



# FAULT ANALYSIS OF LIGHT MOTOR VEHICLES FOR ROAD SAFETY ENHANCEMENT

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## ABSTRACT

The invention of the wheel is considered one of the most significant scientific achievements to date. The utilization of wheels in vehicles has revolutionized transportation worldwide, providing unprecedented convenience and benefits to humanity. However, the ancient inventors of the wheel in 3000 BC could not have foreseen the tragic reality that modern wheels, as part of vehicles, would bear witness to the deaths of over a million individuals each year in road accidents. These accidents involve collisions between vehicles and accidents involving other road users. While a multitude of factors contribute to these accidents, this research primarily focuses on two main categories: driver errors and mechanical deficiencies. Driver errors account for nearly 70% of the total causes of accidents. Over speeding and poor overtaking are particularly significant contributors to driver-related accidents. Furthermore, mechanical faults in vehicles, such as defective brake or steering systems, play a substantial role in these incidents. Additionally, the inadequate road sense displayed by pedestrians, cyclists, motorcyclists, and animal-driven vehicles exposes them to increased vulnerability and involvement in accidents. Poor road conditions, characterized by narrow congested roads with potholes, wheel ruts, drop shoulders, and inadequate curves, also contribute to accident occurrences. Inadequate first aid and evacuation facilities further hinder the provision of immediate medical treatment, impacting the potential for early recovery and survival. The aim of this research is to address the technical (mechanical) factors contributing to road accidents and propose remedial measures to enhance road safety. By examining critical mechanical defects and deficiencies, this study seeks to minimize road accidents stemming from technical issues. Furthermore, through the analysis of survey data obtained from 161 accident victims, this research identifies driver errors as a prominent concern in road accidents, reinforcing the importance of addressing this issue for improved road safety.

**KEYWORDS: HEAT, TEMPERATURE, ROAD SAFETY**

## 1. INTRODUCTION

Road safety has always been a matter of great concern to mankind particularly after introduction of powered vehicles. Damage is being caused to human life by the vehicles moving with speed [1]. Summary of road traffic injuries was worked out worldwide by World Health Organization (WHO) in March 2013. Due to increase in power, speed, crash protection, height, and weight, quite a few of 4 wheelers moving on the road, this category of road goers has become highly vulnerable. Lot of fuel is wasted in speed driving and that increases the quantity of smoke on the road. Hardly any time is saved by speed driving, but the chances of accident and severity of accidents goes up [2-7].

In advanced countries, a single institution is often dealing with various agencies connected with road safety. Such agencies could be vehicle designers, road construction agencies, traffic police, transport authorities testing drivers and testing road worthiness of vehicles etc. In most other countries that includes India too; all these agencies work independently and pursue their own agenda with hardly any interaction with each other. The result is that road safety is adversely affected [8]. Condition of road has a very important role to play. Density of traffic, loading of vehicles, accumulation of water on road and quality of road goes a long way in increasing/decreasing the number of accidents. Banking of roads for curved roads is very important to avoid toppling of vehicles while negotiating curved roads [9, 10].

Taking help of WHO factsheet and lot of other literature/information available on the subject, the cause of road accidents can be broadly divided in to four categories: -

- Human error: Mainly driver's fault. There are errors by pedestrians and cyclists etc. also as misjudgements.
- Mechanical faults in the vehicle: Brake, steering & suspension system are mainly responsible in this category.
- Other external factor like road condition etc: Poor/Bad Road is often a cause of accident.
- Non-assignable reasons.
- Mechanical defects resulting in car accidents in Chicago were mainly coming in following categories:-
- Misaligned or faulty steering or suspension systems.
- Defective brake system.

