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Research Article

An Enhanced AODV Routing Strategy for Secure Communication in VANET

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Abstract

Transportation is a cornerstone of every nation's economy. Unfortunately, traffic accidents cause various problems to the government. The significant drivers of fatal accidents, serious injuries, and fatalities are diverse. The type of roads, track structure, climatic conditions, and driver behavior are some of the relevant factors studied, and the report identified.

There are nine explanatory variables identified from the data file suitable for analysis, like weather conditions, driver behavior, vehicle type, age of the vehicle, road type, road structure and location of the crash, timings of impact, and month vice categorization impacts. The median of the predictor variables is calculated to understand the collision configuration. The type of roads, track structure, climatic conditions, and driver behavior are some of the relevant factors that are investigated and the relationship identified. This paper examines the leading causes of accidents from road accident registers. It provides an enhanced AODV routing protocol to provide a secure route to transmit the data packets from the vehicular node source to the destination.

Keywords: VANET, Routing, AODV, Data packets

1. Introduction

Vehicular adhoc network (VANET) [1] introduces one of the challenging categories of MANET[2]. Some of the challenges are following.

a. Mobility[3]: The vehicle nodes travel very quickly. As a result, there is a very common network partition.

b. Scalability[4]: Because of traffic on the roads, it is possible that vehicle nodes can create an extensive network.

c. Routing protocol[5]: Because of the frequent network partition, there is no fixed route for communication.

d. Security[6]: There is still a threat of assault. Incorrect information in the system can affect drivers. Attacks can destroy diversions, so central nodes cannot know important information.

VANETs is an essential service for every nation. The whole thing will be smothered if the traffic is blocked. Therefore, the government of any country invests heavily in making the transportation system effective. On the other hand, the government also supports recovering the damage caused by road accidents. Aproximately 1.3 million people die, and about 20 to 50 million people are injured each year due to motor vehicle accidents this data is taken from World Health Organization (WHO)[7]. Furthermore, death due to accidents are the major cause in between the age group of 5 and 29.

The number of motor vehicle accidents, injuries, and deaths has increased significantly recently. Road accidents have proven to be a public problem, and mortalities come from every segment of society.

These deaths are caused by many factors involving road design, the behaviour of road users and vehicle operators, so road safety requires a comprehensive approach to addressing causes and deaths. Unfortunately, accidents are not often caused by ignorance but by recklessness, recklessness, and overconfidence. William Haddon (responsible for the Road Safety Agency in the United States) pointed out that road accidents are associated with many problems, each of which must be dealt with separately.

Road accidents have increased by about 8% per year over the last decade and show no signs of falling. [8] He also explained crash models and different factors such as the time of day, Cities vs. Rural regions, age, and gender of road users. In 2017 highest number of road accidents are recored in Tamil, but in Uttar Pradesh the highest number of persons killed in a road accident. Tamil Nadu, Maharashtra, Gujarat, and West Bengal ave experienced significant reductions in road accidents and fatalities in 2017. But Uttar Pradesh and Bihar performs worst n the number of road crashes and fatalities in 2017 as compared to 2016 (Road safety department report, 2017)

Information on the avoidable causes of road accidents is needed to improve road safety. Therefore, traffic accident police reports are the main source of data used to inform traffic accident research and policy.

The relative risk of crash increased on roads and adverse weather conditions; however, there was freezing rain, slippery roads and very slippery roads. When comparing the relative crash risk based on road type, the results showed that the uncertainty in poor weather was higher than two-lane and multiple-lane roads even though the overall risk was lower on highways. Furthermore, the corresponding relative accident risks were generally higher for accidents involving a single vehicle than for more than one vehicle.

Motor vehicle accidents are multi-faceted events. It involves the interaction of cars, road users and the road environment. The road environment includes the design, type of road, road condition, weather, etc. However, road safety is an area neglected in Indian research; therefore, it is always concluded that driver misconduct is the main cause of most road accidents.

The relatively low usage of safety devices such as helmets, seat belts and child restraints has been identified as an important factor. Even in situations where corresponding legislations are present, the enforcement has been found to be weak with limited knowledge of the safety benefits among road users, as shown in a study.

Driving under the influence of alcohol is widespread in India, and alcohol increases deaths and injuries on the roads. Nearly one-third of accidents occur at night and one-third involve alcohol. Approximately 20 to 30 per cent of injured patients are taken to hospital between 7:00 pm. and 7 a.m. tested positive for drinking. 2 to 33 per cent of those injured and 6 to 48 per cent of those killed used alcohol or drugs.

2. Literature review

This study is based on secondary data on road crashes that are classified as fatal, serious, and non-fatal. The crash frequencies on multiple explanatory variables are examined to understand the pattern and frequency of injuries on various dimensions like time, type of road, weather condition, cause of the crash, nature of the collision, location of impacts, location, type of vehicle, age of the vehicle, etc. A seven-year analysis of data from 2012 to 2018 is conducted to identify the seriousness of the phenomenon and its growth profile.

A seven-year road safety service dataset is used to examine the type of road accidents for different reasons. The data were classified according to several parameters like the age of the vehicle, the kind of road, the kind of vehicle, the time interval, the type of weather conditions, etc. In addition, the existing dataset has been reorganized to allow for meaningful analysis.

Nine explanatory variables were identified (Table 1) in the data file subject to analysis. There are nine explanatory variables:

S.No.	**Explanatory variables**	**Explanation**
1	Month by month data for: Fatal (F) Grievous injury (GI) Killed (K)	Fatal refers to a serious injury where the person may be in comma form. A severe injury is an indication of a broken bone or tooth. Killed is an indication of death.
2	Time segments in a day (Rural & Urban – Hour wise)	The time of a day is divided into sections of 3hrs, from 6h. It will be segmented as 6am to 9 am, 9 am to 12 pm, and so on.
3	Type of road (express, national, national and other	In India, roads are divided by property and features. The route that are made for the perplexity of rapid motion are

	roads.	known as the highway. The highways that are regulated by the states are the highways of the state. The road that the central government controls is known as national roads.
4	Road Structure	A typical road type such as T-Junction, Y-Junction, etc.
5	Type of vehicle	Vehicle types include two wheels, three wheels, four wheels, trucks, etc.
6	Age of vehicle	Age of the vehicle according to the production date.
7	Weather Condition	Weather may be clear, rainy, stormy, etc.
8	Driver behavior at a time on driving	It includes driving on the wrong side, drinking alcohol, emergency driving, etc.
9	Location of incidence	Few areas were identified, such as in close proximity to hospitals, a bridge, etc.

Table-1 (List of explanatory variables)

To observe the collision trend each month, we compute the median of the explanatory variable. It also provides an understanding of the configuration and variables that must be targeted by the Road Safety Department so that the impact of such accidents can be optimally reduced. These 9 X 9 matrices allowed us to understand the accident frequency for various variables better. This dissection of the data makes it possible to see the configuration and growth of accidents.

3. Analysis and Interpretation

The analysis are represented using graphs. These graphs are interpreted as follows. The analysis is done for every month. The median is calculated for every month for the year from 2012 to 2018.

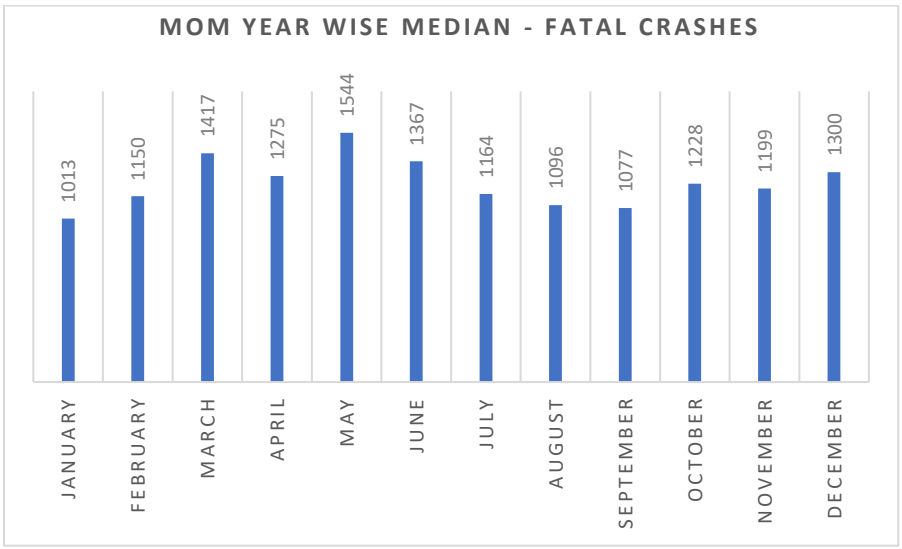


Figure-4.0 (month over month –median fatal crashes)

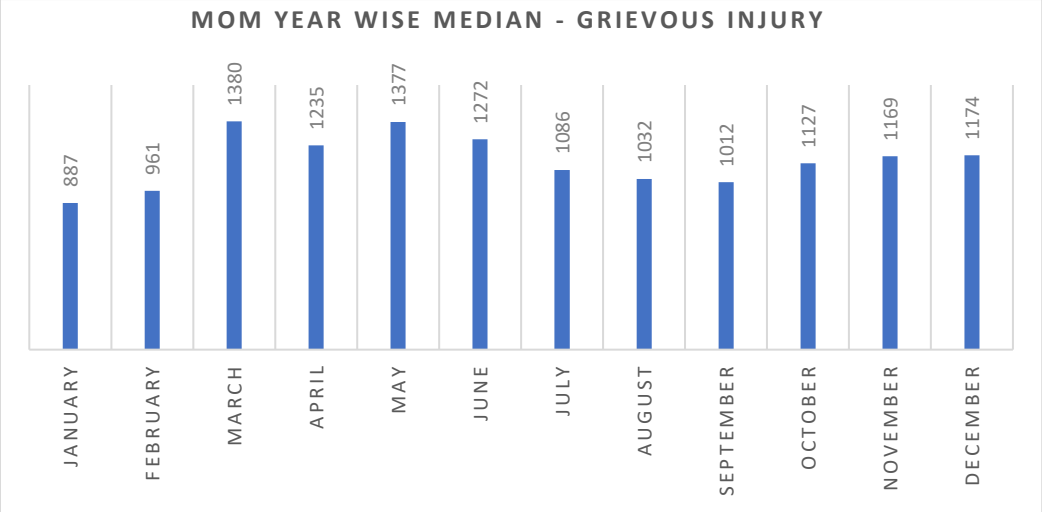


Figure-4.1 (month over month median of Grievous injury)

