Unlocking Insights in Vehicle Alert Generation: Patterns, Correlations, and Locations

MOHAMED MAFAZ, MUHAMMED RUHAAN, IRSHAD YASSEEN

***Abstract*— Ensuring road safety is incredibly important, in todays world with the increasing number of vehicles on the roads. This study delves into an analysis of how vehicle alert generation patterns impact road safety. By examining outliers correlations between vehicle speed and alerts variations in generation over time and spatial insights we aim to provide insights on how to enhance road safety. Our findings highlight the significance of identifying outliers when it comes to understanding and addressing risks on the road. We also show that there isn't always a correlation between vehicle speed and the frequency of generated alerts. This emphasizes the need for a nuanced approach in monitoring road safety. Additionally our analysis reveals peak alert hours throughout the day which can guide the implementation of safety measures during times.**

Furthermore we investigate how daytime alert generation relates to road safety and shed light on the challenges faced during times of day. Moreover by examining alerts we uncover factors to consider for effective alert management and system optimization.

Lastly our examination of locations provides insights, into high risk areas. This knowledge allows for implementation of safety measures and targeted interventions.

These findings highlight the possibility of making advancements in road safety by using data driven insights into vehicle alert generation patterns and locations. This research provides suggestions, for policymakers, vehicle manufacturers and road safety advocates to improve road safety and decrease accidents on our roads.

I. Identifying Outliers and Trends : An Analysis of Vehicle Count on Road

The number of Cars on road have been increasing tremendously, for instance only Chennai in a month of September – 2019 has seen 1.7 Lakhs new two-wheelers and cars being produced, that is **17.8%** increase within a month. The demand for two-wheelers was so high in the state during that particular time period that the price of second-hand vehicles reached **200%.**

With this enormous jumps in vehicles on the road the risk factor of road safety is also at concern. People travelling in busses will be experiencing over crowdedness quite often. *Fig 1* shows the Overlading/Overcrowding experienced by a public transport user thought the years. Reason for the drop of overcrowding in the year 2019 can be credited to the spread of covid – 19 and the situational awareness and precautions taken at the time.

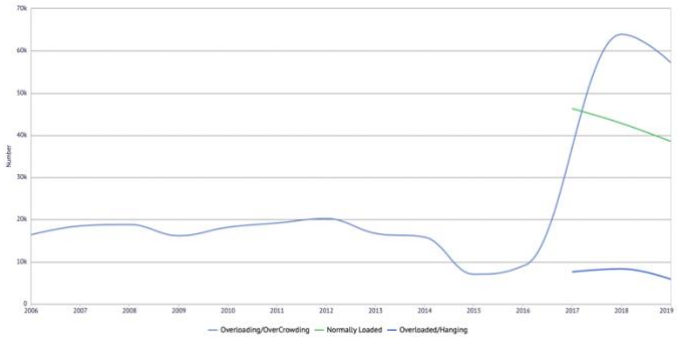

Fig 1. Overlading/Overcrowding experienced by a public transport user thought the years.

Despite the issue of public transport being overcrowded the private transport accidents seems to be at a decline since 2017

Note : Reasons for the drop of accidents could be due to covid – 19

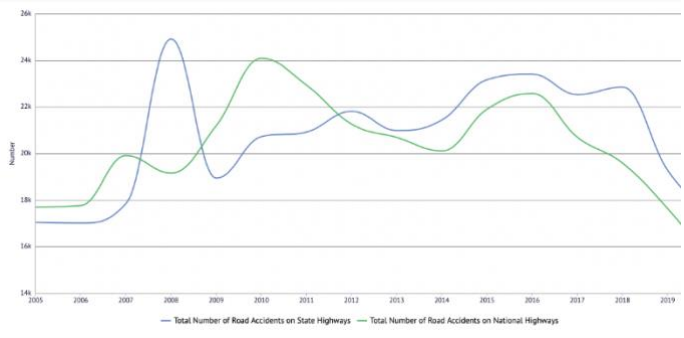

Fig 2. Road accidents (all type of road accident) thought the years.

The plummeting vehicles on road are prone to interfere with the alert systems installed in the vehicles. Various measures were taken to discard any Outliers and errors induced into the system.

Measure 1:

Vehicles that generate alters at speed of 0 (~**4.6%** of the dataset)are mostly caused by faulty alert systems, Incoming vehicles and pedestrians, etc, that for most of which the driver of the vehicle is unprecedented for.

Measure 2:

The data collected showed an irregularity in the alerts generated (9am – 3pm) during the operational time of the vehicle (*Fig 3*), this may have been caused due to vehicle being in standby during their operational time frame. There was no evidence found that support the otherwise of the irregularities.