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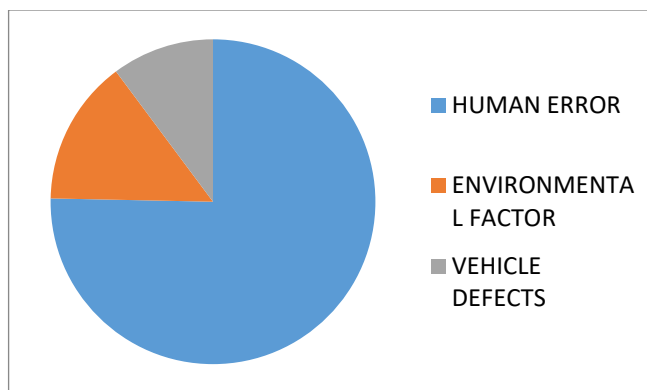
- Burst tyres.
- Wheel detaching suddenly while on move.
- Most of the defects that cause accident in vehicles can be analysed in following sequence to arrive at the root cause of accident:
  - 
  - Whether the defect was the one that ought to have been detected prior to driving the vehicle. Serviceability of brakes is one such thing that should be checked before marching vehicle.
  - Whether the defect was simply a short coming of the vehicle eg lack of Antilock Braking System (ABS) which the driver ought to have known about and should have driven the vehicle accordingly.
  - Whether despite knowing the defect, the defendant (driver) could not have avoided the accident. For example, if the driver is moving the vehicle due to some emergent reason despite faulty brake system, the accident is quite likely.
  - Whether the accident could have occurred even in the absence of the defect. Such accidents mostly occur due to human error.

It is the mechanical defects that are to be examined in this research work in great details to arrive at suitable measures to eliminate or reduce them.

In motor accidents, there are two types of wounds, which may be internal or external and most of them cannot treated in simple way. Murray et al 1997 introduces various injuries caused due to accidents. The injuries could be head injury, spinal injury, blunt cervical injury, thoracic injury, aortic injury, blunt cardiac injury, blunt trachea bronchial injuries, diaphragmatic injuries, abdominal injury and extremity injury.

This article investigates causes of death in United State of America, which summaries mortality rate per different age groups. The report shows that leading cause of death in children's is due to vehicle crash [6].

This article investigates major cause of accidents in South Africa on a 24-meter-wide road. In this research article author consider 404 accidents report and scrutinize dominant causes. The human error factor was the biggest 75.4%, followed by environment factors 14.5% whereas vehicle defect factor was 10.2%. The human factors dominant is excess speed, overtaking, wrong lane driving, and driver liquor etc. The vehicle factors are mostly due to tire puncture, and brake failure. The environmental factors considered in this research were daylight, raining, inadequate facility for pedestrians etc [11].



**Figure 1: Various Factors for Accidents**

This article focuses on road accident due to tire bursting in cars. Authors experimentally analyzed that car crash causes are tire pressure (under-inflation and over-inflation) and abnormal wear of tires. The abnormal wear generally occurs due to excessive pressure, overloading of cars, improper wheel alignment and tires being used six years beyond date of manufacturing etc. The tables mentioned below indicates load index verses maximum load, speed symbol verses maximum speed [12].

<b>Load index</b>	81	82	85	86	87	90	92	95	96
<b>Maximum load/tyre</b>	462	475	515	530	545	600	630	690	710

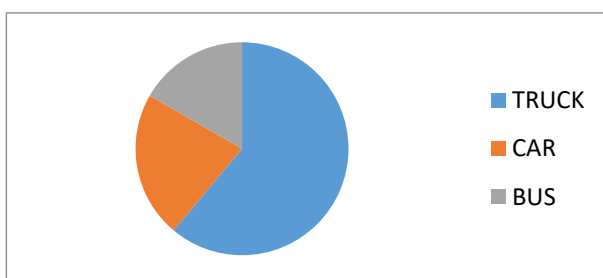
**Table 1: Passenger Car Tire Load Rating**