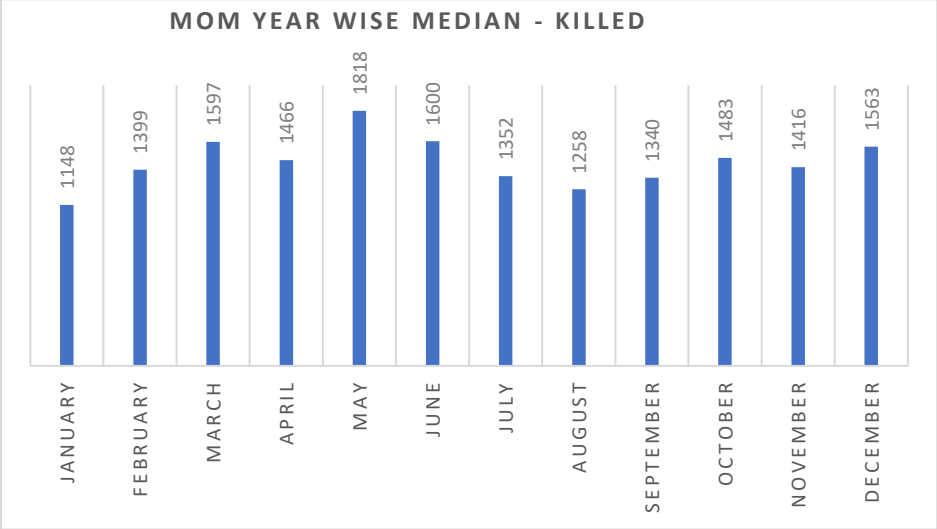


Figure-4.2 (month over month median of fatal crashes)

Figure (4.0, 4.1 and 4.2) shows the number of deaths, serious deaths and deaths per month, respectively. It can be observed that the highest rate of fatal crashes are in the month of May (1544, 10.2%). The high degree of grievous injury is again in May (1377, 10.4%) and June (1272, 9.3%). The month of March also shows a high rate of grievous crashes (1380, 9.3%). The total number of deaths due to collisions are the highest in May (1818, 10%) and June (1600, 9.4%), followed by March (1597, 9.1%).

However, the minimum number of fatal crashes (1013, 6.9%), Grievous (887, 6.7%), and Deaths due to collisions (1148, 6.8%) registered in January month.

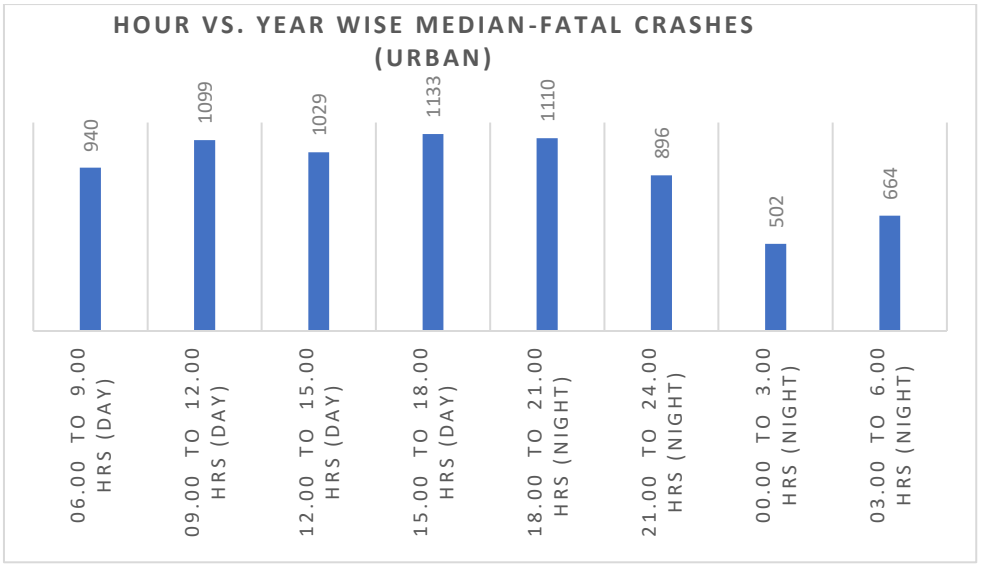


Figure-5.0 (Fatal in crashes at time segments at 3 hrs interval)

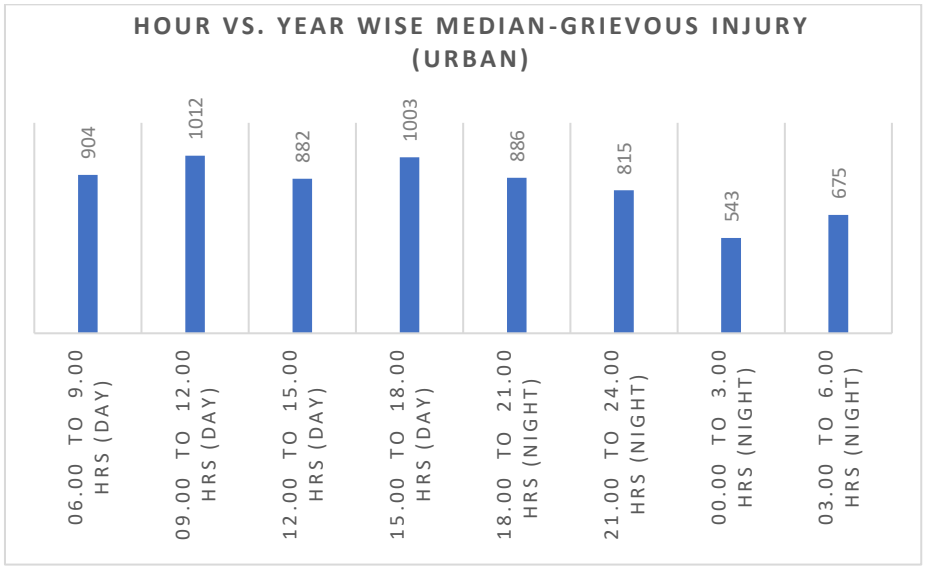


Figure-5.1 (Grievous injury in crashes at time segments at 3 hrs interval)

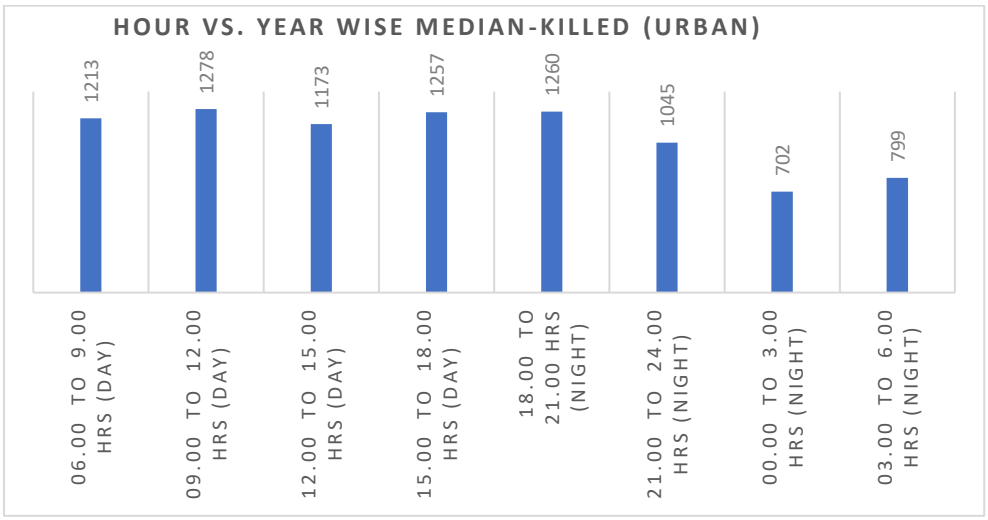


Figure-5.2 (Killed in crashes at time segments at 3 hrs interval)

Figures 5.0, 5.1, and 5.2 show median values of fatal, grievous, and killed in crashes at time segments at 3 hrs intervals for urban areas. The figure shows a high rate of fatalities, serious and caused by accidents vs. time segments distributed across each 3-hour segment. It can be observed that the high frequency of fatal crashes is during between 3 pm-6 pm (1133) and 6 pm-9 pm (1110) followed by 9am-12 pm (1099) whereas the minimum no. of fatal crashes are between 12 Night to 3 am (502) and 3 am-6 am (664), Grievous (543 between 12 night to 3 am, 675 between 3 am to 6 am). The deaths due to crashes were found ((702 (12 night to 3 am), and 799 3 am-6 am)).

