residents face heavy traffic on a daily basis, and the current study will show what pre and post-action measures are taken by the Bangaluru City Traffic Police to monitor and track this issue using GIS and GPS.

- ***Pre-Action Measures:*** Here are some measures taken by the Bangaluru City Traffic Police to prevent traffic violations.

  E-Beat: Here, the police personnel have patrol vehicles embedded with GPS through this, the higher officials supervise the on-field police personnel during their duty to check whether they are doing their job properly or not.

Figure 1.1[5]

Advanced Traffic Sensors: These tools are working with *ultrasonic Doppler* technology. With these tools, they can track the speed of the targeted vehicle and find its movements. And installed these tools at strategic locations near major traffic lights.

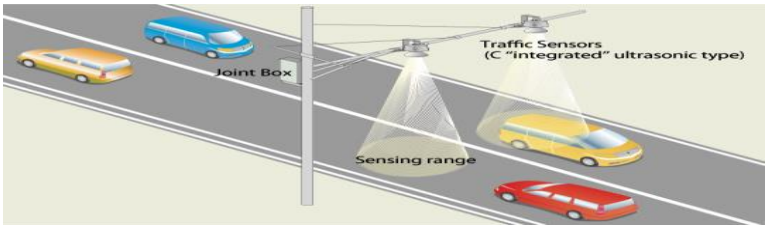


Figure 1.2[5]

High-Surveillance Cameras/CCTV: These are important high-frequency-based cameras. This system is configured to record footage both before and after the offences, and detected it is embedded with sensors that help to detect a clear image of the particular violated vehicle in the process of passing from the singles.

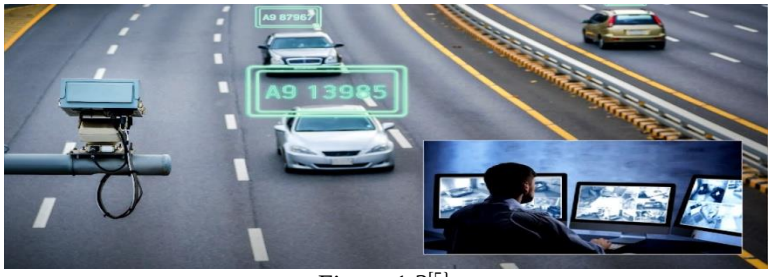


Figure 1.3[5]

Blackberry: This is one of the equipment to Driven enforcement, including mobile set that is installed with the software in the name of the Karnataka State Police. The procedure includes a cell phone and a printer. The information pertaining violations of traffic rules and penalties is captured. Once case registered against any vehicle owner includes a fine levied, driving license details, and vehicle number [4].

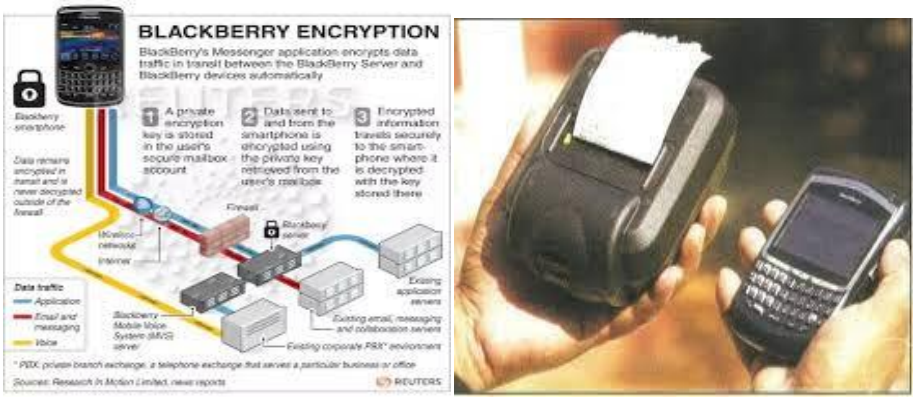


Figure 1.4[5]

Interceptor: Interceptors are vehicles that primarily monitor the speed of vehicles. Which has Doppler radar, with which it can identify the speed, picture the rider with the vehicle, including whether he or she is wearing a helmet or not and also collect information about the pillion rider. With this information, it may be possible to track down the traffic violation.

