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Statistical Analysis of Road Traffic Accidents in Maharashtra State of India

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Abstract

Maharashtra, one of India's largest and most populous states, has developed a comprehensive road transport network essential for the movement of people and goods. This network consists of National Highways, State Highways, District Roads, and Rural Roads. Over the years, the state has made significant strides in improving its road infrastructure through the construction of new roads and the upgrading of existing ones. Notably, Maharashtra boasts the largest network of national and state highways in India, which accounts for 13.26% and 18.26% of the respective total lengths in the country.

Despite these advancements, the rising number of road accidents and fatalities highlights a pressing need for enhanced safety measures. In 2021, Maharashtra ranked sixth in road accidents and third in fatalities, with an increase in both metrics compared to previous years. The road accident severity and risk in the state have consistently surpassed national averages, prompting concerns about road safety. Data reveals that the majority of accidents occur on district roads, which account for 43.28% of fatalities, followed by national highways at 28.73%.

Moreover, the demographic analysis of road accidents indicates a significant gender disparity, with males comprising 89% of the total fatalities in 2021. Vulnerable age groups, particularly those aged 25 to 45, are most affected, indicating the need for targeted interventions for these demographics. Over speeding is the leading cause of road accidents, responsible for nearly 60% of incidents, followed by reckless driving behaviors.

INTRODUCTION:

A road accident is an unfortunate incident involving one or more vehicles on the road that results in personal injury or property damage. It is the leading cause of pre-mature death and injury worldwide. Around 1.35 million people die in road accidents every year in the world. Among them, the death rate is highest in the age group of 15 to 49 years. More than 90 percent of the world's total road traffic deaths occur in low and middle-income countries. India accounts for the highest number of road accident deaths (11%) in the world. In the year 2021, there were 412432 road accidents in India, in which 153972 people died and 384448 people were injured.

Maharashtra is one of the developing states in India, where road transport is the most cost-effective means of transport for goods and passengers. Increasing urbanization, rapid motorization and high rate of economic development have increased the incidence of adverse traffic environment in Maharashtra. As a result, the incidence of road accidents, traffic injuries and deaths are unacceptably high. So, it is necessary to know the nature of road accidents.

AIM AND OBJECTIVES:

The central aim of this research work is to analyze road accidents in Maharashtra and India. Other supportive objectives are-

1. To understand the road infrastructure of Maharashtra.
2. To identify primary causes of road accidents in Maharashtra.
3. To examine demographic factors in road accidents.
4. To explore temporal and spatial patterns in accidents.
5. To study the correlation between number of road accidents and months and time of day.
6. To suggest effective road safety measures

DATABASE AND METHODOLOGY:

The present research work is purely based on secondary data. Data (regarding the number of accidents, deaths and injuries) from the National Crime Records Bureau's annual reports on 'Accidental Deaths and Suicides in India' (published by the Ministry of Home Affairs, Government of India) have been used for this research work. The study covers a period of 50 years (1971 to 2021), analyzing road accidents at both the state and national levels. The data has been processed through the necessary statistical methods and presented through appropriate maps, tables and graphs. The entire discussion of this research paper is divided into two major parts. Part I discusses the concept of accidents, road accidents, causes and impact of road accidents. The second part focuses on road development and road accidents specifically in the state of Maharashtra.

In this study, the following formulas have been used for statistical analysis-

1. **Road Accident Severity**

$$\textbf{Road Accident Severity} = \frac{\text{Road Accidental Deaths in a Year}}{\text{No of Road Accidents in a Year}} \text{ X } 100$$

2. **Road Accident Risk**

$$\text{Road Accident Risk} = \frac{\text{No of Road Accidents in a Year}}{\text{Total Population in a Year}} \text{ X } 100000$$

3. **Road Accident Rate**

$$\text{Road Accident Rate} = \frac{\text{No of Road Accidents in a Year}}{\text{No of Vehicles in a Year}} \text{ X } 10000$$

4. **Road Accident Fatality Risk**

$$\text{Road Accident Fatality Risk} = \frac{\text{Road Accidental Deaths in a Year}}{\text{Total Population in a Year}} \text{ X } 100000$$

5. **Road Accident Fatality Rate**

$$\text{Road Accident Fatality Rate} = \frac{\text{Road Accidental Deaths in a Year}}{\text{No of Vehicles in a Year}} \text{ X } 10000$$

STUDY AREA:

To enhance road safety and reduce accidents, it is essential to conduct a thorough analysis of data related to the number, causes, and consequences of road accidents. For this purpose, the state of Maharashtra has been selected as the study area. Maharashtra plays a significant role in the road traffic scenario in India.

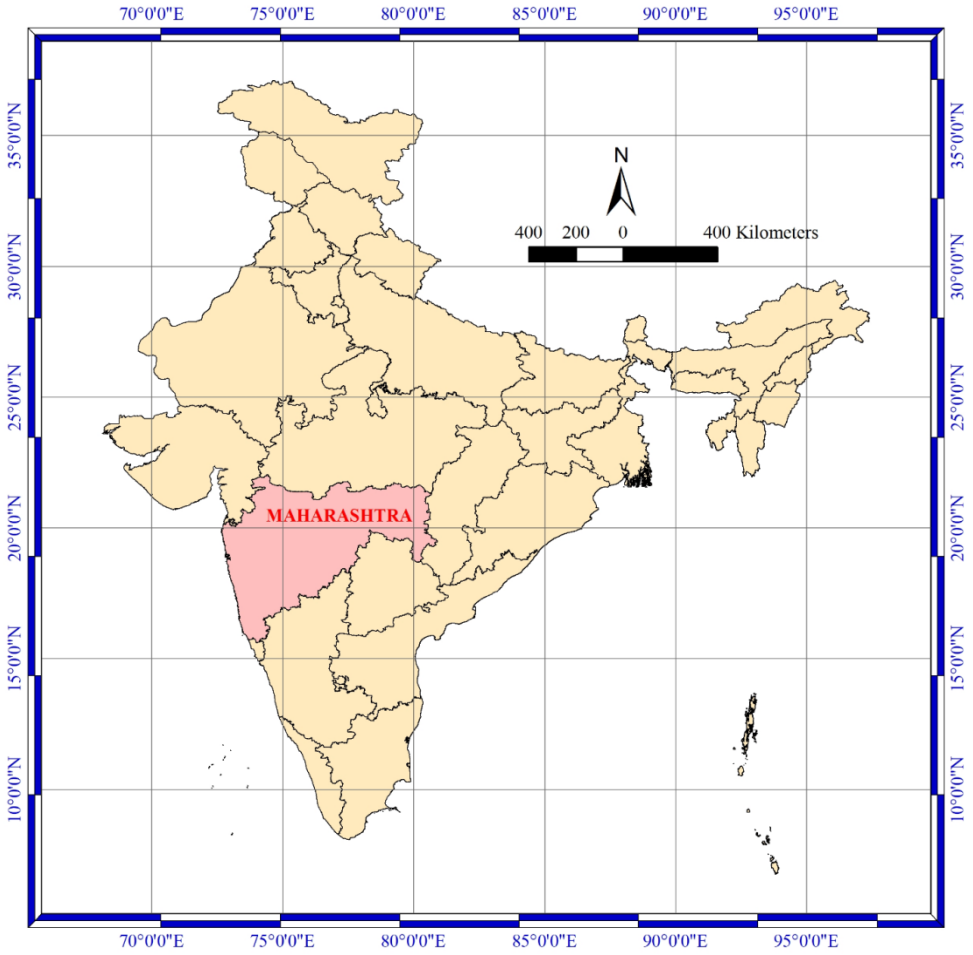
The state of Maharashtra is one of the 28 states of India. This linguistic state came into existence as an independent state on 1 May 1960. It is the third largest state in India in terms of area. It is located in the western and central parts of India and covers a large part of the Deccan Plateau in the Indian Peninsula. Administratively, the state is made up of 36 districts in six administrative zones.

Profile of Study Area (Maharashtra State)

1. Establishment of State	1st May 1960	
2. Location	State in Western and Central Part of India	
3. Extent		
Latitudinal	$15^0$48’ North to $22^0$06’ North	
Longitudinal	$72^0$36’ East to $80^0$54’ East	
4. Length and Width		
Length (East-West)	870 km	
Width (North-South)	680 km	
5. Total Area	307713 km^2 (9.36% of India) (3rd Rank in India)	
6. Boundaries	Northwest- Gujarat North- Madhya Pradesh East- Chhattisgarh Southeast- Telangana South- Karnataka Southwest- Goa West- Arabian Sea (720 km Coastline)	
7. Topographical Regions	1. The Konkan Coastal Strip 2. The Sahyadri or The Western Ghat 3. The Maharashtra Plateau	
8. Climate	Tropical Monsoon (Hot and Dry)	
Rainfall	135 cm (annual average)	
Temperature	25^0C to 27.5^0C (annual ranges)	
9. Major Rivers	Godavari, Krishna, Tapi, Bhima, Wainganga, Koyna	
10. Soil Types	Black, Laterite, Alluvial, Red, Marshy and Peat	
11. Natural Vegetation Type	Tropical Dry Deciduous	
Forest Area	61907 km^2 (20.11% of Maharashtra)	
12. Administrative Set-Up	(2021)	
Administrative Divisions	6	
Number of Districts	36	
Tahsils	355	
Towns	534	
Inhabited Villages	40959	
Un-Inhabited Villages	2709	
13. Population	**(Census 2011)**	**(Projected 2021)**
Total	112374333	129877541
Male	58243056.51) 83%)	67468852 (51.95%)

Female	54131277 (48.17%)	62408689 (48.05%)
Rural	61556074 (54.78%)	68303286 (52.59%)
Urban	50818259 (45.22%)	61574255 (47.41%)
14. Transport	(2021)	
Railway Route Length	6242.14 km	
Total Road Length	323115 km	
Motor Vehicles	38636247	

Map-1: Location of Study Area (Maharashtra State) in India



ANALYSIS AND DISCUSSION:

Concept of Accident and Road Accident:

Meaning of Accident:

Accident is an unplanned and unfortunate incident that results in injury, deaths, damage to property or some other losses.