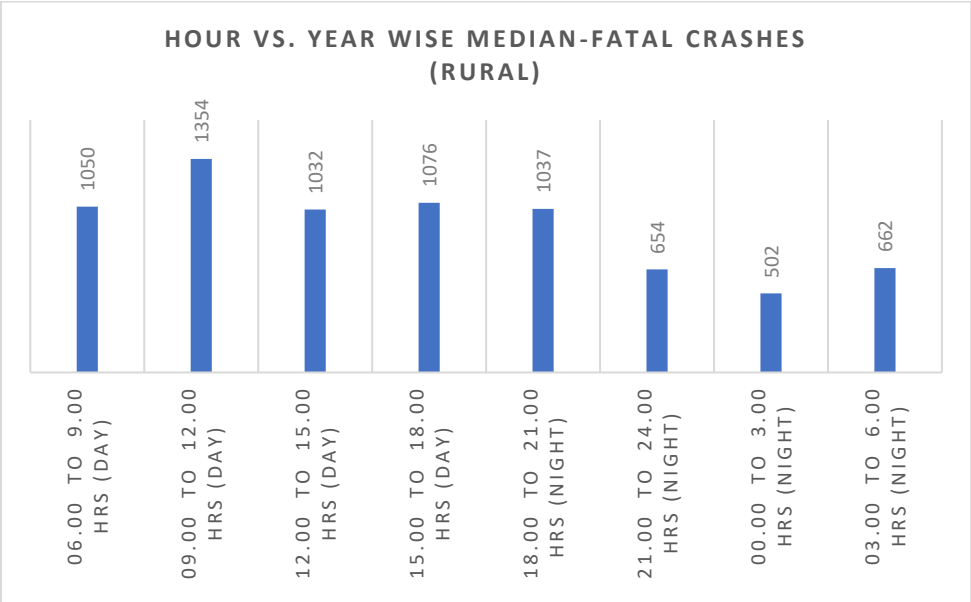


Figure-6.0 (Fatal in crashes at time segments at 3 hrs interval)

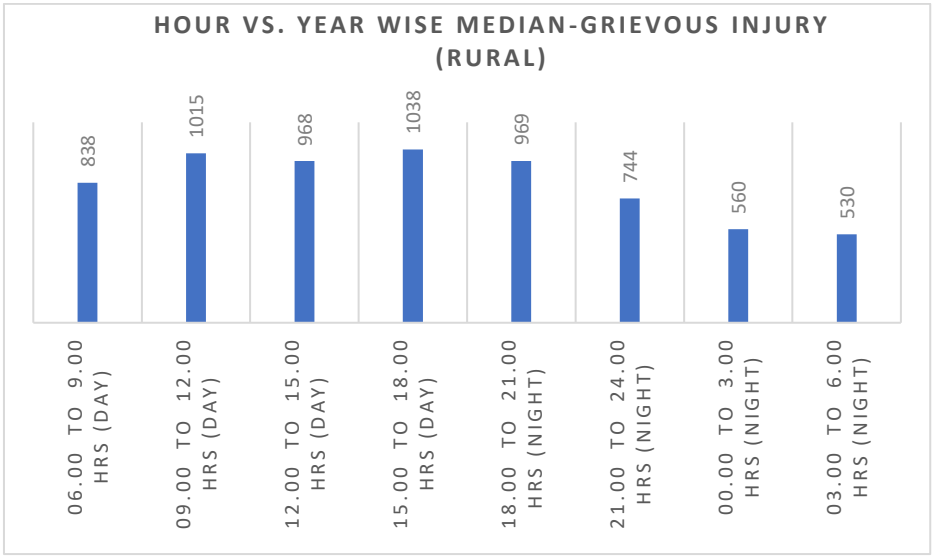


Figure-6.1 (Grievous injury in crashes at time segments at 3 hrs interval)

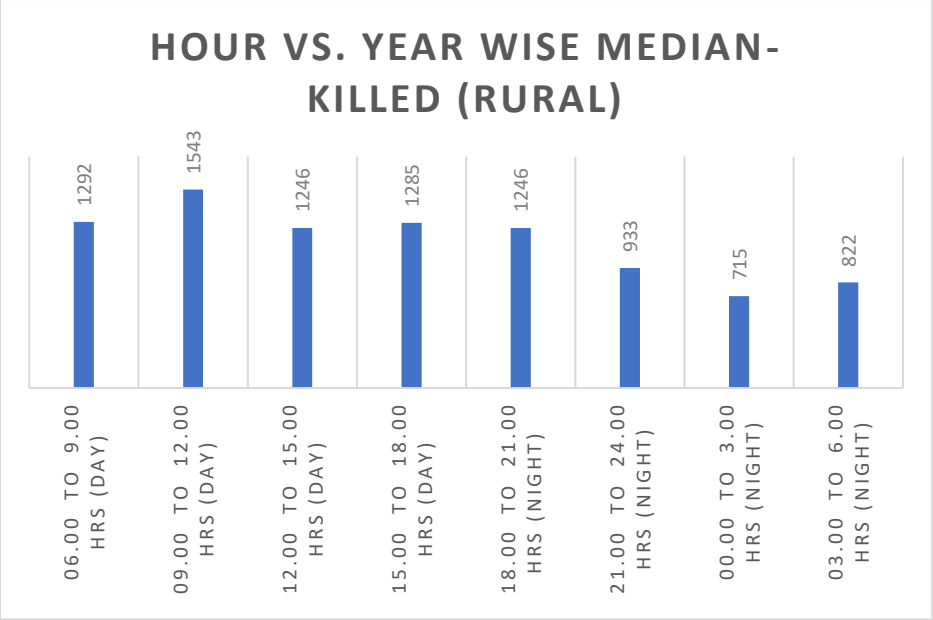


Figure-6.2 (Killed in crashes at time segments at 3 hrs interval)

In similar way figure 6.0, 6.1 and 6.2 shows median data of fatal, grievous and killed in crashes at time segments at 3 hrs interval for rural area. The figure shows a high rate of fatal, severe and accidental deaths relative to the time segments divided in each 3-hour segment. It can be observed that the high frequency of fatal crashes is during between 9 am- 12 pm (1354). High frequency of Grievous (1038 between 3 pm to 6 pm, 1015 between 9 am to 12 pm). The deaths due to crashes were found ((1543 (9 am- 12 pm), and 1285 (3 pm to 6 pm)).

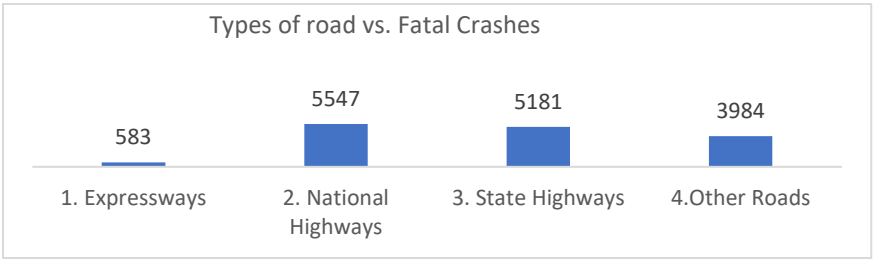


Figure-7.0 (Fatal in crash frequency vs. type of road)

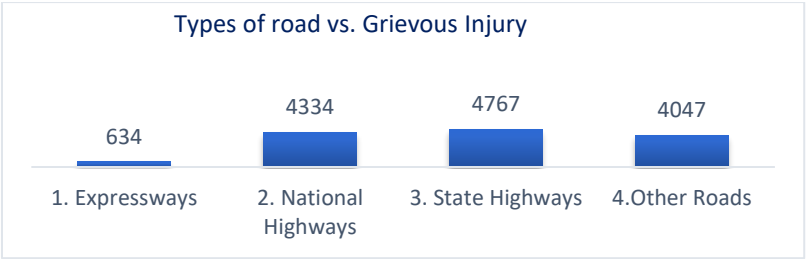


Figure-7.1 (Grievous injury in crash frequency vs. type of road)

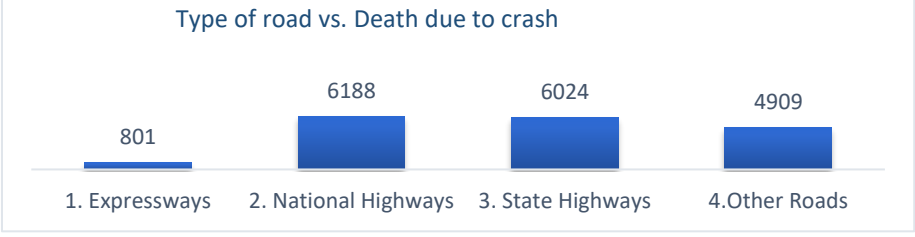


Figure-7.2 (Killed in crash frequency vs. type of road)

The figure above indicates that the high accident rate occurs on national motorways (5547) and state motorways (5181), while the minimum number of collisions occurs on expressways (median-583). There is a similar pattern in serious injuries and fatalities caused by collisions. The median case of serious injuries (4,767) on state and national roads (4,434) and the lowest on expressways (634).

The median fatalities due to accidents are highest in national highways (6188) and state highways (6024), and the least in expressways (801).

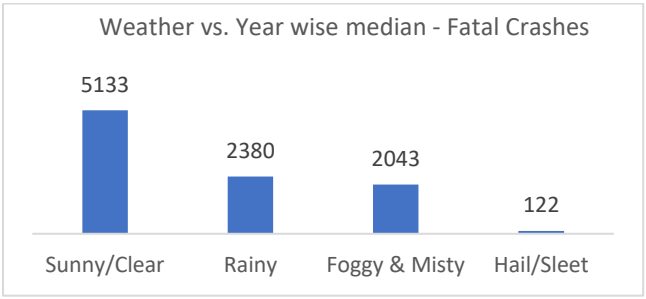


Figure-8.0 (Fatal crashes in different weathers)

Figure 8.0 shows fatal crashes vs. weather conditions. It can be observed that the maximum number of fatalities

occurred in sunny and clear conditions (5133), followed by the rainy season (2380) and fog (2043).

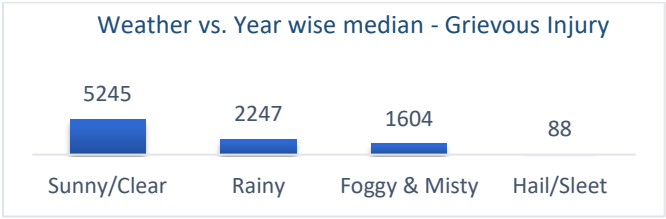


Figure-8.1 (Grievous crashes in different weathers)

Figure 8.1 shows grievous crashes vs. weather conditions. A similar trend is observed when maximum incidence occurs in bright sunlight (5245), followed by the rainy season (2247) and foggy and foggy weather (1604).