Speed symbol	Maximum speed (km/h)
N	140

P	150
Q	160
R	170
S	180
T	190
U	200
H	210
V	220
Z	230
W	240
Y	250

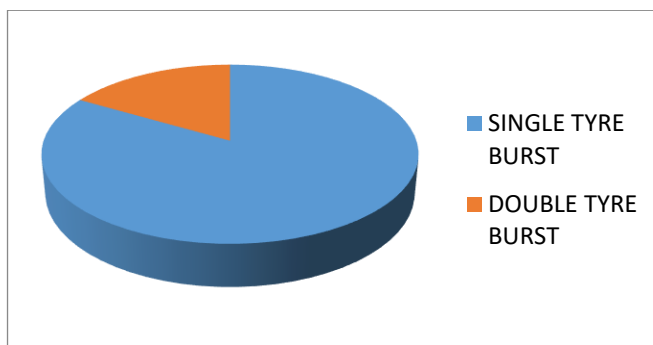
**Table 2: Tire Speed Rating**

In this study an attempt is made to identify the various causes for road accidents in Bangladesh and to develop a System Dynamics simulation model as conventional model lacks in reducing accident severity. Systems approach is not a mere theory, but a way of thinking and practical philosophy of solving problems. In this article authors collect huge amount of data in road accident happens in Bangladesh. It was observed that 72 incidents out of 1011 are due to tier burst, out of these 72 incidents tier burst in truck was 61.1%, care burst was 22.2% and in buses it was 16.7%. Based on casualty figures, buses are found to be the most vulnerable vehicle which constituted about 85% of total casualties [12].



**Figure 2: Accident share of Various Vehicles**

In this article authors also collected the data regarding bursting in tires, if bursting dominantly occurs in one tier or in two tires. They found out that out of 72 accident due to tier bursting, 60 accidents happen due to one tier and 12 accidents due to two tier bursting.



**Figure 3: Figure Indicate Single and Double Tyre Bursting**

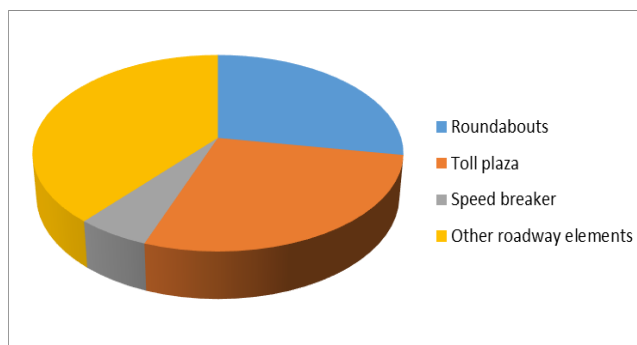
Authors scrutinize from total 1011 number of accidents all cause of mortality, such as tier burst, brake failure, wheel jam, axle failure, defective light, and passenger fallen from roof etc. in tabular form [11].

Vehicle factor	Road accident
Tyre burst	72
Brake failiure	16

Wheel jam	12
Axle failure	7
Defective light	2
Passenger fallen from Roof & Freight Top	50

**Table 3: Summary of accidents caused by vehicular defects**

Above study also indicates that brake failure also be a dominant technical measure. The accidents due to brake failure had been visible at various locations such as roundabouts, toll plaza, speed breaker, and other roadway elements etc [12].



**Figure 4: Figure Indicate Brake failure data**

## OBJECTIVE

The prime objective of this work was to study various causes of accidents in automobiles and suggest some mechanical measure to mitigate/minimize road accidents causes due to some technical reason.

## 2. MATERIALS AND METHODS

Literature review has brought out that mortality due to human error is approximately 74%. It has been apprehension that controlling this only by wary people of world regarding traffic rules. Therefore, techie should stand up and implant aide accessories perpetually for mitigate casualties due to technical defects. Technical defects have been divided broadly three cardinal types-

- Tire bursting
- Leakage in hydraulic fluid
- Electric fault in steering system.
- Toppling of vehicles on curved roads.
- Survey based study of road accident.

**Tire bursting:** Occurs because temperature increase and over stressing of tier materials. These are caused due to uneven wear and tear in tires, number of plies in tires are less than prescribed number of plies, increase of temperature tier more than limiting value prescribed by manufacturer. As the temperature of tier increase thermal stresses developed due that tier will burst.

Uneven wear and tear can be decimating by checking wheel balancing and alignment timely prescribed by automobile manufacturer. Uneven wear and tear due to manufacturer fault is a daunting task for recognize, this is the responsibility of manufacturer absolve tires. Bursting of tires due to higher temperature is a dominant causer and implant a device shown in figure will be outset to cease tier bursting. Suggested setup navigates for removing heat sprouts due to excessive speed prescribed by tier manufacturer. When automobile car exceeds water, sprinkle sprayed on tier and release heat to environment. This technique will be a milestone for sacked tier bursting especially in high-speed light vehicle and truck/buses etc.