Types of Accidents:

Accidents can occur in a wide range of contexts and can vary in their causes, consequences, and severity. Here are some common types of accidents:

1. **Natural Accidents:** These involve natural disasters like earthquakes, volcanoes, cyclones, floods and wildfires.

2. **Home Accidents:** These can happen in or around the home and include events like falls, burns, electrical shocks, or accidents involving household appliances.
3. **Workplace Accidents:** These occur in the workplace and can involve slips, falls, machinery malfunctions, chemical spills, and other incidents that cause injuries to employees or damage to equipment.
4. **Road Accidents:** These occur on the road and involve collisions or incidents involving vehicles, such as cars, trucks, motorcycles, and bicycles. They can result in injuries or damage to property.
5. **Railway Accidents:** Accidents that occur within the context of railway transportation systems, such as train collisions, derailments, and level crossing accidents.
6. **Water Transport Accidents:** Accidents that occur on bodies of water involving boats, ships, and other watercraft, including collisions, capsizing, and drownings.
7. **Aviation Accidents:** These involve incidents related to aircraft, including commercial airline crashes, private plane accidents, and helicopter mishaps.
8. **Industrial Accidents:** These typically occur in industrial areas and may involve chemical spills, explosions, fires, or other incidents that can lead to injuries, environmental damage, or property destruction.
9. **Construction Accidents:** Accidents that occur at construction sites, including falls from heights, equipment accidents, and structural collapses.
10. **Medical Accidents:** Also known as medical errors or malpractice, these involve mistakes made by healthcare professionals during medical treatment, surgeries, or the administration of medications.
11. **Sports and Recreational Accidents:** These occur during sports and recreational activities and can involve injuries ranging from minor sprains and bruises to more severe injuries like concussions or fractures.

Meaning of Road Accident:

When one or more vehicles (such as trucks, cars, motorcycles, bicycles etc.) on the road cause personal injury or damage to property, the incident is called a road accident.

Characteristics of Road Accidents:

1. Road accident is an unexpected, undesirable and unfortunate incident.
2. A road accident, also known as a traffic accident or car accident.
3. In road accident, one or more vehicles on the road are involves.
4. Road accidents occur when vehicles collide with each other, pedestrians or stationary objects on the road.
5. Frequency and impact of road accidents mainly depends on location, type of vehicle and human factors.
6. Road accidents can vary in terms of severity, from minor fender-benders with minimal damage to catastrophic crashes resulting in serious injuries or fatalities.

Causes of Road Accidents:

Road accidents can have multiple causes, often involving a combination of factors. These causes can be broadly categorized into the following:

1. **Human Factors:**

Distracted Driving: Using mobile phones, texting, eating, or engaging in other distractions while driving diverts attention from the road.

Impaired Driving: Operating a vehicle under the influence of alcohol, drugs, or medications impairs a driver's coordination, reaction time, and judgment.
Speeding: Driving above the posted speed limit or too fast for road conditions reduces a driver's ability to react to hazards.
Fatigue: Fatigued or drowsy drivers have reduced alertness and impaired decision-making.
Aggressive / Reckless Driving: Behaviors like tailgating, road rage, weaving in and out of traffic, and excessive speeding can lead to accidents.
Inexperienced Drivers: Novice or inexperienced drivers may lack the skills to handle complex traffic situations.
Negligence of Safety Gears: Avoiding safety gears in driving like seat belts and helmets.
Pedestrian and Cyclist Behavior: Accidents can occur when pedestrians or cyclists disobey traffic rules, jaywalk, or enter the road unexpectedly.

2. **Environmental Factors:**

Adverse Weather Conditions: Rain, snow, ice, fog, and heavy winds can reduce visibility and traction, making roads slippery and increasing the risk of accidents.
Poor Lighting: Reduced visibility during nighttime or in poorly lit areas can lead to accidents.
Road Hazards: Potholes, debris, and poorly maintained roads can contribute to accidents.
Wildlife and Animals: Collisions with wildlife, such as deer or livestock, can occur in rural areas and cause accidents.

3. **Mechanical Failures:**

Brake Failures: Malfunctioning brakes can prevent a driver from stopping or slowing down as needed.
Tire Blowouts: Blowouts or flats can cause a driver to lose control of the vehicle.
Engine or Transmission Failures: Mechanical failures can lead to loss of control or stalling on the road.

4. **Traffic Conditions:**

Congestion: Heavy traffic can increase the likelihood of rear-end collisions and slow reaction times.
Road Construction: Work zones and lane closures can create confusion and increased risks for accidents.
Traffic Flow Disruptions: Sudden stops, merging, or lane changes can lead to accidents.

5. **Road Design and Infrastructure:**

Lack of Proper Signage: Inadequate or confusing road signs and signals can lead to driver errors.
Poor Road Design: Dangerous curves, intersections, and inadequate shoulders can contribute to accidents.
Absence of Safety Features: Lack of guardrails, median barriers, and other safety features can increase the severity of accidents.

6. **Vehicle-related Factors:**

Lack of Maintenance: Poorly maintained vehicles are more likely to experience mechanical failures.
Vehicle Defects: Design or manufacturing defects in vehicles can lead to accidents.
Overloaded or Unsecured Cargo: Improper loading or securing of cargo on trucks and trailers can lead to accidents when cargo shifts or falls onto the road.

7. **Medical Conditions:**

Sudden Illness: Drivers experiencing medical emergencies (e.g., heart attacks, seizures) may lose control of their vehicles.

Vision or Hearing Impairments: Drivers with impaired vision or hearing may not detect hazards in a timely manner.

Impacts of Road Accidents: Road accidents can have wide-ranging and significant impacts on individuals, families, communities, and society as a whole. These impacts can be both immediate and long-term, affecting physical, emotional, financial, and social aspects of people's lives. Here are some of the key impacts of road accidents:

1. **Loss of Life:** The most tragic impact of road accidents is the loss of human life. Fatal accidents result in the death of drivers, passengers, pedestrians, and other road users. These losses have a profound and lasting impact on families and loved ones.
2. **Injuries:** Road accidents can cause a range of injuries, from minor cuts and bruises to severe injuries like fractures, spinal cord injuries, traumatic brain injuries, and burns. These injuries can lead to long-term physical disabilities and chronic pain.
3. **Emotional Trauma:** Survivors of road accidents and witnesses may experience emotional trauma, including post-traumatic stress disorder (PTSD), anxiety, depression, and other mental health issues.
4. **Financial Burden:** Road accidents often result in significant financial costs. This includes medical expenses for treatment and rehabilitation, property damage repair or replacement, legal fees, and lost wages due to injuries or fatalities.
5. **Disruption of Daily Life:** Injured individuals may face a long recovery period during which they are unable to work, take care of their families, or perform everyday tasks independently. This disruption can lead to stress and hardship.
6. **Loss of Quality of Life:** Long-term injuries and disabilities resulting from road accidents can reduce an individual's quality of life, limiting their ability to engage in activities they once enjoyed and impacting their overall well-being.
7. **Increased Healthcare Costs:** Road accidents place a burden on healthcare systems, including emergency response, hospitalization, and ongoing medical care. This strain can lead to increased healthcare costs for society as a whole.
8. **Legal Consequences:** Road accidents often result in legal consequences, including insurance claims, lawsuits, and potential criminal charges for drivers who were at fault. Legal proceedings can be time-consuming and emotionally taxing.
9. **Impact on Families:** Families of accident victims may face emotional stress, financial strain, and changes in their roles and responsibilities, particularly when caring for injured family members or coping with the loss of a loved one.
10. **Decreased Productivity:** Accidents can lead to a decrease in workforce productivity as injured individuals may be unable to work for extended periods. This can have economic implications at both individual and societal levels.
11. **Social and Community Impact:** Road accidents can impact communities as a whole, leading to increased awareness of safety issues, calls for improved road infrastructure, and initiatives to promote safe driving behaviours.
12. **Insurance Premiums:** After an accident, insurance premiums may increase significantly for those involved, even if they were not at fault. This can place additional financial strain on individuals and families.
13. **Traffic Congestion:** Accidents often lead to traffic congestion and delays, which can have a cascading effect on other drivers and the overall efficiency of transportation systems.

14. **Environmental Impact:** Some accidents involving hazardous materials or fuel spills can have negative environmental consequences, including soil and water contamination.