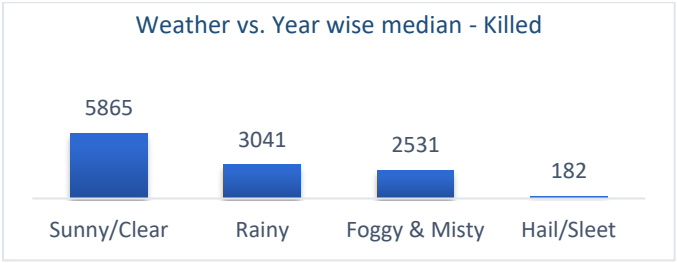


Figure-8.2 (Killed in crashes in different weathers)

Figure 8.2 shows killed in crashes vs. weather conditions. It can be seen that the maximum number of fatalities due to impacts occurs in clear weather (5,865) compared to wet and misty weather (3,041).

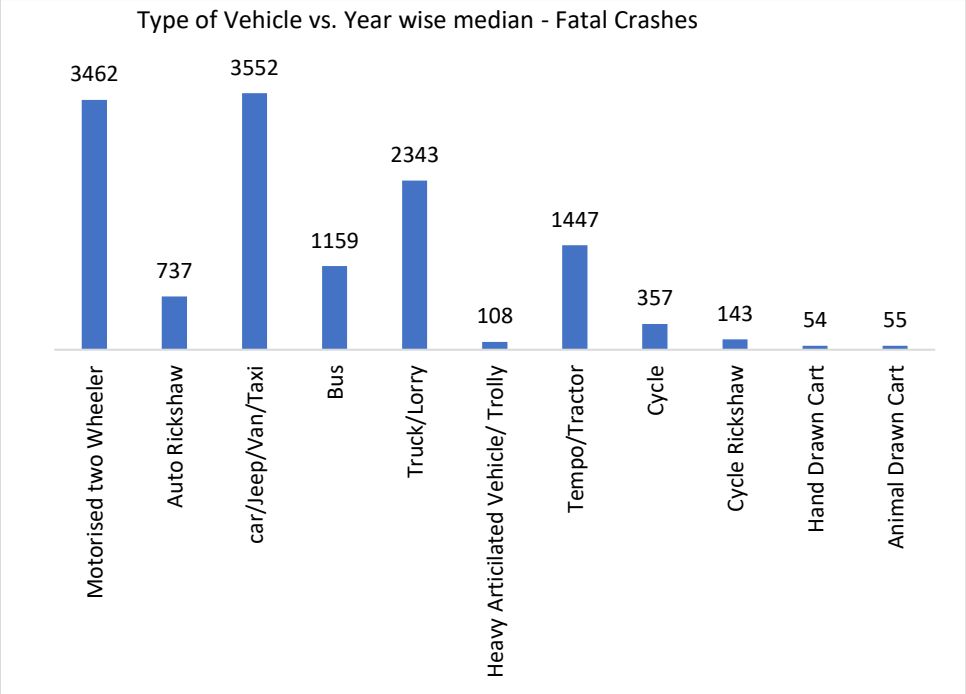


Figure-9.0 (Fatal in crashes in a different type of vehicles)

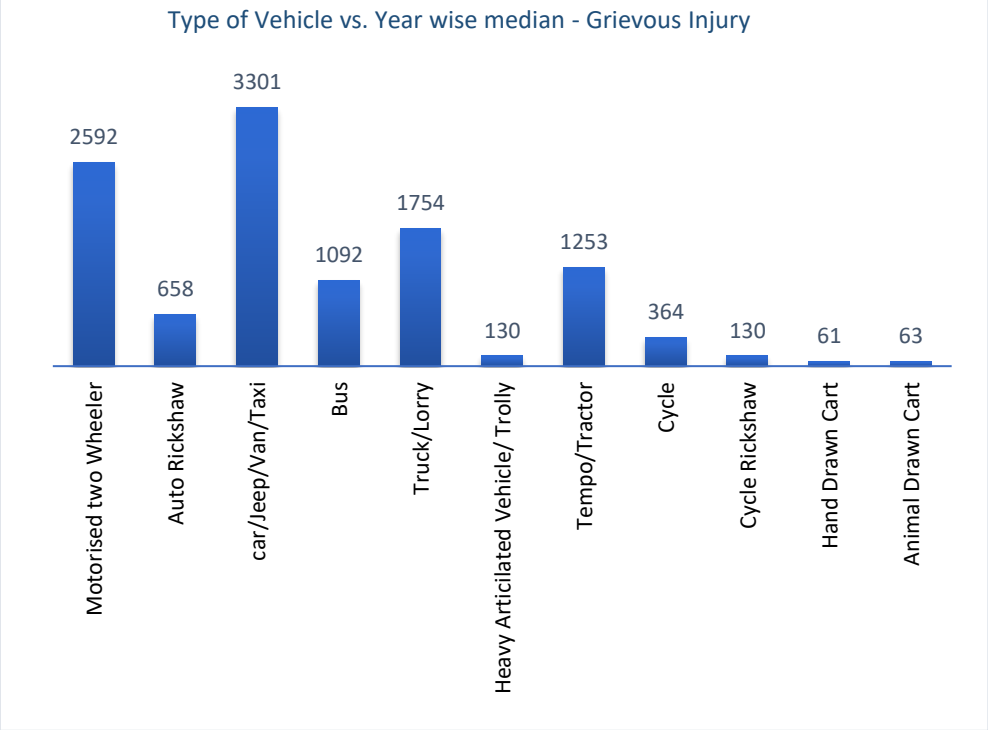


Figure-9.1 (Grievous in crashes in a different type of vehicles)

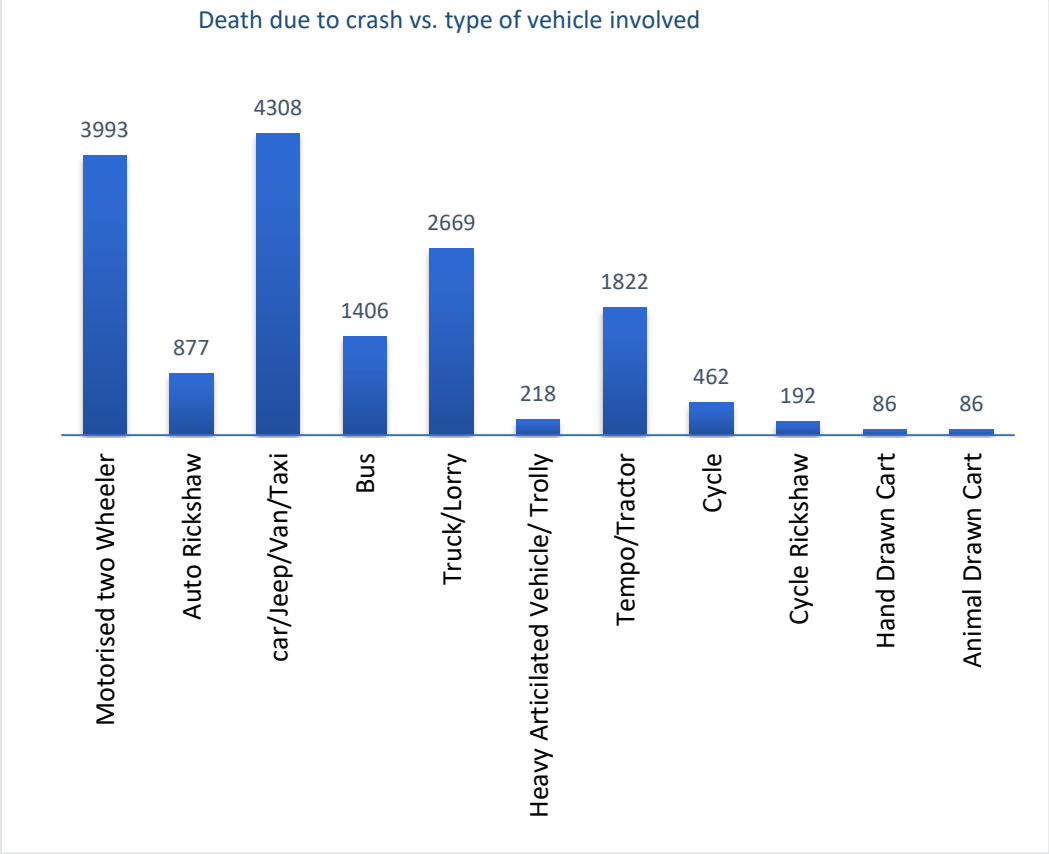


Figure-9.2 (killed in crashes in a different type of vehicles)

Figure 9.0 shows fatal in crash frequency analysis vs. the type of vehicles. The median value of fatal in car/jeep/Van/Taxi (3552) is maximum. The other vehicles like motorized two-wheelers (3462), Truck and Lorry (2343), and tempo/Tractor (Median-1447) are also having high values for the median. The fewer crashes and types of vehicles involved are hand-drawn cart (median -54), animal-drawn cart (median-55), heavy articulated vehicles (median- 108), and cycle rickshaw (median-143). The inference could be that high-speed vehicles have more propensity for fatal crashes than slow-speed vehicles. A similar pattern is observed in the case of Grievous injury cases (figure 9.1), which is further followed in the case of deaths due to crash cases (figure 9.2).