Figure 1.5[5]

GIS/GPS Enabled Devices: These are the major tools that embed GIS and GPS systems, and they play an effective role in detecting and tracking traffic violations, such as the Automatic Vehicle Location System (AVLS), G-CARE (which includes GIS for crime mapping and crime analysis), Making Crime Hot Spots, Interceptors, and so on

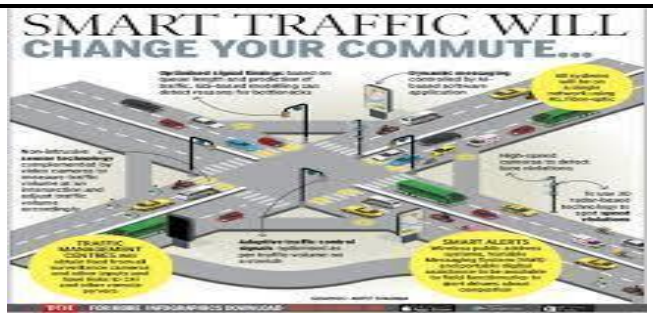


Figure 1.6[5]

These are the major monitoring systems used by our Bangaluru City Traffic Police to supervise traffic violations**.**

- ***Post-Action Measures:*** Now what are the tracking systems they are using to tackle the traffic violation? I only covered specific traffic violations includes: Signal jumping, Over Speeding, Triple riding, Driving negligently or Recklessly, Driving without a helmet, and Pillion riding without a helmet. In recent years, these have been the most common traffic violations in Bengaluru.

So, with this, the Bangaluru City Police adhere to the major Three Post-Action Mechanisms, those are as follows:

GPS Embedded Signals: To determine location, the tracker uses a process called Trilateration, which works with the help of the Global Navigation Satellite System (GNSS). As we all know, our vehicles are outfitted with GPS navigation receivers that allow them to display driving instructions to drivers while also acting as a satellite receiver to track a specific vehicle's position and time.

Figure 2.1[5]

In a precise orbit, GPS satellites make two orbits per day around the globe. Receivers of this device embodied with GPS and decoding and calculate the precise position of a satellite with

unique signals and orbital characteristics that each satellite broadcasts. This data and Trilateration are used by GPS receivers to track a user's exact position and time. And this system not only determines the place and time, and also the speed of vehicle/object going through traffic lights, which is computed using the equation X=d/t (i.e., X-Speed of the car, d-Distance traveled by car between two places, and t-Time spent to get there).

For example, if a car travelled from point A to point B in 5 minutes and the distance covered was 2 kilometers, than we can calculate the speed of the car as follows:

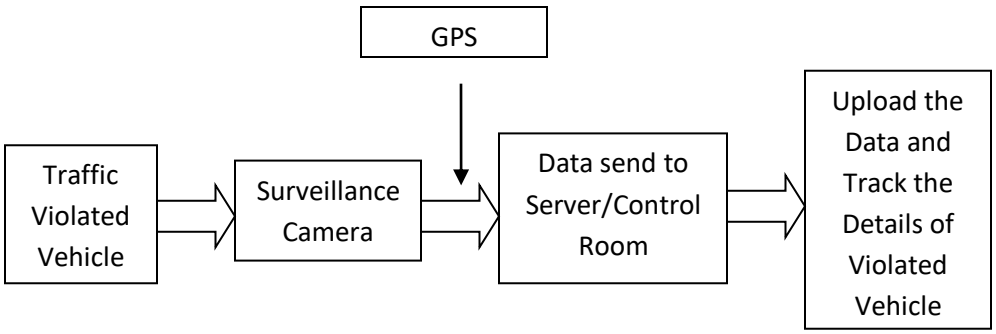
X=2 km/5 minutes.
X =0.4 Km/Min. (If we convert it into hours, it becomes)
X = **24 km/ hour.**