Road Transport in Maharashtra:

Maharashtra is one of the largest and most populous states in India. It has a comprehensive road transport network that plays a crucial role in the movement of people and goods within the state. Maharashtra's road network consists of National Highways, State Highways, District roads, Rural and Village Roads. Over the years, there has been consistent improvement in road network through the construction of new roads and upgradation of the existing roads.

Table-1: Category-Wise Roads in Maharashtra State: 1961-2021

Year	National Highways (km)	State Highways (km)	District Roads (km)	Rural / Village Roads (km)	Total (km)
1961	2312	9804	18012	9114	39242
1971	2445	14203	28696	20020	65364
1981	2945	18949	50637	68600	141131
1991	2959	30975	77509	61522	172965
2001	3688	33212	90447	89599	216946
2011	4376	34103	96833	106400	241712
2021	18089	32288	114758	157980	323115

Maharashtra has the largest network of national and state highways in India. It alone covers 13.26% of the total length of National Highways and 18.26% of the total length of State Highways in India. National Highways accounted for 5.60% of the total road length of the state as of 2020-21. The rest of the road network consists of State Highways (9.99%), District Roads (35.52%), and Rural Roads (48.89%). During the period 1961-2021, the share of National and State Highways in the total road length of Maharashtra State has always been higher than the share of National and State Highways in the total road length of the country. Also, except for 1961, the share of district roads is higher than the national average. From 1961 to 2021, there has been a steady increase in road construction in Maharashtra. Road density in Maharashtra increased from 127.53 per 1000 sq. km. in 1961 to 1050.05 per 1000 sq. km. in 2021.

Table-2: Registered Motor Vehicles in Maharashtra State: 1971-2021

Class of Motor Vehicles	1971	1981	1991	2001	2011	2021
1. Motor-Cycles Scooters & Mopeds	83930	346826	1696157	4409906	12060990	28340408
2. Cars, Jeeps & Station Wagons	122508	224752	423505	901278	2382789	5388475
3. Taxi Cabs	17806	31302	43168	86438	182676	373237
4. Auto Rickshaws	3049	29474	126049	407660	644037	1060616
5. Stage Carriages	10250	13789	18203	27286	34061	40482
6. Contract Carriages	--	1498	3980	13975	31459	72273
7. Lorries	56778	105084	194657	398661	955428	1907408
8. Ambulances	441	925	2233	4025	9600	17362

9. School Buses	491	594	1025	1714	6117	32628
10. Private Service Vehicles	810	2171	4622	5815	9421	13037
11. Trailers	7075	23173	60858	167856	284696	432412
12. Tractors	7821	24079	61088	172578	358556	868750
13. Others	810	1319	5040	9872	29829	89159
Total	**311769**	**804986**	**2640585**	**6607064**	**16989659**	**38636247**

Maharashtra also has the largest number of registered transport and non-transport vehicles in India. About 12% of the vehicles in the country are in Maharashtra. During the 50 years (1971-2021), the number of motor vehicles increased by about 248% annually. Two-wheelers accounted for 73.35% of the total motor vehicles on the road in 2021, compared to 26.92% in 1971. Cars, jeeps and taxis accounted for 45.98% of the total number of motor vehicles on the road in 1971, which declined to 17.66% by 2021. The percentage of buses declined from 0.42% in 1971 to 0.12% by 2021. The number of freight vehicles was 23.77% in 1971, which decreased to 6.35% by 2021. Other vehicles, which include tractors, trailers and other types of motor vehicles, increased from 2.91% in 1971 to 2.52% in 2021.

Road Accidents in India

Although the United States has the highest number of road accidents in the world, India accounts for the highest number of road accident deaths (11%) in the world. In the year 2021, a total of 412432 road accidents occurred in the states and union territories of India, in which 153972 people died and 3,84,448 people were injured. According to these statistics, the country has an average of 1130 accidents and 422 deaths every day or 47 accidents and 18 deaths every hour. The incidence of road accidents can vary significantly from state to state within India. Some states have higher rates of accidents and fatalities due to a combination of factors, including population density and road conditions. Among India's 28 states, Tamil Nadu (13.5%) recorded the highest number of road accidents in 2021, followed by Madhya Pradesh (11.8%), Uttar Pradesh (9.1%), Karnataka (8.4%), Kerala (8.1%). and Maharashtra (7.1%). Uttar Pradesh (13.8%) is the top state in road accident deaths followed by Tamil Nadu (10%).

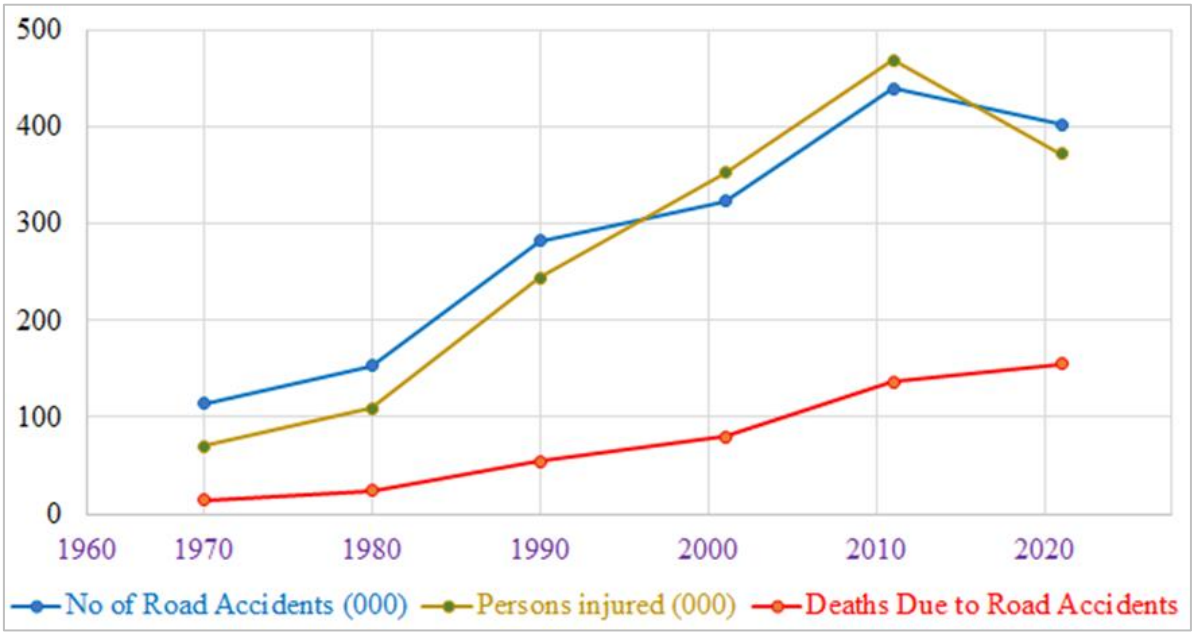
The incidence of road accidental deaths has shown an increasing trend during the period 1971-2011 with an increase of 973.25% in the year 2011 as compared to 1970. The rate of road accidental deaths during the last decade was 2011-2021 was 13.73%. Since 1970, the number of deaths per thousand vehicles in India has been steadily decreasing. It was 10.35 in 1971 and 0.48 in 2021.

Table-3: Road Accidents, Deaths, Injuries and Registered Vehicles in India

Year	No of Road Accidents (000)	Persons Injured (000)	No of Deaths	No. of vehicles (000)	Population	Rate of Deaths per Thousand Vehicles
1971	114.1	70.1	14500	1401	548159652	10.35
1981	153.2	109.1	24000	4521	683329097	5.31
1991	282.6	244.1	54100	19152	846302688	2.82
2001	323.7	353.1	80262	54991	1028610328	1.46
2011	440.1	468.8	136834	141866	1210854977	0.96

2021	403.1	371.9	155622	326299	1407563842	0.48

Fig.-1: Decadal Trend in the number of Road Accidents, Deaths and Injuries in India



In the figure-1, the statistics are represented by a multiline graph at ten-year intervals. After 2010, the rate of road accidents is steadily slow. Due to this, the number of accidental deaths and injuries is decreasing.

Road Accidents in Maharashtra

Maharashtra ranks sixth in India in terms of number of road accidents and third in terms of road accident deaths. Maharashtra accounts for 7.1% of the total road accidents and 8.8% of the total road accident deaths in the country. The number of road accidents in 2021 has increased by an average of 12.6 percent compared to the previous year 2020. Similarly, the number of deaths and injuries due to road accidents has increased by 16.9 percent and 10.39 percent respectively.

Table-4: Road Accidents, Deaths, Injuries and Registered Vehicles in Maharashtra

Year	No of Road Accidents	Persons Injured	No of Deaths			No. of vehicles (000)	Population	Rate of Deaths per Thousand Vehicles
			Male	Female	Total			
1971	-	-	1142	208	1350	312	50412235	4.33
1981	-	-	2128	323	2451	805	62782818	3.04
1991	-	-	2428	615	3043	2641	78937187	1.15
2001	37269	-	8686	1736	10422	6607	96878627	1.58
2011	47120	-	11825	1855	13680	16990	112374333	0.81
2021	26598	19676	12407	1504	13911	38636	129877541	0.36

Severity, Risk and Rate of Road Accidents:

Road Accident Severity- Severity of road accident measured by the number of persons died per 100 accidents. The severity of road accident is increasing day by day in Maharashtra and India. The severity of road accident in Maharashtra is always higher than in India. In 2001, road accident severity was 28 in Maharashtra and 25 in India. In 2021 it will be 52 and 39 respectively.