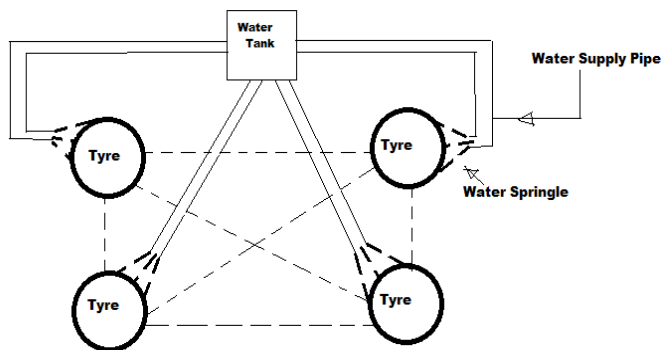


Figure 5: Schematic Diagram of Tire Cooling

**Leakage in hydraulic fluid:** Hydraulic fluid leakage is a great concern in many automobiles parts, these parts are power steering system, braking system, clutch system etc. If leakage is removed, accidents due to brake/clutch/steering failures will be reduced by a great extent.

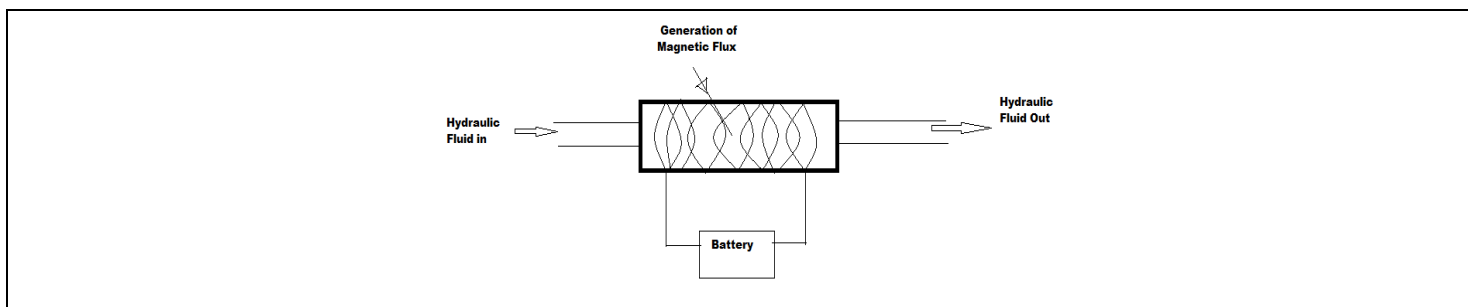


Figure 6: Leakage Detection Device

In this system where generally leakage of fluid is major concern, at those locations this system trusts a lot. A conductive material wire wounded on major concern area, if there may be any flux difference due to oil leakage, it can be buzz by a device based on the principal of heat flux. The driver can easily consider remedial operations.

The wounded wire should be connected to D.C battery for empowering heat flux, leakage in hydraulic fluid brace for flux difference.

**Electric fault in steering system:** Now a day's modern light vehicle steering system are based on the principal of electrical motor system. If this motor system has any fault than it will strike completely automobile without wary driver of light vehicle. The deficiency in current may be due to wiring deficiency or due to mechanical failure etc. If a device is implanted for detecting eddy current loses, then accidents due to eddy current changes may be eliminated partially but in this case till now research dampener techie. In this regard techie portrayals, have not been improvised but in future it will soar and diminish accidents due to deficiency in electricity.

**Driving on curved roads:** Vehicles tend to topple on to their LHS due to centrifugal force generated while turning on curved roads in case the banking of road is not adequate, or the speed of vehicle is excessive. The relationship between vehicle speed while turning ( $v$ ), angle of banking/super elevation ( $\theta$ ) and radius of road ( $r$ ) is given by the expression  $\tan \theta = v^2/gr$ . From this expression, it comes out that for a given patch of curved road, where  $r$  and  $\theta$  are fixed,  $v$  will have a max safe value beyond which the vehicle will tend to topple. In a way, two wheelers can overcome this difficulty by tilting the 2-wheeler sideways. To overcome the error of judgment/carelessness by drivers or to cater for inadequacies of roads, some sort of warning or correcting system can be incorporated to reduce toppling of vehicles.