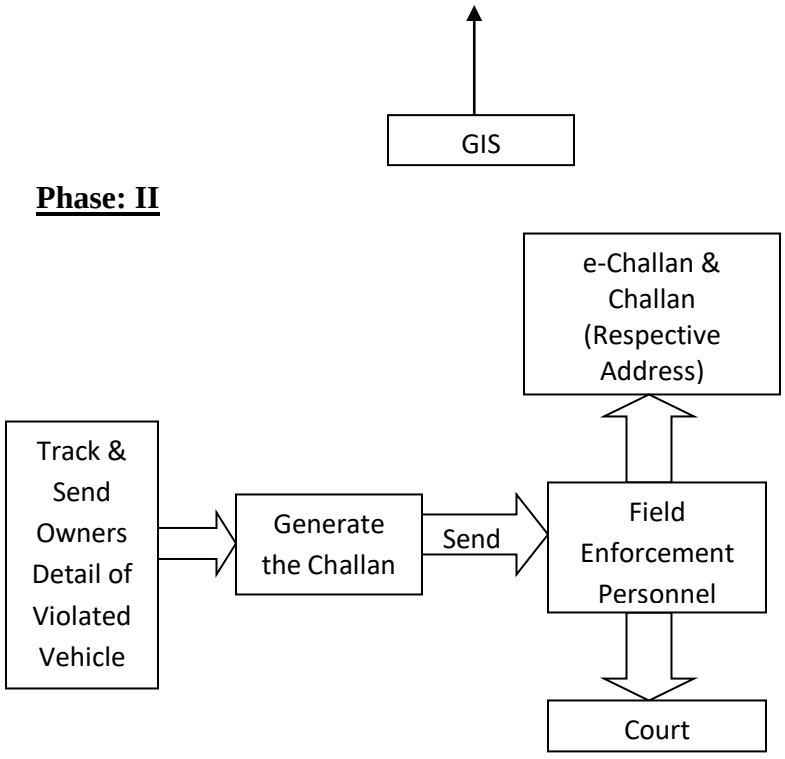
Interceptor: The vehicles embedded with an interceptor used by traffic police to trace out speeding, triple riding, driving without a helmet, and pillion riders riding without helmets—these are the major two-wheeler traffic violations—can be detected with the help of an interceptor. There is a radar gun camera placed at the rear of the police interceptor. On the camera, one officer observes vehicles passing through the road. The camera display can see vehicles in a range between 200 meters and 600/1000 meters. The

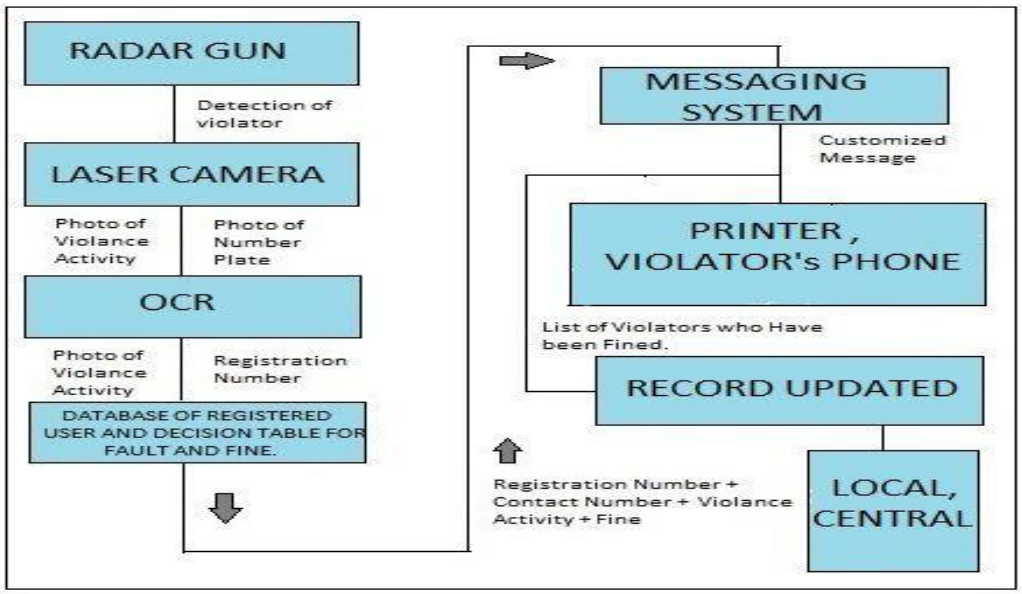
display shows speed, geographical location, and other details of the specific vehicles. The camera not only tracks over speeding, but it can also take action if they were on triple

riding, a two-wheeler without a helmet, or a pillion rider without a helmet. If violations occur immediately, they can pick up the photo and send it to the Central Traffic Police Control Room, which includes a server and maintains the data with RTO and police station records. They take the owner details of that specific traffic violated vehicle and send them to on-field traffic police personnel, who can then generate a fine challan based on their violation on the spot using a black box, or they can sometimes send the fine challan to the respective owners of the vehicles.

Phase: I







Identification of Speed: This system is also used for identifying the speed of vehicles. It consists of Doppler radar, which consists of radio transmitters and receivers. They send radio signals to opposite objects and then receive the same radio signals back within a specified time frame. Using this technology, they can measure the speed of the objects using the received radio signals.