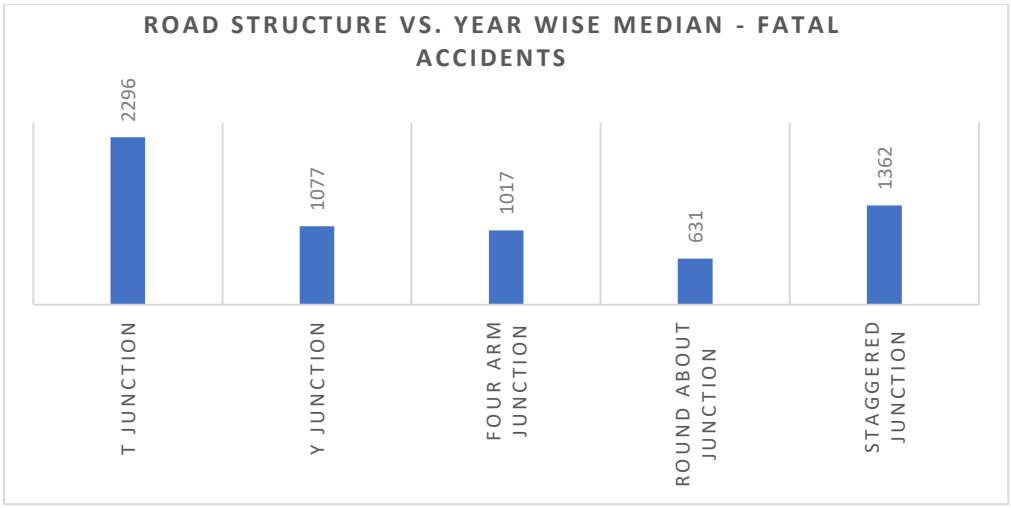


Figure-10.0 (Fatal in crashes vs road structure)

Figure 10.0 shows the graph between road structure and the median of fatal crashes during 2012-2018. The structure of roads are defined as:

- T-junction is the intersection of two roads that forms a T like structure,

- Y- Junction is the intersection of three streets that includes a Y shape structure,
- Four arms junction is the intersection of four roads,
- Roundabout junction is a point where multiple paths converge, and a circle is formed to change the direction for commuters,
- The offset crossing is a specific type of intersection within a highway system. Two traffic flows can be discerned in the staggered junction: one is the traffic flow on the main road, whose traffic volume is higher, and the other is that on the minor way, which is crossing the mainstream of traffic.

It can be observed that the maximum crashes occurred at T-junctions (2296) followed by a staggered junction (1362), Y-junction (1077), four-armed (1017). On the other hand, the frequency is less in roundabout junctions (631).

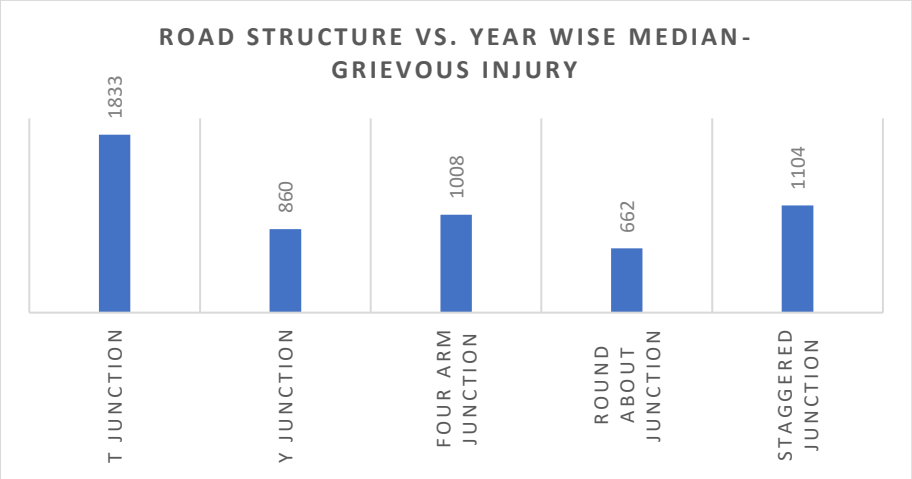


Figure-10.1 (Grievous injury in crashes vs. road structure)

Figure 10.1 shows a similar pattern for serious impact damage. Thus we can say the focus point to minimize such collisions is to have a traffic control mechanism on T-junctions and staggered junctions more.

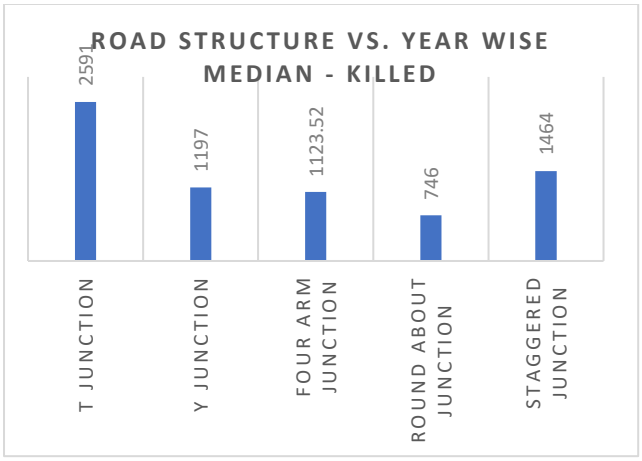


Figure-10.2 (Killed in crash vs. road structure)

It can be observed in figure 10.2 that the deaths due to crashes are not an exception and follow the same pattern as in the case of fatal and grievous injury cases.

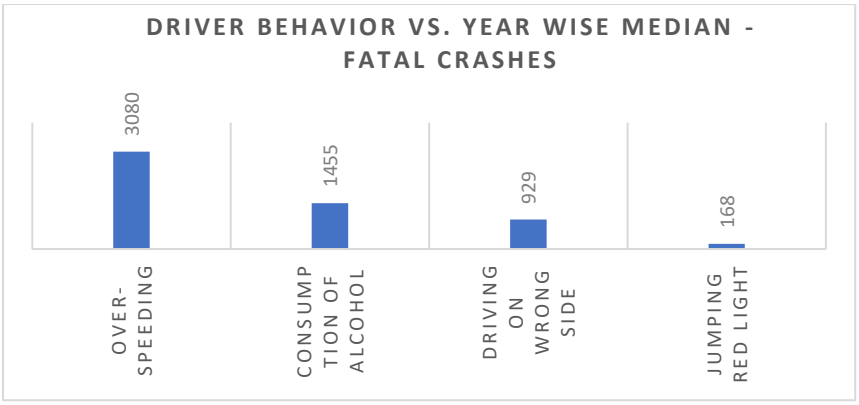


Figure-11.0 (Driver behavior Vs Fatal crashes)

Figure 11.0 shows the median of fatal crashes from 2012-2018 due to driver's behavior. The analysis of impacts occurrence vs. behavior of driver reveals that the maximum crashes happened due to over-speeding (median-3080) followed by consumption of alcohol (median-1455) and driving on the wrong side (median- 929) in a fatal case of crashes. Refer figure (11.0)

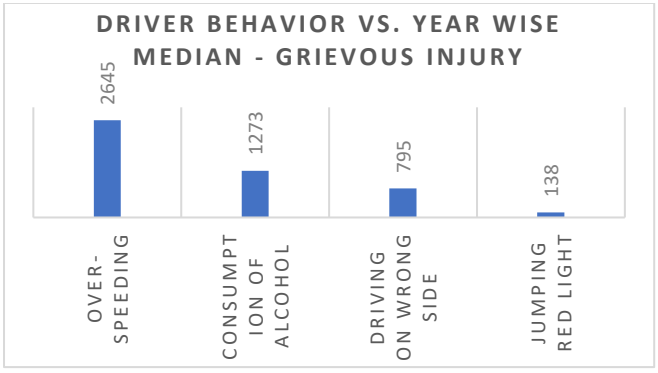


Figure-11.1 (Driver behavior Vs. Grievous injury)

A similar trend is observed for severe injuries, as shown in Figure 11.1. Over speeding, consumption of alcohol, and driving on the wrong side cause more painful injuries.

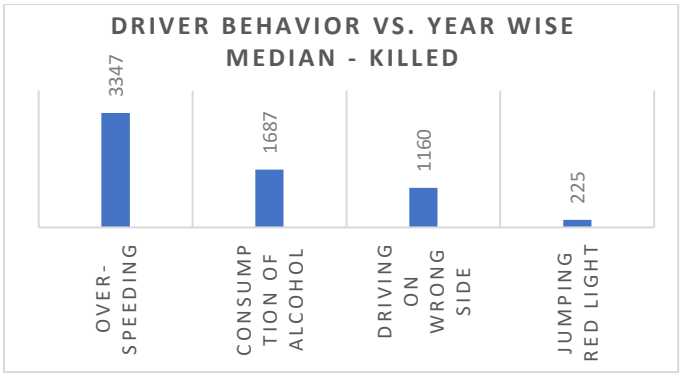


Figure-11.2 (Driver behavior Vs. killed in crashes)

Figure 11.2 shows the person's median died during the year 2012-2018 due to driver behavior. The more people killed due to overspeeding and alcohol consumption compared to driving on the wrong side and jumping red lights.