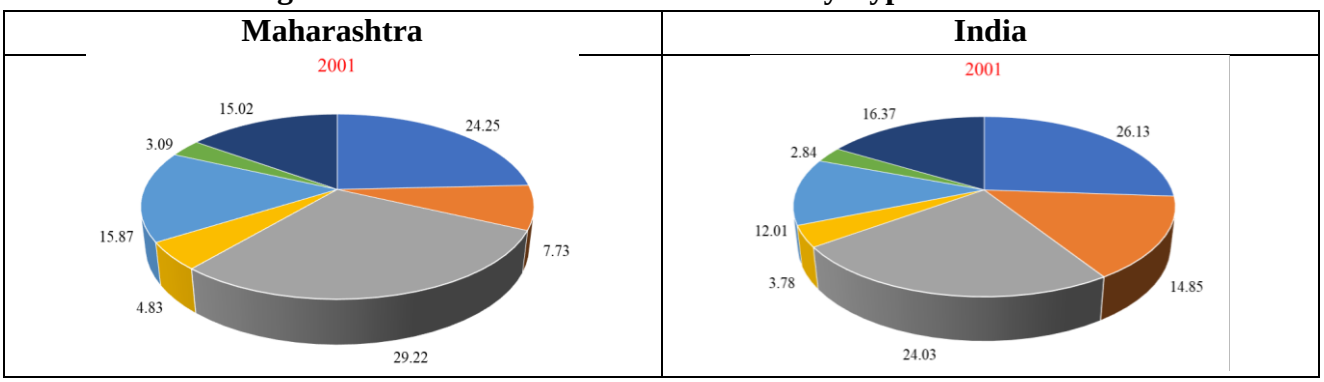
Road Accident Risk- Accident risk is a measure to observe the number of road accidents in the region in a year relative to the population for the year. It is expressed in terms of road accidents per lakh population and which provides appropriate measure of incidence of accidents in the region. The risk of road accidents in Maharashtra is also higher than in India. But after 2011 it has decreased.

Road Accident Rate - Accident rate denotes rate of road accident relative to vehicular population in the region. It is measured by the number of road accidents per 10000 or 1000 vehicles. This rate in India is higher than the state of Maharashtra. In 2001 it was 56 in Maharashtra and 59 in India. In 2021, this rate drops to 7 in Maharashtra and 12 in India.

Table-5: Severity, Risk and Rate of Road Accidents in Maharashtra and India

Year	2001		2011		2021	
Region	Maharashtra	India	Maharashtra	India	Maharashtra	India
1. Road Accident Severity (number of persons died in a year per 100 accidents)	28	25	29	31	52	39
2. Road Accident Risk (number road accidents in a year per lakh population)	38	31	42	36	20	29
3. Road Accident Rate (number of road accidents in a year per ten thousand vehicles)	56	59	28	31	7	12
4. Road Accident Fatality Risk (number of accident fatality (persons died) in a year per lakh population)	11	8	12	11	11	11
5. Road Accident Fatality Rate (number of accident fatality in a year per ten thousand vehicles)	16	15	8	10	4	5

Fig.-2: Share of Road Accidental Deaths by Type of Vehicles



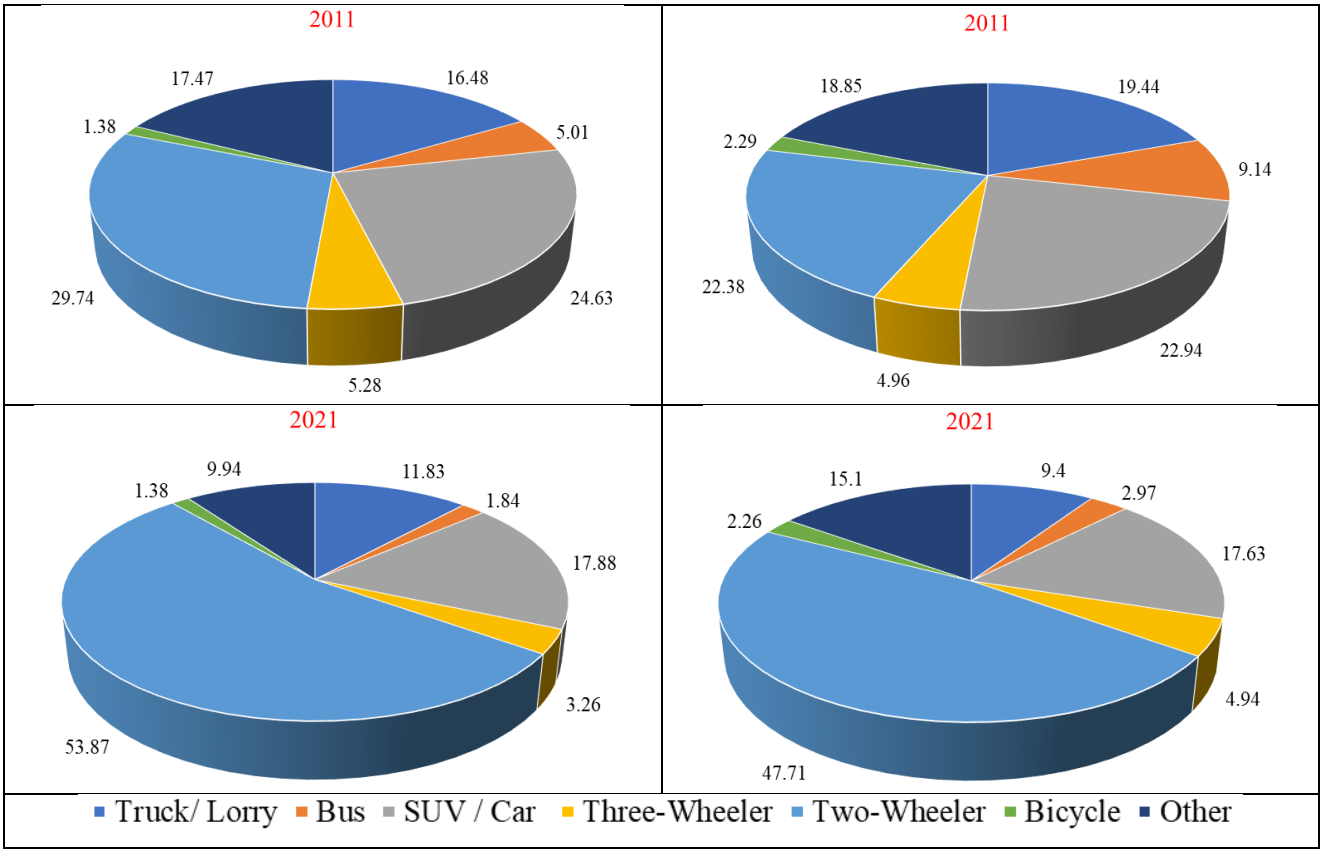
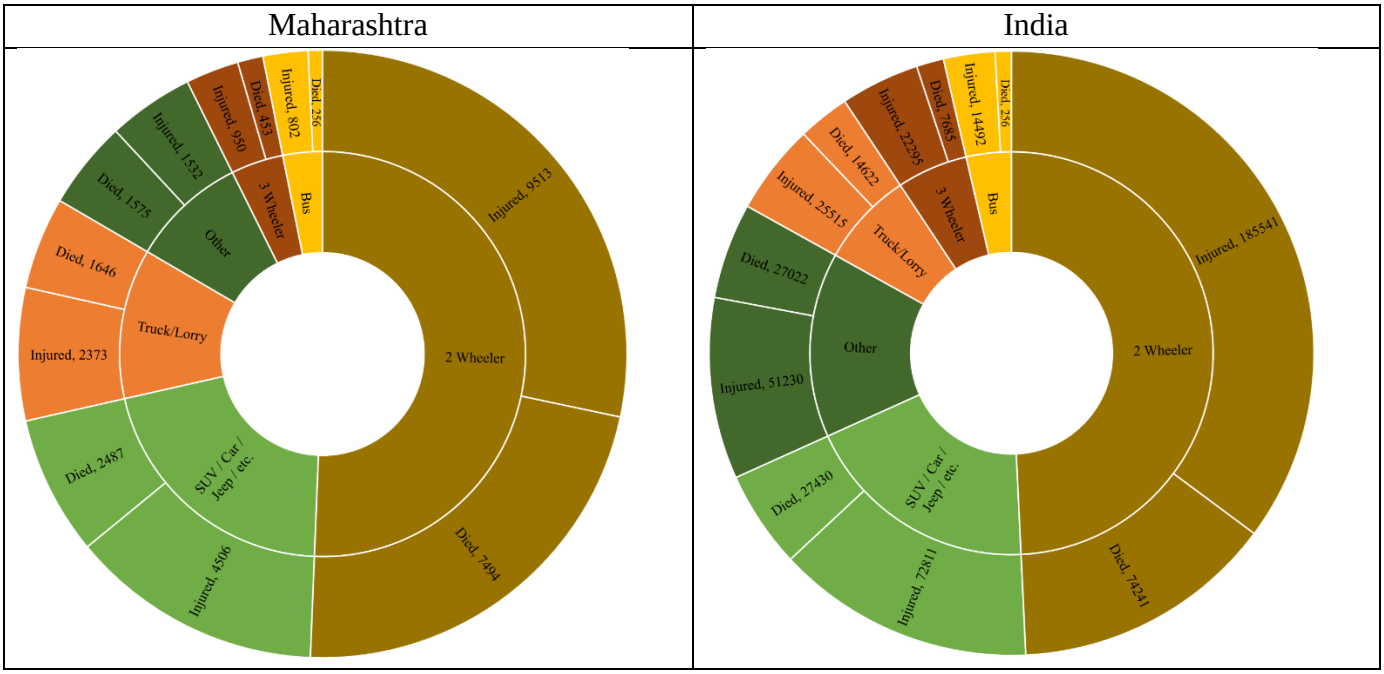