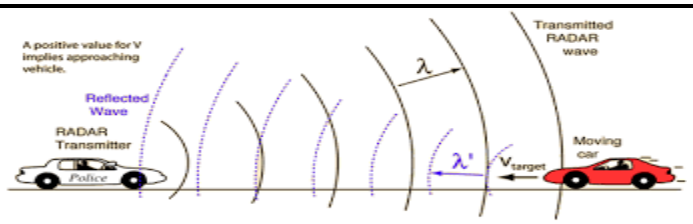


Figure 2.2[5]

E-Challaning: Under the ITS (Intelligent Traffic Signals) embedded with GIS technology, which helps identify and trace the traffic violated vehicles, that system generally includes e-challaning. And e-challaning means, It is a mobile mechanism included (or electro-mechanical) device which is capable of challaning electronically to the traffic rule violators and actions to take instantly and maintaining the integrity of the system. And under this system, we can identify signal-jumping and reckless-driving vehicles.[7

Rash Driving: To tackle this, the "CORDON" device is used in all the signal junctions, which work under GIS. This multi-target photo radar system can capture data from four lanes simultaneously, along with wrong lane detection and lane violations automatically, and it works through the wave length measurement, which can easily detect wrongly moving vehicles and capture the number plate of the wrongly moving vehicle. [7]

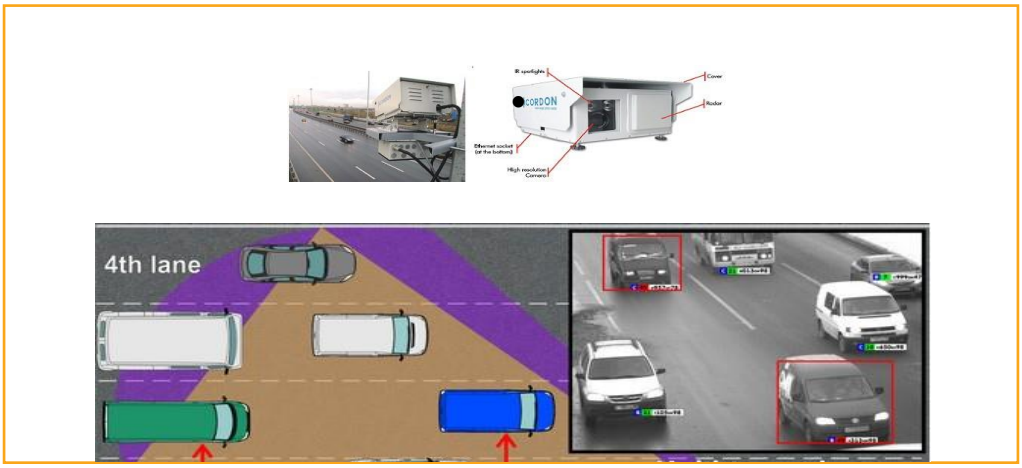


Figure 2.3[5]

Signal Jump or Red Light Violation: The system connects with the traffic controller. Typically located at ground level of the stop line, traffic sensor is supervised by the system for the presence of vehicles during the red phase. The detector might be an over-the-ground device having a

video-based detector, infrared detector, and it could be an on-road sensor like a loop detector or a magnetometer. When a vehicle gets crossed the line, the system captures a picture of it and creates the necessary proof for challaning. Through the communication device, the violation information is transmitted to a centralized server in the back-office processing and challan creation. Additionally, the evidence is stored locally and later passed on to the server if the connection over the network is out.

This is one of the primary systems for detecting signal jumps or red light violations. As I mentioned in the section on results and analysis, these are the major systems, and they all have GIS or GPS embedded, which aids in the monitoring and detection of traffic-offending vehicles in Bengaluru