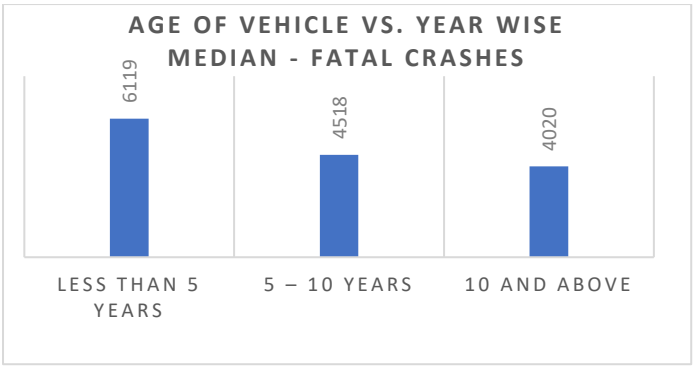


Figure-12.0 (Age of vehicle Vs Fatal crashes)

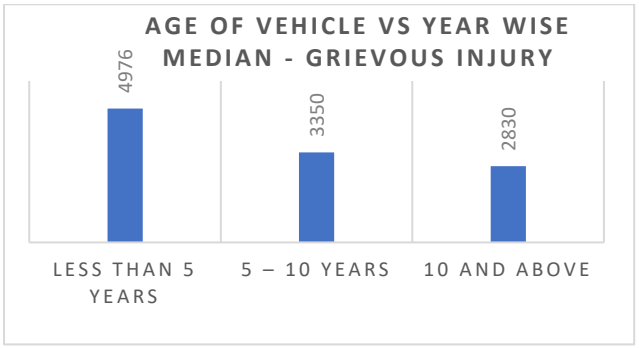


Figure-12.1 (Age of vehicle Vs Grievous Injury)

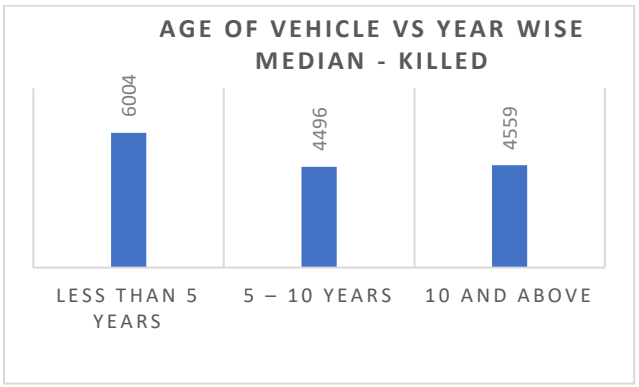


Figure-12.2 (Age of vehicle Vs. Killed in the crash)

Figure (12.0, 12.1, and 12.2) shows the median value of fatal, grievous, and killed in crashes during 2012-2018 due to vehicle age. New vehicles (under 5 years old) present a high risk of collision compared to older vehicles. This may be because modern vehicles can be quick get-up-and-go. Nearly all parameters, speed has a direct or indirect relationship to the type of crash.

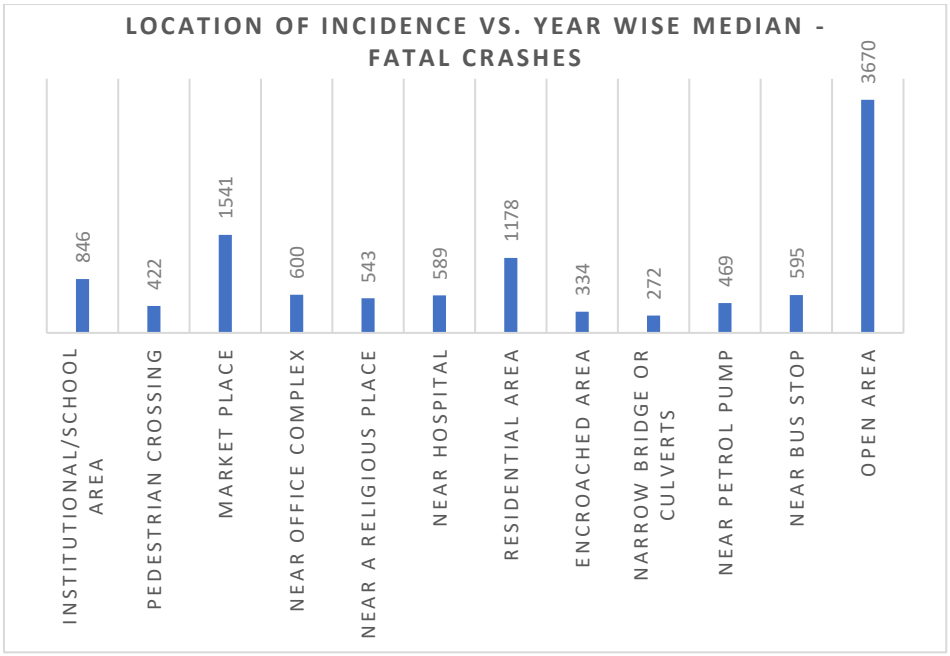


Figure-13.0 (Location of vehicle Vs Fatal crash)

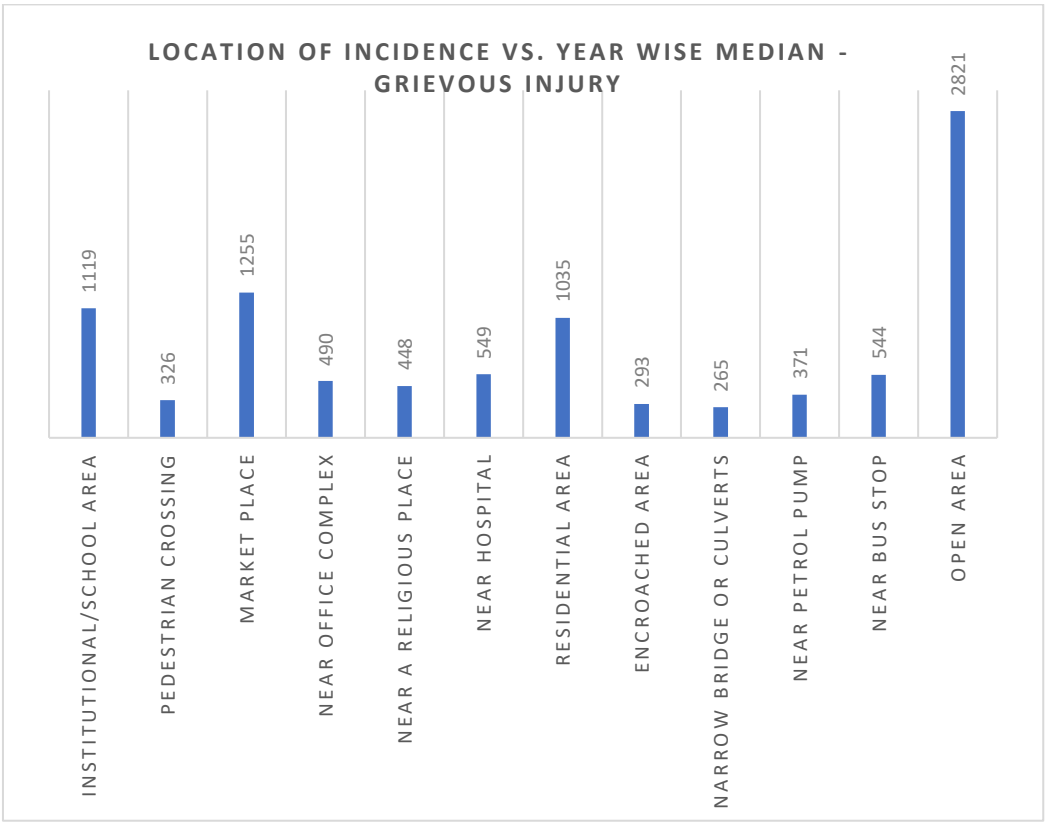


Figure-13.1 (Location of vehicle Vs. Grievous)

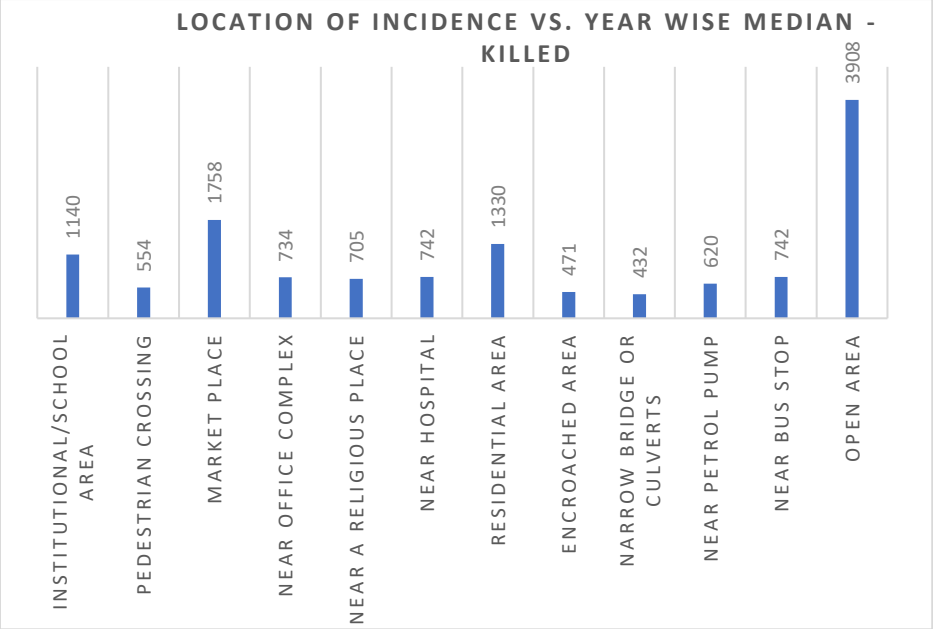


Figure-13.2 (Location of vehicle Vs. Killed in the crash)

It can be observed in figures 13.0, 13.1, and 13.2, the high incidences of fatal crashes are in open areas (Median 3670) followed by market area (median- 1541), residential areas (median -1178). On the contrary, the low incidence rate is near narrow bridges (median – 272), encroached areas (median – 334). The low rate of incidences is also observed in pedestrian crossing (median- 422), near petrol pumps (median- 469), near a religious place (median- 543), and hospitals (median – 589). This may be due to proper signage and marking in these areas, and people may be conscious when driving near hospitals, but the incidence is not less near institutions and schools.

The more vulnerable location for crashes is the Open area, near or inside the village, in Bazaar, and near the residential field. The higher frequency in the open space is the speed of vehicles in the open is high, and that's why the probability of crashes goes up. Bazaars are crowded, and people do not follow traffic rules, and thus crashes occurs. A residential area is also found prone to such happenings. The crashes are less near office area complexes, Hospitals, religious places, and recreational places (Cinema complex). It may be due to proper guidelines of vehicle movement, and people are also aware of driving cautiously—signboards for safe driving near such places also valuable for controlling such incidences.

The relationship between the age of vehicle and frequency of road crashes is found if the vehicle is new (1 to 5 years old) or a vehicle is more than ten years old, the probability of a collision is high.