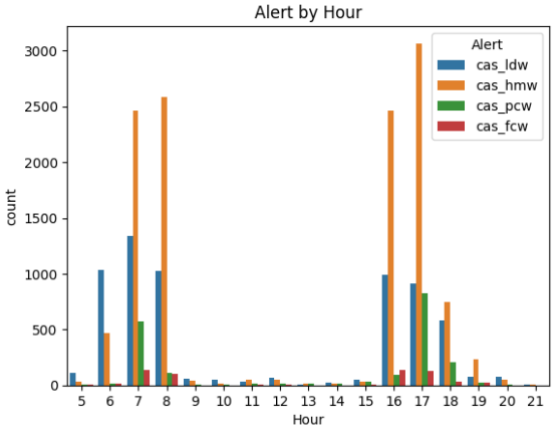

Fig 3. Irregularities of the alerts generated by hour.

Measure 3:

One of the vehicle used for data collection didn't get to perform as much as the other vehicles got to perform on the road (*Fig 4*)

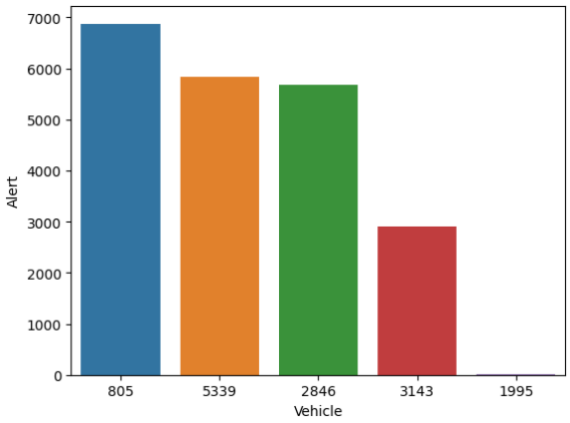

Fig 4. Vehicles used for data collection (identified by unique numbers).

II. Decoupling Speed and Alerts: A Correlation Study in Vehicle Monitoring

When the alerts generated were analyzed to examine any interesting relation between speed and type of alerts that were generated, it found that the vehicles showed no improvement of correction of speed when an alert was registered during the course of its time.

Fig 5.1. LDW vs Speed.

Fig 5.2. HMW vs Speed

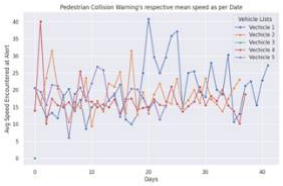

Fig 5.3. PCW vs Speed.

Fig 5.4. FCW vs Speed.

Meaning that the alerts were generated because of the particular speed they were on. This

insight doesn't rule out effect of speed's relation with traffic accident but emphasizes that the particular alters that are generated fits well when the vehicle belongs to a particular speed frame.

Speed can be a factor that be relied on prediction and avoidance of road accident. Model trained on the dataset shows interesting results:

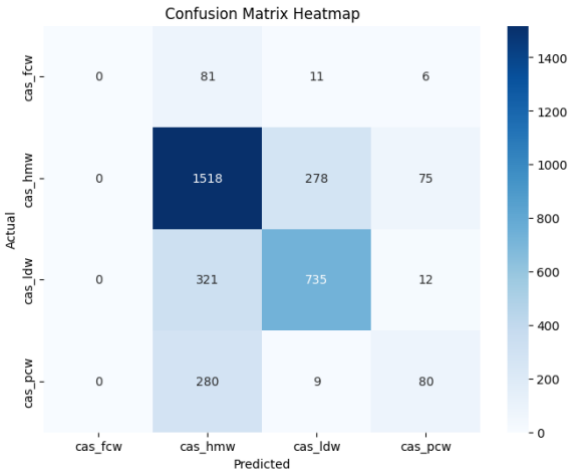

Fig 6. Confusion Matrix Heatmap.

Model is able to predict the most accurate for Headway Monitoring Warnings and Lane Departure Warnings, as the *Fig 5.1* and *Fig 5.2* also are the best fitting line graphs. Using these insights, the prediction ability of vehicle crash avoidance can be enhanced when it comes to the above two warnings.

As the type of vehicle changes (e.g., from cars to trucks), there is a small decrease in speed on average, but the effect is not very pronounced. Remember that correlation coefficients close to 0 indicate weak or no linear relationship, while positive values indicate a positive linear relationship, and negative values indicate a negative linear relationship.

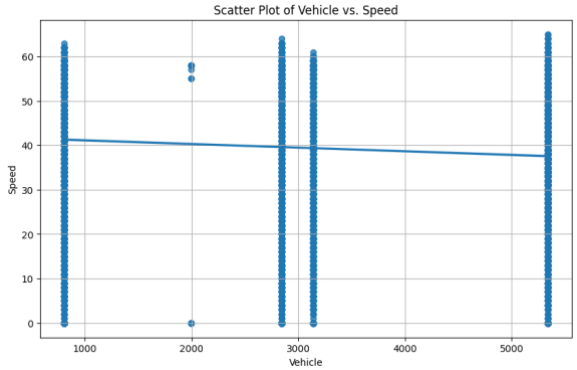

Fig 7. Vehicle vs Speed.