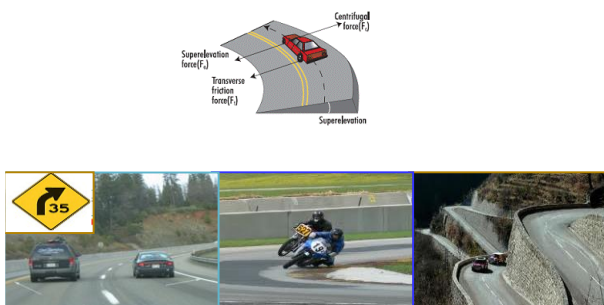


Figure 7: Driving on curved roads

### 3. RESULT AND DISCUSSION

#### 3.1 EXPERIMENTAL BASED

Experiment was performed on Bajaj Pulsar 150 cc Bike for investigating effects of velocity, tier size, and ground roughness on skidding of bikes. The experimental analysis has been performed by using mentioned parameters, which is engine speed varies from 15-35 Km/hour, angle of banking/super elevation ( $\theta$ )= $30^\circ$  and radius of road ( $r$ )=25 meter, width of road=20 meter. The size of bike tires was front 2.75x 17 and rear wheel 100x17, tires selected for experiments were Michelin pilot sporty, MRF ZFS, Ceat Secura F, Ceat Secura 72. The prime function of selecting various parameters is to investigate effect on skidding of bikes.

Figures 8 and 9 shows experimental investigation for various company tires and the result obtained by experiments indicates that properties of road surface have significance effect on skidding of bikes.

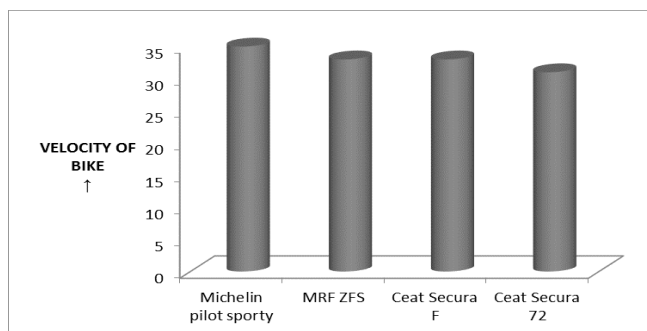


Figure 8: Relationship between skidding velocity and tier type for dry road surface

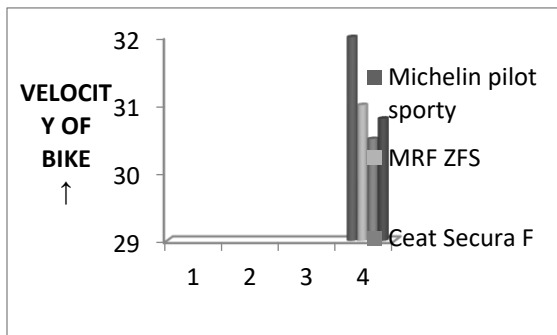


Figure 9: Relationship between skidding velocity and tier type for water wet road surface

### 3.2 SURVEY BASE

The study is based on data collected by conducting a survey among 161 victims in Noida city. The collected data were organized in the form of pie chart and percentage statically technique was adopted the analysis.

Figure 10 illustrations connection between road accidents and various causes of fates. The major contributor which was considered in this survey are drivers fault, pedestrian careless attitude, passenger incorrect movement, improper use of road, defect in vehicles, improper road condition, and defective road design etc. In survey it was concluded that the major contributor for road accidents were driver's faults and subsequent dominant parameter is pedestrian careless attitude.