The nature of crashes analysis reveals that crashes' maximum incidence is overturned (on T-junctions and Staggered junctions). This may be due to poor vision on such intersections and the driver not accessing the other side vehicle movement. The speed barkers and traffic lights can reduce such incidences on such junctions.

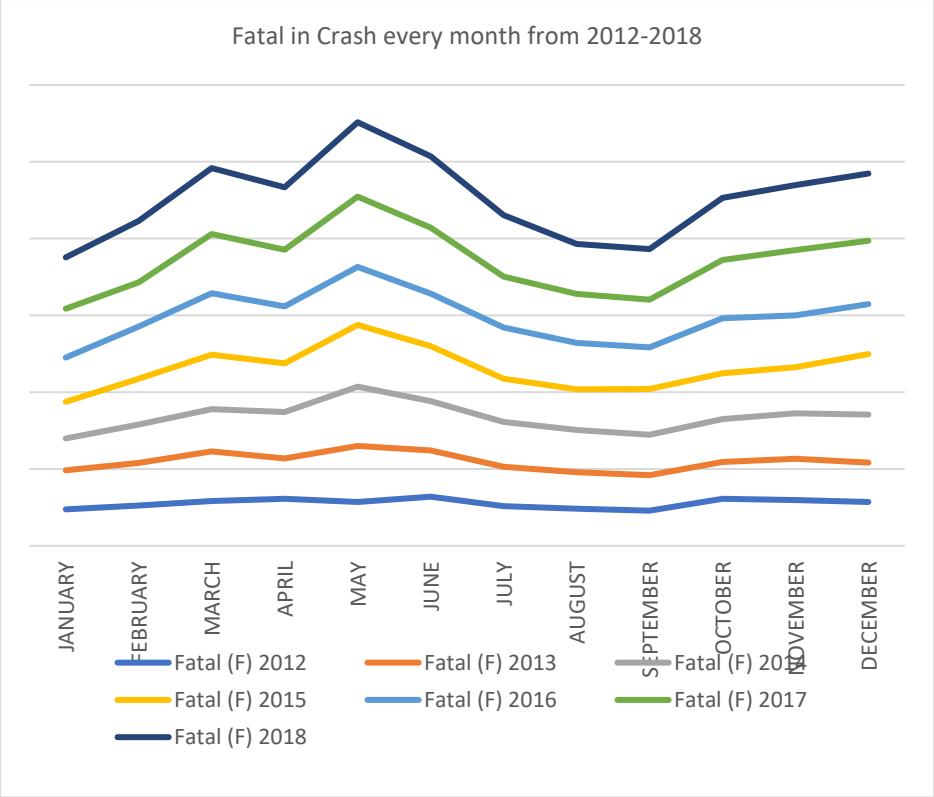


Figure-14.0 (Fatal in Crash every month from 2012-2018)

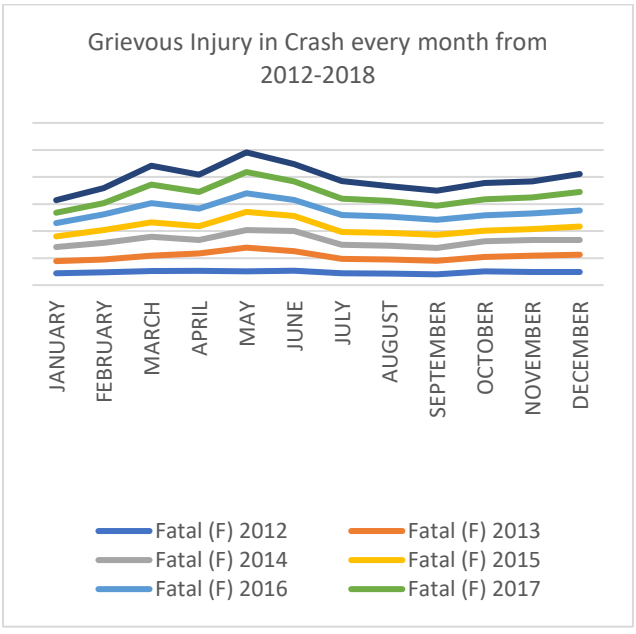


Figure-14.1 (Grievous in Crash every month from 2012-2018)

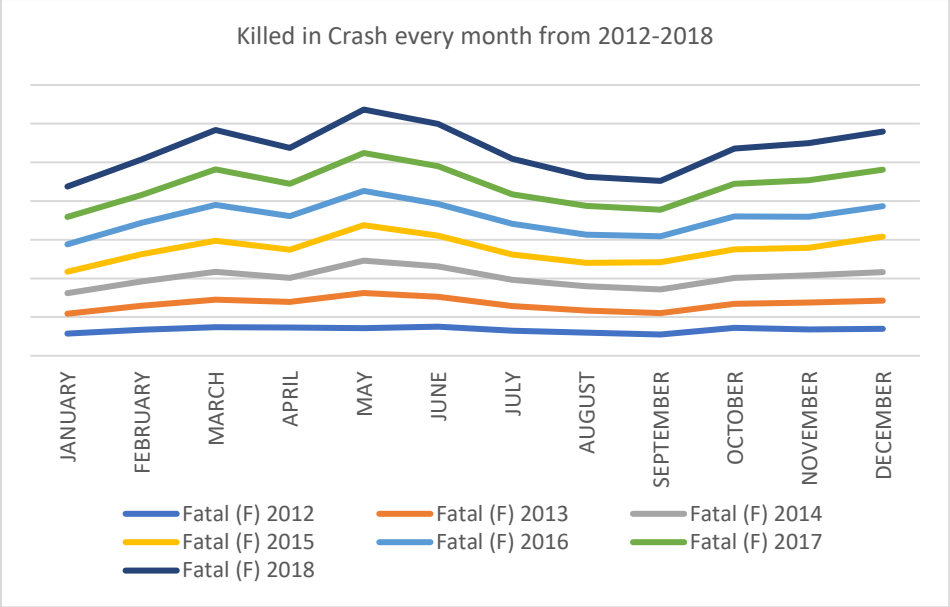


Figure-14.2 (Killed in Crash every month from 2012-2018)

Figure 14.0, 14.1 and 14.2 shows the plot of total fatal, grievous and killed in every month in each year from 2012 to 2018. In the figures, the number of crashes increased every year, and it was maximum in 2018. The second observation for all the cases is, the impacts are maximum in May.

This study shows a serious issue regarding crashes every year. That's why an action plan is needed to improve the situation and a new security mechanism, is required to send the data packets from sender to vehicular receiver nodes in a secure manner.

4. Proposed Protocol

The proposed routing protocol is an enhancement over the AODV[9,10] routing protocol. The AODV Routing Protocol and Proposed Routing Protocol stream is as follows:

Discovery of the road: the discovery of the road is upon demand. Each time the sender needs to send a packet, it launches a Route Request Packet (RREQ) through the broadcast. RREQ contains the source address, source sequence, broadcast ID, destination address, destination sequence, and hop count. Each neighbor that has the destination address sends an RREP response to the sender. Nodes may be able to accommodate multiple requests. RREP creates an inverse path when RREQ gets to the destination. The sender uses it to send packets.

Path Maintenance: AODV maintains the paths by regularly sending RREQ packets and sending hello messages.

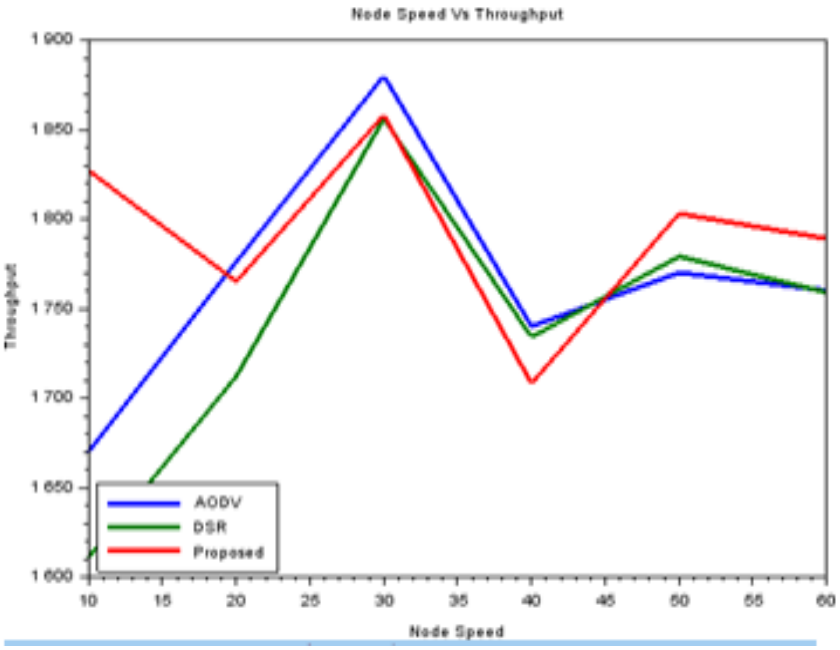
Demerits of AODV:

1. The sender releases the packets, creating unnecessary traffic. Nodes that do not have a destination address that also receives packets. 2. In fast-moving nodes such as vehicles, the route between the sender and the recipient changes frequently. In this case, the sender becomes busy with route maintenance. 3. In the event of a network attack, AODV has no escape mechanism. 4. If two nodes transmit a packet to the same node, there is a potential for collision. Then the data packet will be lost.

The proposed algorithm is the improvement of AODV that covers AODV demerits. The architecture of the suggested routing protocol is illustrated in Figure 2. S and D are the source and destination. A, B, C, E, F, G are the intermediate nodes between source and destination.