Fig.-3: Road Accidental Deaths and Injuries by Type of Vehicles: 2021



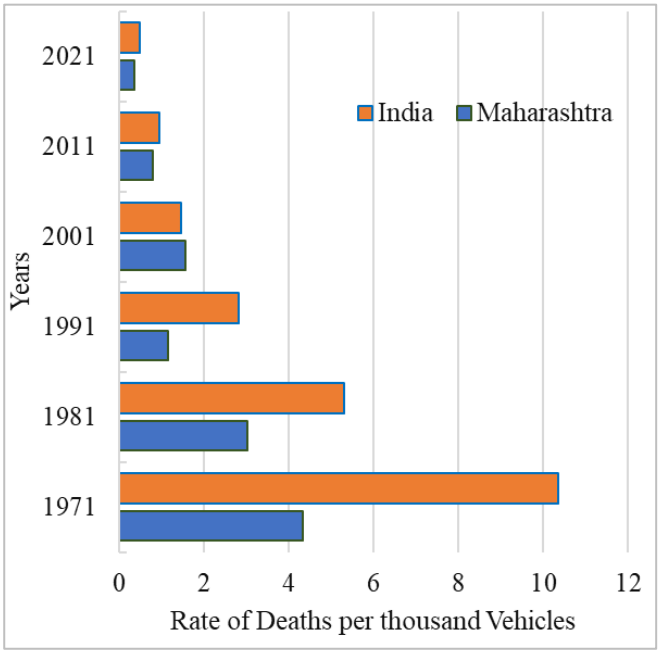
Road Accident Fatality Risk - Road accident fatality risk is measured by the number of accident fatality (persons died) in a year per 100000 population. This rate is almost the same throughout the study period. It is generally around 11 in Maharashtra and India.

Road Accident Fatality Rate - Road accident fatality rate is another indicator which compares the number of fatality (persons died) with the number of vehicles in the country. It is expressed in terms of

road accident fatality per 10000 or 1000 vehicles. Maharashtra's Road Accident Fatality Rate was higher than India's Road Accident Fatality Rate in 2001. It has been declining since 2011 and is below the national average. Between 2001 and 2021, this rate decreased by about three times in Maharashtra and two times in India.

During the study period, buses have been found to have the highest road accident fatality rate while two-wheelers have the lowest. The road accident fatality rate for all type of vehicles except two-wheelers in Maharashtra is higher than India's road accident fatality rate. In 2021, the road accident fatality rate for buses in Maharashtra was 56, for trucks 7, for car-jeep 4 and for two-wheelers 3, while in India it was 21 for buses, 10 for trucks, 6 for car-jeeps and 3 for motorcycles.

Fig.-4: Road Accident Deaths per Thousand Vehicles in Maharashtra and India: 1971-2021

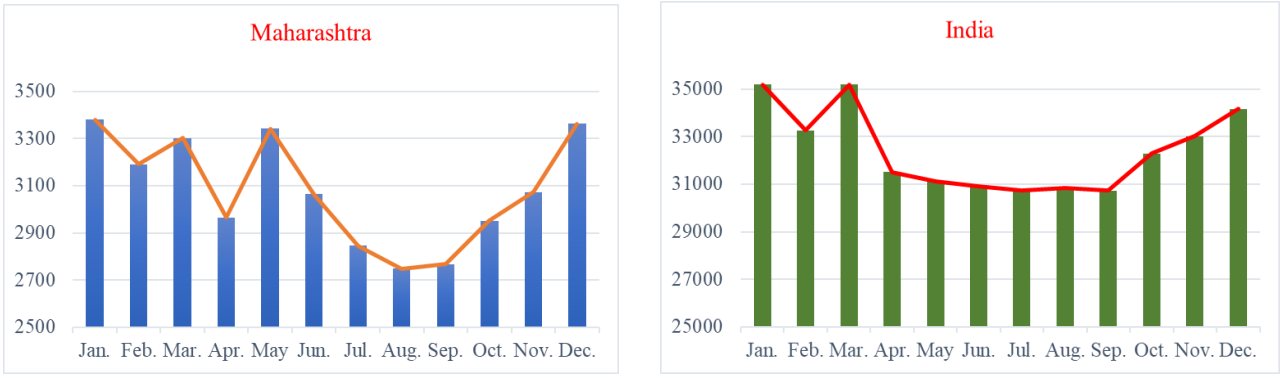


The figure shows the statistics of road accident deaths per thousand vehicles for the period 1971-2011. Since 1971, the number of road accident deaths per thousand vehicles has been decreasing in India and Maharashtra. The number of road accident deaths per thousand vehicles in Maharashtra is lower than the number of road accident deaths per thousand vehicles in India for all periods. In 1971, the number of road accident deaths per thousand vehicles in Maharashtra was 4.33, which decreased to 0.36 in 2021. The number of road accident deaths per thousand vehicles in India during the same period was 10.35 (1971) and 0.48 (2021) respectively.

Road Accidents by Month of Occurrence:

When considering the month wise number of accidents in Maharashtra and India for the years 2001, 2011 and 2021, January has the highest number of accidents and August has the lowest number of accidents throughout the year. In the four rainy season months of July, August, September and October, the number of accidents is less than other months. In these four months, the percentage of accidents in Maharashtra is less than that of India.

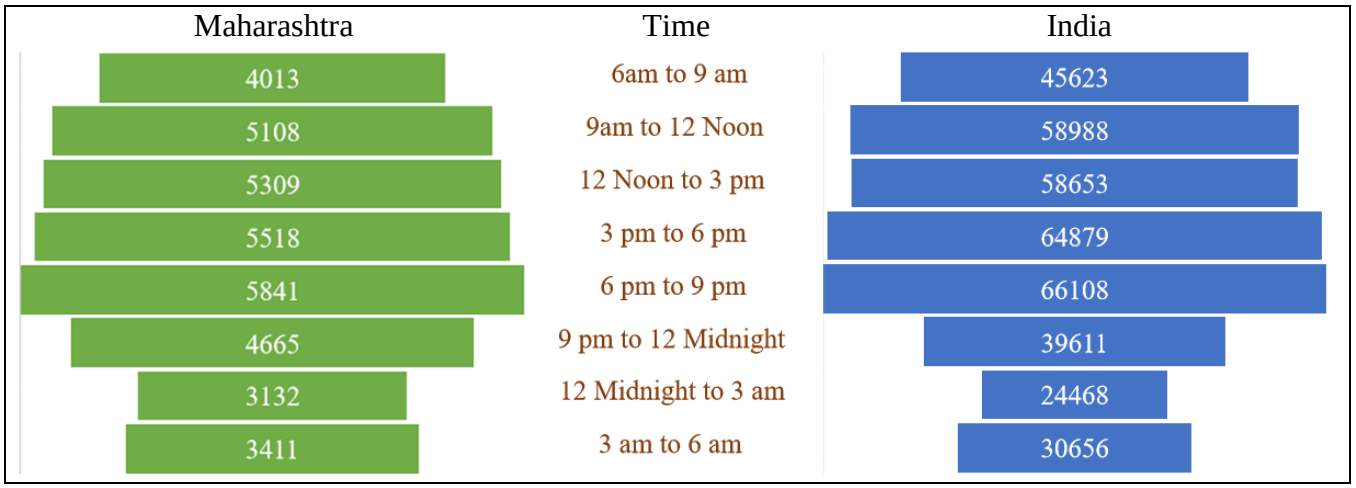
Fig.-5: Three Year Average of Road Accidents by Month of Occurrence (2001, 2011 & 2021)



Road Accidents by Time of Occurrence:

As per time-wise analysis, the maximum numbers of road accidents (about 16%) occur between 6 pm and 9 pm in the twenty-four hours of the day. The number of accidents is less between 12 midnight to 6 am. About 60% of accidents occur in the 12 hours between 9 am and 9 pm.