Vehicle type	Speed	**-0.085**

Furthermore the alert system needs improvement by additional information provided by various new sensors and real time processing capabilities.

III. Back-to-Back Alerts: Unpacking Patterns and Implications

Analysis of Back-to-Back alters generation and meaningful insights can lead to a safer crash avoidance system where the previous data of the alters can be taken into account with various other real time factor, such as speed and location.

The most prominent alters that were found that occurred most repeatedly within a short window repeatedly were –

Lane Departure Warnings.
Headway Monitoring Warnings.

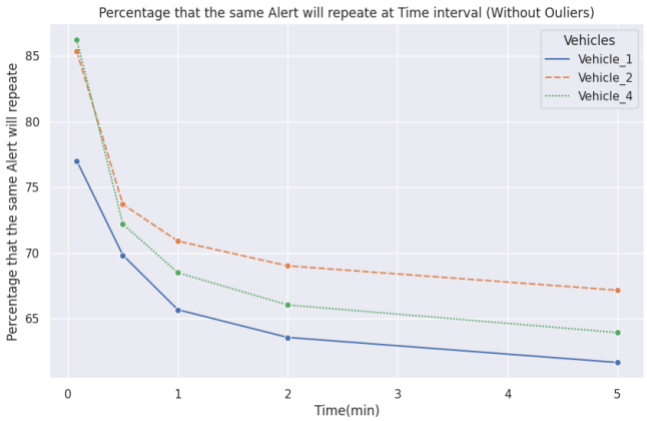

Fig 8. Percentage that the LDW and HMW will repeat itself.

Note- Vehicle 2 and Vehicle 5 were considered as Outliers (*Refer section I*)

The Chances that the LDW and HMW will be repeated within one minute time frame is **65% – 87%** (Fig 8), Using this the crash avoidance system can better prepare itself for what time of

Collision it may have to deal with based on past Alerts.

IV. Location Matters: Spatial Analysis of Alert Generation in Vehicle Systems

Insights that we have achieved using the spatial data gave us a tactical knowledge and advantage of what type of accident a vehicle can except depending on what type of road the vehicle is currently on.

Based on the dataset we have successfully exacted the type of road the vehicle was on on the time of the incident (*Fig 8*).

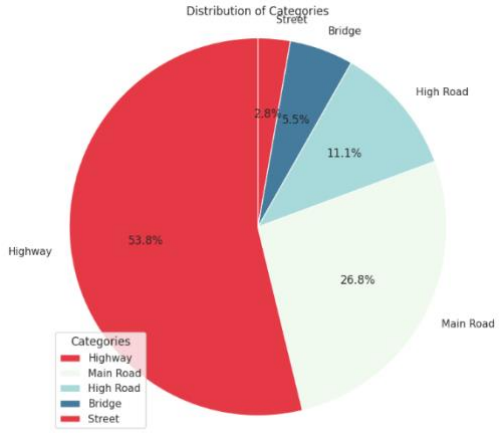

Fig 8. Distribution of road type when alerts were registered.

State roads - **37.9%** were further divided into:

High Road	11.1%
Main Road	26.8%

With these insights, road safety can be bought into order, for example, Traffic rules and fines be heavily imposed on Highway and police patrol also be increased on Highway to monitor the unregulated speed and unsafe lane changes.

Using these insights, we can view the distribution of Alert type based on the route it was currently on (*Fig 9*)

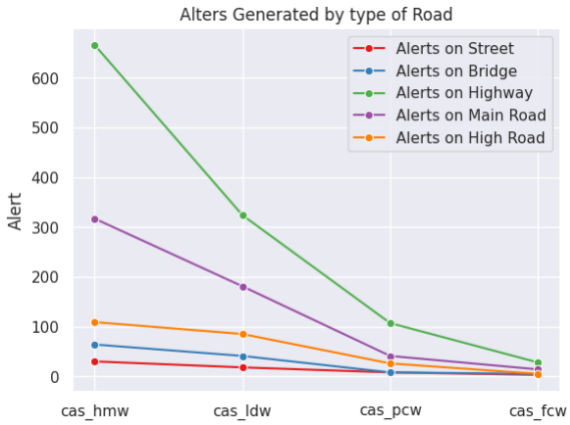

Fig 9. Alerts generated by road type.

Notice how well the Road distribution and Alter Generated line graph compensate each other.

Highway's Alter contributes –

~ **30%** in Headway Monitoring Warning

~ **52%** in Lane Departure Warning

~ **20%** in Pedestrian Collision Warning

~ **9%** in Forward Collision Warning

V. Conclusion

In conclusion, this study highlights significant opportunities for improving road safety without delving into specific technical details. By examining unusual incidents, refining safety systems, considering time-related factors, and studying incident locations, we offer practical strategies for enhancing road safety. These insights can guide policymakers and industry stakeholders to prioritize safety measures more effectively, ultimately reducing accidents and ensuring safer roadways. This research provides a roadmap for doubling the impact of road safety initiatives, fostering a safer transportation environment for everyone.