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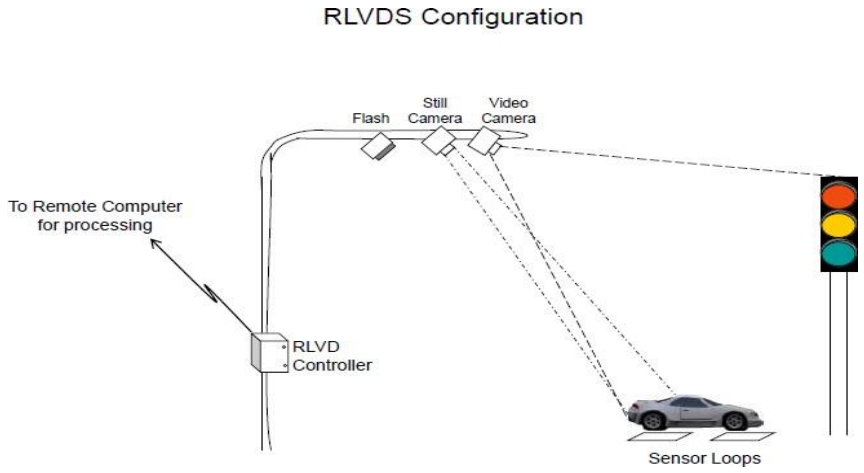

To learn about the relationship between the e-challan system and the rate of traffic violations.

There is no significant relationship between e-challan systems and incident rates.

To fulfill this objective, to conduct a statistical hypothesis test by using the incident rates of 2019 and 2021 comparatively to show whether the e-challan system really works to tackle and trace traffic violations.

A t-test is suitable for comparing over two dependent variables, and by using a one-tailed test, we can show the relation between the e-challan and the rate of traffic violation incidents.

Nature of Incidents	Incident Rate	
	2021	2019
Reckless Driving	66666	50,457
Over speeding	65482	61,531
Signal Jump	822529	823468
Triple Riding	112773	84276
Riding without Helmet	3900651	2030000
Pillion Rider without Helmet	2309563	1290000

Source- CCRB report, Bangaluru

I used a scale for calculation, and the data was computed as per the scale.

Nature of Incidents	Incident Rate	
	2021	2019
Reckless Driving	0.66666	0.50457
Over speeding	0.65482	0.61531
Signal Jump	8.22529	8.23468
Triple Riding	1.12773	0.84276
Riding without Helmet	39.00651	20.3
Pillion Rider without Helmet	23.09563	12.9

Scale: 100000=1/ lakh=1

As the outcome, the t-test's level of significance has been set at 0.05

Degree of Freedom (df) = (n1+n2) - 2
(df) = (6+ 6)-2
Df = 10

S-Standard Deviation
n- Number of Samples
t critical value**= 1.812**
X- Mean.

Standard Rule for t-Test: **t calculated value > t critical value = Nullify the Ho** and **Validating the H_1**

So, $$t = \frac{\bar{X}1 - \bar{X}2}{\sqrt{\frac{S1}{n1} + \frac{S2}{n2}}}$$

X1- mean of 1set of variable = **$\bar{X}1$**= 7.23288
X2- mean of 2 set of variable = **$\bar{X}2$**= 12.129
S1- Standard Deviation of 1 set of variable = **S1**= 3.890

S2- Standard Deviation of 2 set of variable = $S2$= 2.809
n- Number of Samples = **n**= 6
So,

$$t= \frac{12.129-7.23288}{\sqrt{\frac{2.809^2}{6}+\frac{3.890^2}{6}}}$$

$$t= \frac{4.896}{\sqrt{1.315+2.522}}$$

$$t= \frac{4.896}{1.92}$$

Calculated value, **t= 2.510**

Result: **t**'s calculated value is greater than **t**'s critical value, so I nullifying the null hypothesis (**Ho**) and validating the alternative hypothesis (H1)

i.e, **t** Calculated value (**2.510)> t** critical value **(1.812)**

Based on the results, I concluded with **H1**, i.e., there is a relationship between e-challan and incident rate, so based on the test, I discovered that e-challan has an impact in Bengaluru and the e-callan system is used to track and trace traffic violations.

5. CONCLUSION

With this study, try to concluding that these are the major systems used by the Bangaluru Traffic Police to monitor and track the traffic-offending vehicles in a very effective manner. And with GIS/GPS enabled this systems is helping the police personnel to do more convenient and impactful work, and that helps to create a healthy environment for public-police relations in Bengaluru.

And with these systems, we can tackle the offending incidents quickly and in a sophisticated manner without barriers like identification, communication, etc., and the incident rate is also increased because of the use of the e-challan system in traffic management with the avoidance of barriers.

6. SUGGESTION

According to the findings of this study, Intended to suggest that these GIP/GPS enabled systems be implemented throughout Karnataka rather than just in Bangaluru City and that these are the major applications that now using only in traffic violations. Rather than this it is very essential requirement in the crime prevention, crime mapping, and crime analysis.

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