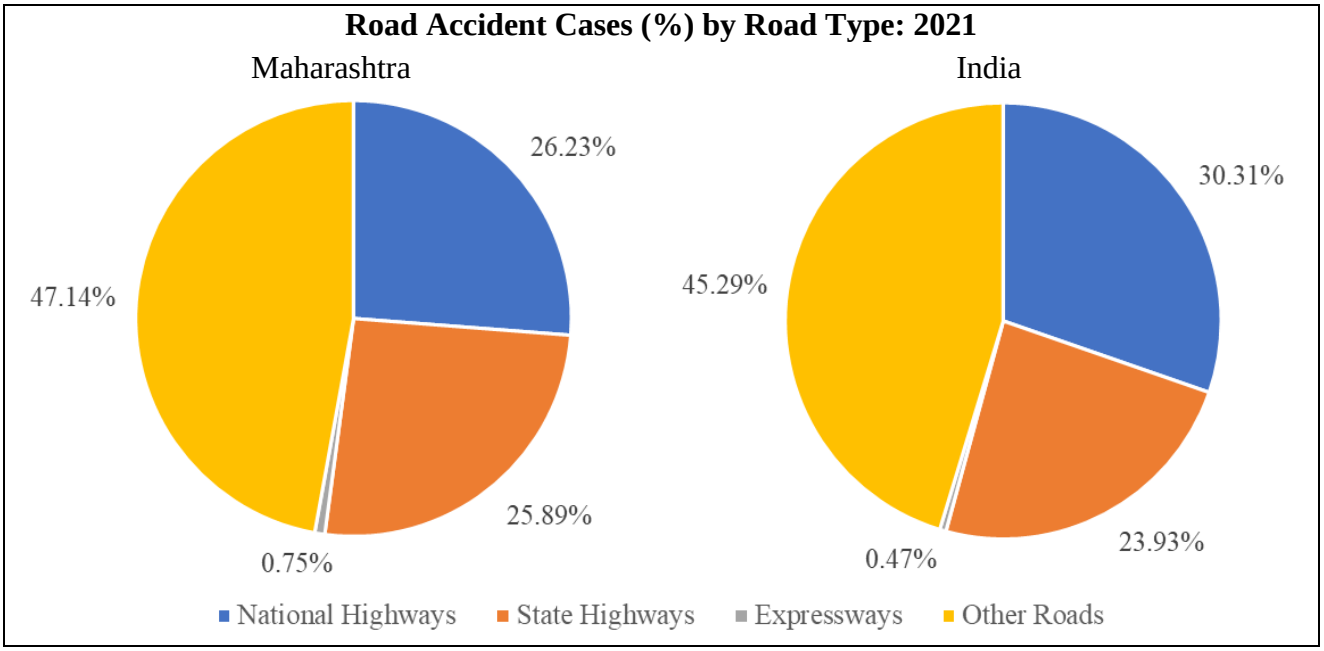
Fig.-6: Three Year Average of Road Accidents by Time of Occurrence (2001, 2011 & 2021)

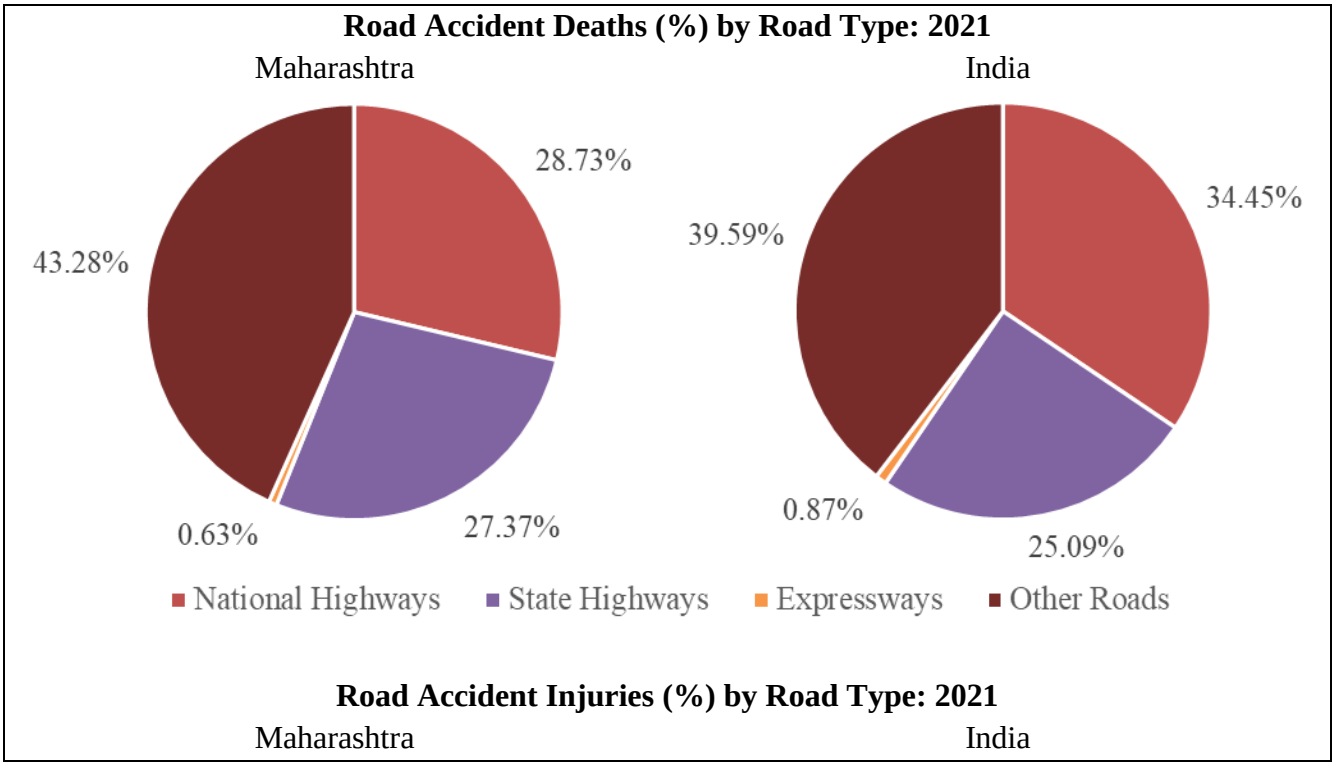


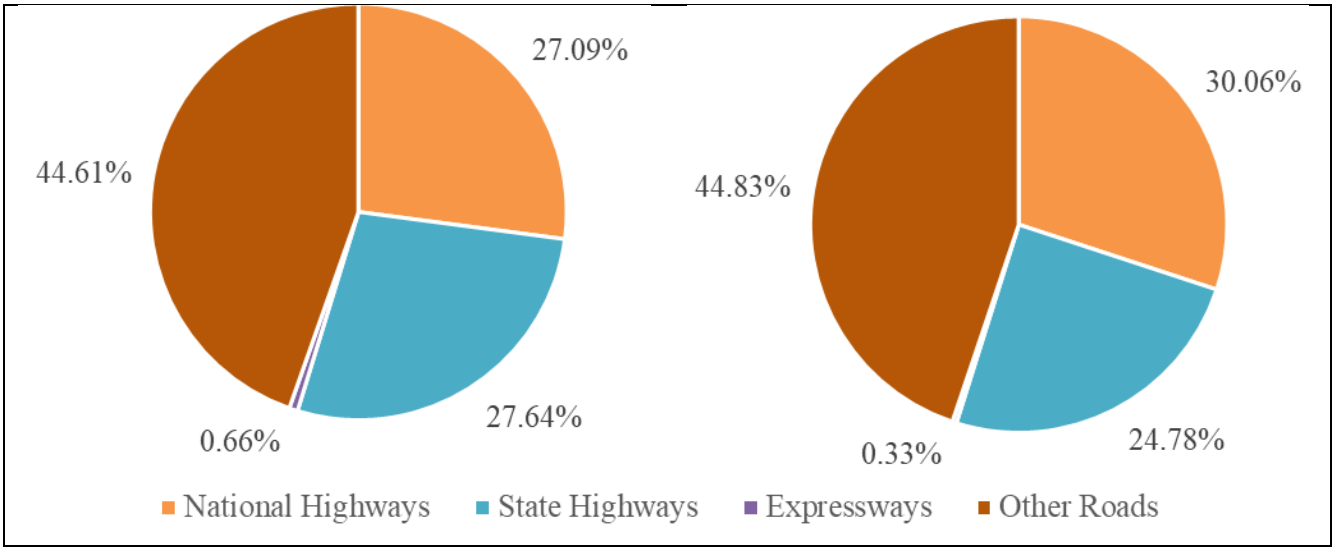
Road Accidents by Road Type:

The figure-7 shows the number of road accidents, deaths and injuries in Maharashtra and India in 2021. Maharashtra and India have the highest number of accidents on district roads. The number of accidents on national highways is more than the number of accidents on state highways. Of the total road accident deaths in Maharashtra in 2021, 43.28% were due to accidents on district roads, 28.73% were due to accidents on national highways and 27.37% were due to accidents on state highways. The highest number of injuries in road accidents is also found on district roads. Although the number of accidents on state highways in Maharashtra is less than that on national highways, the number of injuries caused by accidents is higher.