The algorithm is as follows:

Step 1: If (sender having packet)
Send packet to nearest node A
Step 2: If (Node A having destination address)
Transmit packet to Destination
Send acknowledgement to sender
Step 3: else (Node A doesn't having destination address)
Forward packet to next nearest node B
Send information to sender node about packet forwarding node
Step 4: if (Node B send acknowledgement)
Node A receives acknowledgement of B
Node A transmits acknowledgement to previous node
Step 5: else (Node B doesn't send acknowledgement)
Node A forward packet to next nearest node C
Wait for acknowledgement of C
Send information to sender node about packet forwarding node
Step 6: if (Node A didn't get acknowledgement from further nodes)
Send information to sender to change the route
Report about the attack or malicious activity in network
Step 7: Sender node again transmits the packet to nearest node except node A



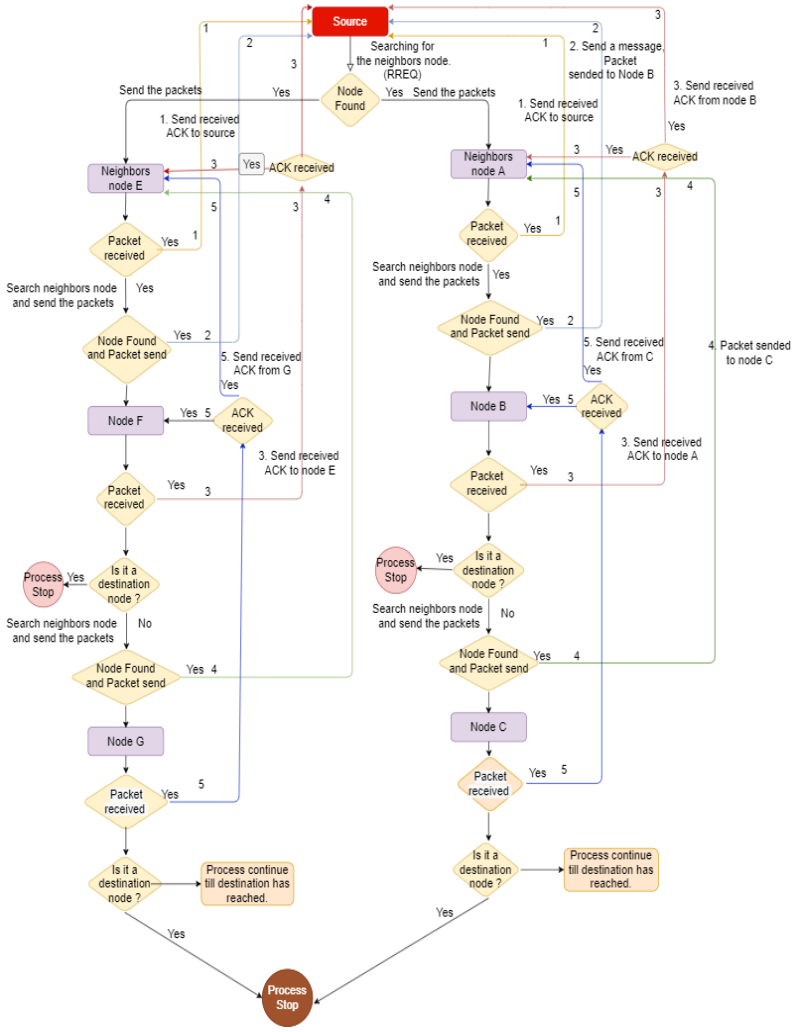


Figure:15 Data Flow Diagram.

5. Implementation and Results

The suggested routing protocol is implemented on NS-2[10]. Simulated parameters are presented in Table 2.

Simulated parameters are presented in Table 2.

• **Terrain**	Coordination 2500 * 2500 m
• **Physical layer parameters**	Data rate: 2Mbps Packet reception model
• **MAC Protocol**	802.11
• **Routing Protocol**	P-Routing (Proposed Routing), AODV, DSR
• **Transport Protocol**	TCP
• **Number of Node**	20
• **Node Placement**	Manual according to street structure
• **Speed of Node**	10 mps, 20 mps, 30 mps, 40 mps, 50mps, 60mps
• **Pause time**	15s.
• **Connection**	FTP (File transfer protocol) Item size 512(byte)

Table 2:- Simulation parameters.

Figure 17: graph plot between throughput vs. node speed

This figure reflects the Proposed comparison study between Proposed Routing protocols, AODV and DSR[11] on the basis of Throughput and Node Speed. Then, depending on the proposed outcome, the algorithm works best when the speed of the nodes is minimal and maximum.

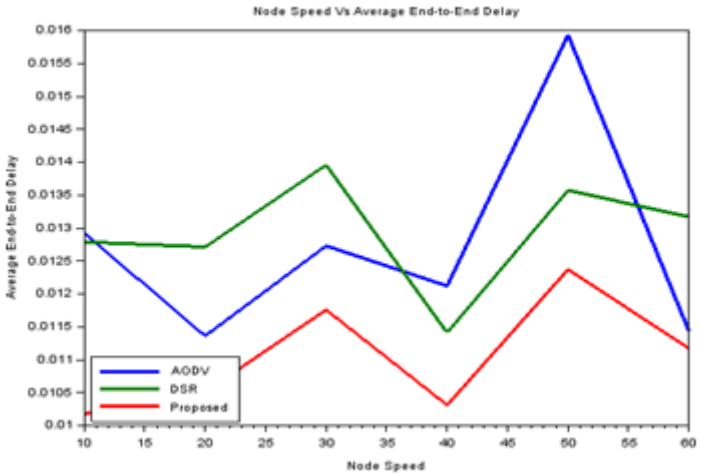


Figure 18: graph plot between average end-to-end delay vs. node speed.

Figure 18 shows that the comparison between the routing protocols on the basis of Average End-to-End delay and Node speed result shows that the Delay between the sender to receiver is becomes less of proposed algorithm with respect to traditional AODV and DSR. This means that the transmission rate is very high when using the available routing protocols. Even in all situations where the speed of the nodes is at least or maximum.

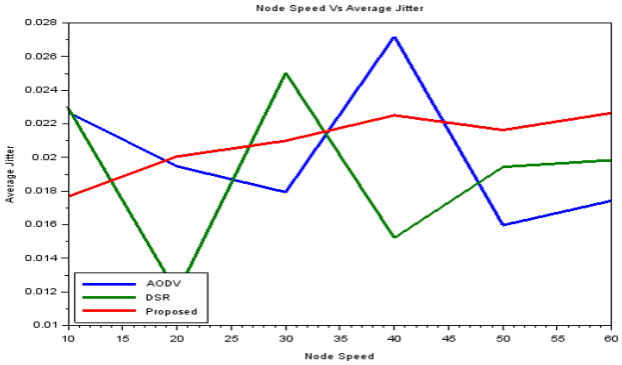


Figure 19: Graph plot between average Jitter vs. node speed.

In Figure 19, proposed routing protocols give a constant latency (approximately). This means that the proposed routing protocol gives no deviation to transmit the packets to the sender to the receiver. But in case of ADOV and DSR result, the large amount of deviation found when the node speed is in any condition i.e. it's maximum or minimum or in-between.

6. Conclusion

This paper analyzed the most common factors that result in accidents. In this paper, there are three types of accidents, fatal accidents, serious injuries, and fatalities due to collisions. It has been observed that the pattern of incidences is similar in all three types of crashes. May and June are expected to experience more accidents. This may be due to high temperatures and improper maintenance of vehicle tires and engines.

Similarly, the maximum incidence of crashes observed from 6 am- 9 am followed by between 3 pm-9 pm; usually, these are office hours, and people are in a hurry to reach their destinations. It was fascinating to observe that the maximum number of accidents occurs in precise, high-speed conditions. It's obvious when the weather is clean, people drive fast and cause casualties. This research has some limitations on the availability of comprehensive data, which can provide more detailed information on the causes of crash types. The routing protocol was implemented in NS-2 and simulated in a variety of environments. It can be seen in the results that the suggested routing algorithm can work better than AODV and DSR.

References

[1] Wai Chen "Vehicular Communications and Networks Architectures, Protocols, Operation and Deployment" 1st Edition, Woodhead Publishing 2015.

[2] PiyushChouhan,GirishKaushal,andUrmilaPrajapat,"omparativeStudyMANET and VANET". International Journal Of Engineering And Computer Science.2016.

[3] S. Smiri, A. Boushaba, R. Ben Abbou and A. Zahi, "Geographic and topologybased routing protocols in vehicular ad-hoc networks: Performance evaluation and QoSanalysis,"2018InternationalConferenceonIntelligentSystemsandComputer Vision (ISCV), Fez, 2018, pp. 1-8.

[4] B. Haider, S. Henna, A. Gul and F. Aadil, "A Survey on Mobility Management Techniques in VANETs," 2016 IEEE International Conference on Computer and Information Technology (CIT), Nadi, 2016, pp. 125-133.

[5] Zeadally, S., Guerrero, J. & Contreras, J. "A tutorial survey on vehicle-to-vehicle communications", Telecommun Syst 73, 469-489 (2020).

[6] C. Dai, X. Xiao, Y. Ding, L. Xiao, Y. Tang and S. Zhou, "Learning Based Security for VANET with Blockchain," 2018 IEEE International Conference on Communication Systems (ICCS), Chengdu, China, 2018, pp. 210-215.

[7] Mohan Dinesh (2009) IATSS Research volume 33 No.1.

[8] Road traffic injuries https: //www.who.int/news-room/fact-sheets/detail/road-traffic-injuries.

[9] A. Pandey, V. Deep and P. Sharma, "Enhancing ADOV routing protocol for Vehicular Ad Hoc Networks," 2018 5th International Conference on Signal Processing and Integrated Networks (SPIN), Noida, 2018, pp. 565-568.

[10] Baozhu Li, Yue Liu and Guoxin Chu, "Optimized AODV Routing Protocol for Vehicular Ad-hoc Networks", Mobile Congress(GMC) 2010.

[11] S. Mohapatra, P. Kanungo "Performance analysis of AODV, DSR, OLSR and DSDV Routing Protocols using NS2 Simulator", Procedia Engineering Volume 30, Pages 69-76, 2012.