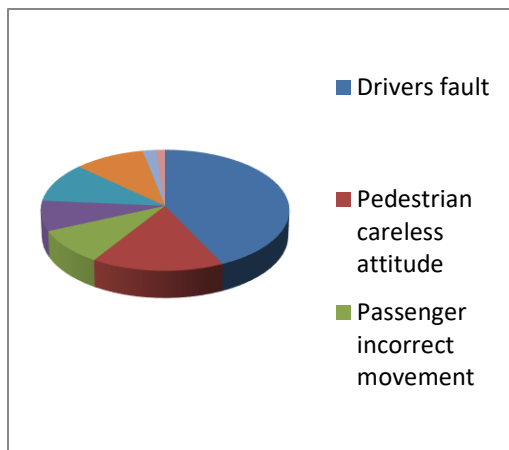


FIGURE10: RELATIONSHIP BETWEEN ACCIDENT AND CAUSES OF ACCIDENT

Figure 11 demonstrate relationship between age of driver and number of accidents conducted on survey of 161 people. The result obtained by survey indicates that younger age group driver is more dominating to road accident when compared to more than 50 years age group persons.

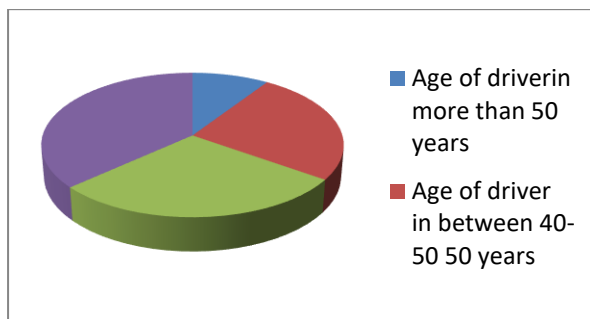


FIGURE 11: RELATIONSHIP BETWEEN AGE OF DRIVER AND NUMBER OF ACCIDENTS

Figure 12 shows relationship between different type of disability occurs due to road accidents. In majority of road accidents, victim acquired minor injury and second factor is fatal injury which is major concern for government as well as for society too. The persons who loss there one of leg/hand also have significant number.

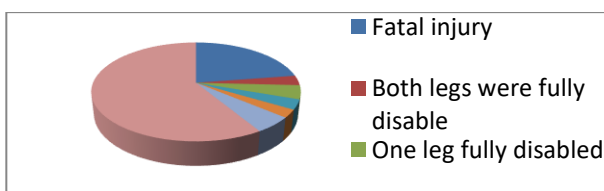


FIGURE 12: RELATIONSHIP BETWEEN DIFFERENT TYPES OF INJURY

Figure 13; elaborate relationship between various causes of driver's fault. The driver in alcoholic condition had maximum road accident, second dominant cause is improper vision followed by over speeding and improper overtaking.

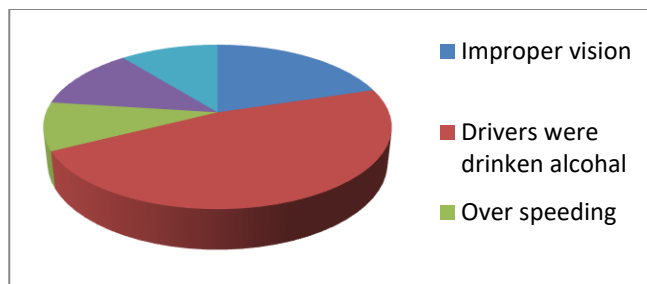


FIGURE 13: RELATIONSHIP BETWEEN DIFFERENT PARAMETRS OF DRIVERS FAULTS

#### 4. CONCLUSION

This article summarizes and spotlights some of the causes of accidents due to technical reasons. Literature reviews presented in this article indicate/scrutinize major concern areas of research to mitigate mortality. This article suggests some major and minor and trying to quote enigma of accident in light as well as heavy vehicles. It's a very lanky and fragile task because implanting suggested devices will surge the cost which is an important parameter for developing nations. Since human life is priceless, suggested measure should be considered for reducing accidents due to technical causes. The road accidents growing day by day because of growth in traffic density, if some mandatory approach will implement than accidents can be condensed sufficiently. The main activity to be educates the people about road safety rules and regulations, strict enforcement of law, strong engineering design, and road infrastructure.

#### ACKNOWLEDGMENTS

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