Fig.-7: Road Accident Cases, Injuries and Deaths (%) by Road Type: 2021







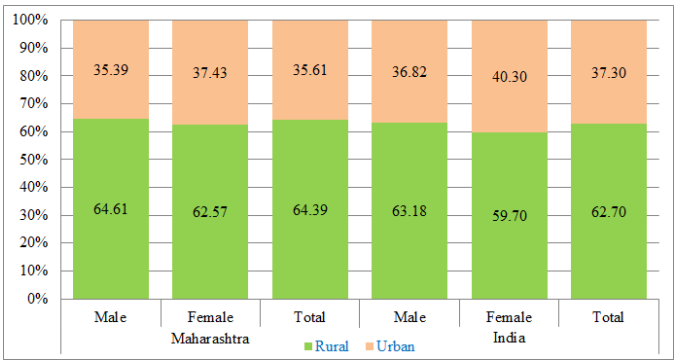
Rural-Urban and Male-Female Differential in Road Accidental Deaths:

Table-6: Road Accidental Deaths by Area and Gender

Area	Gender	Rural		Urban		Total	
		No	% to Total	No	% to Total	No	% to Total
Maharashtra	Male	8016	64.61	4391	35.39	12407	100.0
	Female	941	62.57	563	37.43	1504	100.0
	Total	8957	64.39	4954	35.61	13911	100.0
India	Male	84891	63.18	49483	36.82	134374	100.0
	Female	12685	59.70	8563	40.30	21248	100.0
	Total	97576	62.70	58046	37.30	155622	100.0

Table-6 provides data on road accidental deaths categorized by area (Rural and Urban) and gender for Maharashtra and India as a whole. In 2021, the number of road accident deaths in rural areas of India and Maharashtra state was higher than in urban areas and the male accident death rate was about 8 times higher than that of females. Maharashtra accounts for 9.18% of the total rural road accident deaths and 8.53% of the total urban road accident deaths in the country. Males accounted for 89% of the total road accident deaths in Maharashtra in 2021 compared to 86% in India. About 30% of the total road accident deaths in rural and urban areas occurred near residential areas. In road accident deaths near residential areas, the ratio of male and female accident deaths is similar.

Fig.-8: Road Accidental Deaths by Place of Occurrence: 2021

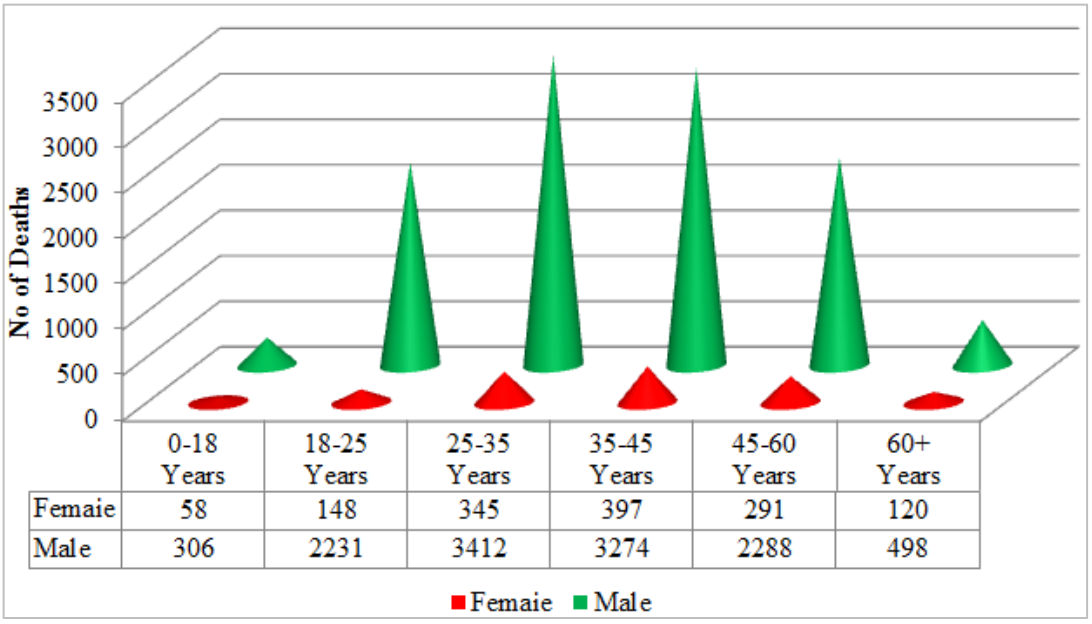


Age and Gender-wise Distribution of Road Accidental Deaths:

Figure 8: Road Accidental Deaths by Age and Gender (2021) highlights the significant disparity in road traffic fatalities across different age groups and between genders. The data indicates that individuals aged 25 to 45 years face the highest risk of road accidents, reflecting their greater mobility and likelihood of engaging in risky driving behaviors. In contrast, the 0-18 age group has the lowest fatality rates, possibly due to reduced independence and exposure to high-risk situations.

Moreover, a notable gender imbalance has been observed, with males accounting for a greater share of road accident deaths. This disparity can be attributed to a variety of factors, including more aggressive driving behavior and higher rates of drug use.

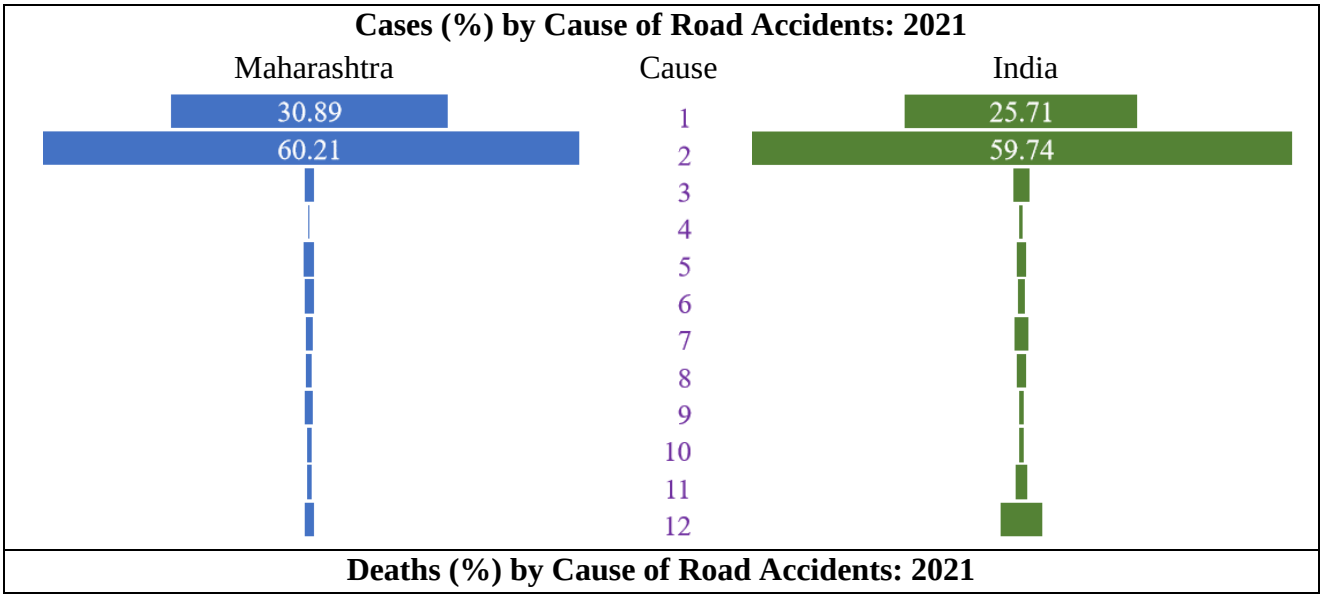
Fig.-8: Road Accidental Deaths by Age and Gender: 2021

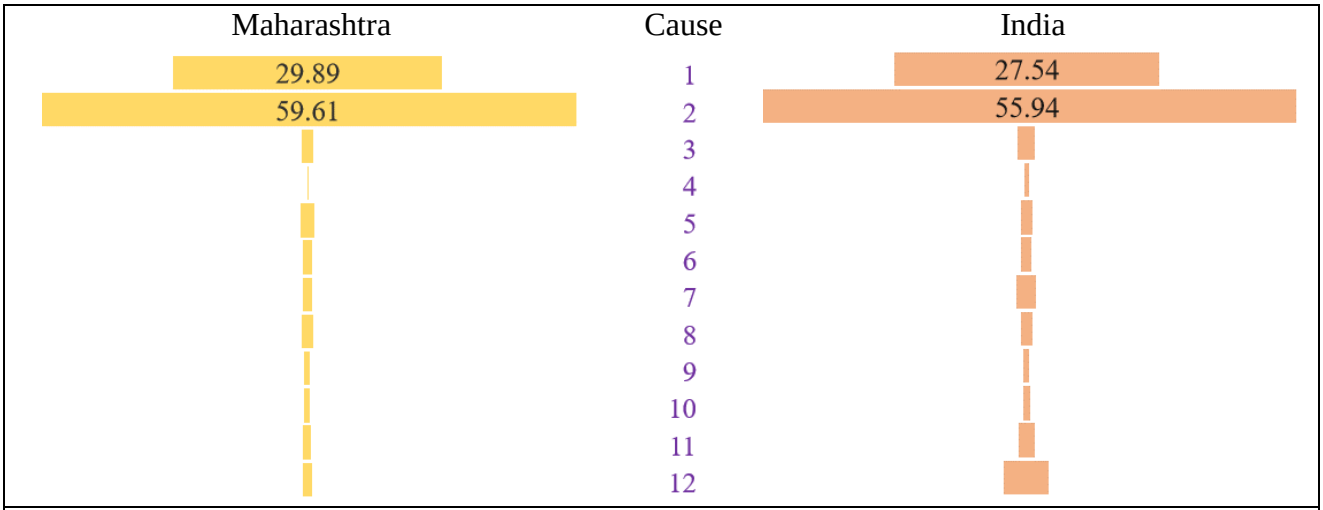


	0-18 Years	18-25 Years	25-35 Years	35-45 Years	45-60 Years	60+ Years
Femaie	58	148	345	397	291	120
Male	306	2231	3412	3274	2288	498

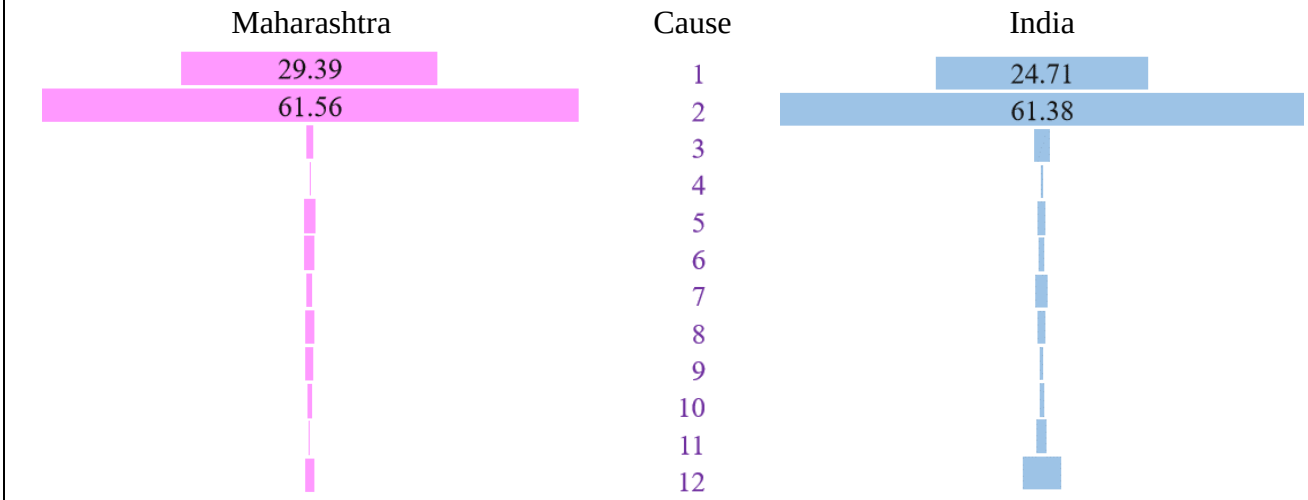
Causes of Road Accidents:

Fig.-9: Cause-wise Distribution of Road Accidents; 2011





Injuries (%) by Cause of Road Accidents: 2021



Legend

1	Dangerous or Careless Driving/ Over-taking/etc.	7	Weather Condition (Poor Visibility)
2	Over Speed	8	Weather Condition (Others Causes)
3	Driving under Influence of Drug/Alcohol	9	Lack of Road Infrastructure
4	Physical Fatigue of Drivers	10	Vehicles Parking at Road Shoulders
5	Defect in Mechanical Condition of Motor Vehicle	11	Causes Not Known
6	Animal Crossing	12	Other Cause

The data of the primary factors leading to road accidents in Maharashtra and India reveals that dangerous or careless driving, including reckless overtaking, is a predominant cause. Along with this, over speeding has emerged as another important reason. Driving under the influence of drugs or alcohol is also an important cause of road accidents. Besides, physical fatigue among drivers contributes to accidents, especially during long distance journeys. Apart from driver behavior, external factors such as bad weather, inadequate road infrastructure, vehicle parking on road and defective vehicles are also responsible for road accidents.

Figure-9 shows the number of road accidents, accidental deaths and injuries in Maharashtra and India in 2021 by their causes. It generally considers the following ten reasons.

1	Dangerous or Careless Driving/ Over-taking/etc.		6	Animal Crossing
2	Over Speed		7	Weather Condition (Poor Visibility)
3	Driving under Influence of Drug/Alcohol		8	Weather Condition (Others Causes)
4	Physical Fatigue of Drivers		9	Lack of Road Infrastructure
5	Defect in Mechanical Condition of Motor Vehicle		10	Vehicles Parking at Road Shoulders

A cause-wise analysis of road accidents, accidental deaths and injuries reveals that among the top ten causes of road accidents, maximum road accidents, accidental deaths and injuries are due to over speeding. Over speed accounted for nearly 60% of road accidents, accidental deaths and injuries in 2021. After that dangerous or careless driving and overtaking are the second major causes of road accidents, accidental deaths and injuries. About 20 to 30% of accidents in Maharashtra and India are due to this reason.

Road Safety Measures

Road safety measures are strategies and actions taken to improve the safety of drivers, passengers, pedestrians, and cyclists on roads and reduce the risk of accidents. Effective road safety measures require collaboration between government agencies, law enforcement, vehicle manufacturers, and the public. When implemented comprehensively, these measures can significantly enhance road safety, reduce accidents and save lives. Some of the important road safety measures are:

1. **Education and Awareness**:
   - **Driver Education**: Offer comprehensive driver education programs that emphasize the importance of safe driving practices, adherence to traffic rules, and awareness of potential hazards.
   - **Public Awareness Campaigns**: Conduct public campaigns to educate drivers, pedestrians, and cyclists about the dangers of distracted driving, speeding, drunk driving, and the importance of seatbelt use.
2. **Enforcement of Traffic Laws:**
   - **Strict Enforcement**: Enforce traffic laws rigorously, including speed limits, seatbelt and helmet usage, and driving under the influence.
   - **Swift Enforcement Against Drunk Driving:** Strict penalties for drunk driving, along with regular DUI (Driving Under the Influence) checkpoints.
3. **Vehicle Safety Enhancements:**
   - **Safety Features:** Promote the use of vehicles equipped with advanced safety features, including airbags, anti-lock brakes, electronic stability control, and collision avoidance systems.
   - **Vehicle Inspections:** Encourage vehicle owners to maintain their vehicles properly, ensuring that brakes, tires, and lights are in good working condition.
   - **Vehicle Maintenance:** Promotion of proper vehicle maintenance to prevent mechanical failures on the road.
4. **Improved Road Infrastructure:**
   - **Road Design:** Develop and maintain roads with safety in mind, including proper signage, lane markings, and adequate lighting.
   - **Roundabouts:** Replace traditional intersections with roundabouts to reduce the severity of accidents and improve traffic flow.

5. **Pedestrian & Cyclist Safety:**
   - **Crosswalks and Signals:** Install marked crosswalks, pedestrian signals, and countdown timers at high-traffic pedestrian areas.
   - **Dedicated Cycling Lanes:** Create dedicated cycling lanes that are separate from motorized traffic.
6. **Effective Emergency Response Systems:**
   - **Swift Response:** Ensure that emergency services can quickly reach accident scenes and provide timely medical care.
   - **Advanced Warning Systems:** Implement systems that alert emergency services and other drivers to accidents in real-time.
7. **Adoption of Technologies:**
   - **Advanced Driver Assistance Systems (ADAS):** Promote the adoption of ADAS, such as lane departure warning, adaptive cruise control, and automatic emergency braking, in vehicles to prevent accidents.
   - **Vehicle-to-Infrastructure (V2I):** Develop technology that allows vehicles to communicate with traffic infrastructure, providing real-time traffic information and enhancing safety.
8. **Data Analysis & Research:**
   - **Data Analysis:** Regularly analyze accident data to identify high-risk areas and make targeted improvements.
   - **Research:** Conduct research to develop new technologies and strategies to further enhance road safety.
9. **Speed Control Measures:**
   - Enforcement of appropriate speed limits on various types of roads with the help of speed cameras, radar guns, and traffic police.
   - Installation of speed bumps and rumble strips in accident-prone areas.
10. **Road Safety Audits:**
    - Conducting audits to identify potential hazards and implementing corrective measures.
    - Continuous monitoring and evaluation of road safety programs to adapt to changing needs and improve strategies.
11. **Improved Public Transportation:**
    - Investment in efficient and safe public transport options to reduce the number of private vehicles on roads.
    - Regular safety checks for buses, taxis, and other public transport services.

CONCLUSION:

Maharashtra, one of India's largest and most populous states, has developed a comprehensive road transport network essential for the movement of people and goods. This network consists of National Highways, State Highways, District Roads, and Rural Roads. Over the years, the state has made significant strides in improving its road infrastructure through the construction of new roads and the upgrading of existing ones. Notably, Maharashtra boasts the largest network of national and state highways in India, which accounts for 13.26% and 18.26% of the respective total lengths in the country.

Despite these advancements, the rising number of road accidents and fatalities highlights a pressing need for enhanced safety measures. In 2021, Maharashtra ranked sixth in road accidents and third in fatalities, with an increase in both metrics compared to previous years. The road accident severity and risk in the

state have consistently surpassed national averages, prompting concerns about road safety. Data reveals that the majority of accidents occur on district roads, which account for 43.28% of fatalities, followed by national highways at 28.73%.

Moreover, the demographic analysis of road accidents indicates a significant gender disparity, with males comprising 89% of the total fatalities in 2021. Vulnerable age groups, particularly those aged 25 to 45, are most affected, indicating the need for targeted interventions for these demographics. Over speeding is the leading cause of road accidents, responsible for nearly 60% of incidents, followed by reckless driving behaviors.

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