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Statistical Analysis of Road Accidents in India

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Abstract
India's Transportation Research Department and the National Central Records Bureau issue annual traffic collision, injury, and fatality statistics. These statistics offer vital information about the nation's traffic patterns and associated problems. However, the nation's involvement in highway fatality research is disproportionately tiny, with only 0.7% of papers focusing on this area. Furthermore, injury numbers are frequently overstated. For every 1,000 road-related deaths, there exists less than one published on injuries from traffic accidents, indicating a substantial research vacuum. This emphasizes how urgently more research on diagnosing and treating injuries sustained in traffic is needed. This program is led by healthcare providers and their respective organizations, who carry out research, promote establishing initiatives to lessen injuries caused by vehicles. Improving the safety and health of the public as well as tackling the serious problem of injuries from crashes in India require this coordinated effort.

Keywords: Injury, MoRTH, trend analysis, forecasting.

Introduction

Road accidents are most common in India, according to data from government agencies including the National Crime Records Bureau and the Ministry of Highways and Road Transport. Whereas causal analysis looks at environmental elements, safety laws, driver conduct, and road conditions, geographic analysis finds geographical inequalities and possible underlying causes. In order to effectively manage traffic accidents in India, it is essential to comprehend risk variables and demographic differences. Model construction and efficacy can be predicted with the aid of regression analysis and spatial analytic approaches.

Initiatives for evidence-based policymaking that aim to lower traffic accidents and raise road safety in India are informed by these insights [1]. Tailoring everyone can benefit from safer driving environments provided interventions are tailored to specifically target money in areas that can have the greatest impact and attend to the needs of vulnerable populations.

In India, traffic accidents pose a serious threat to the safety and health of the public and have a profound effect on both the individual and the community. The nation has an alarming number of traffic accidents annually, with a significant death and injury toll. In-depth investigation of the patterns, causes, and effects of traffic accidents in India over the past few years is the goal of this statistical analysis, which also identifies the critical areas in need of continuous improvement [2].

Millions of kilometres of roads cover India, and they serve a wide range of automobiles and users, such as motorcyclists, cyclists, walkers, and operators of different types of motorized vehicles. The administration of road safety is faced with substantial issues due to diversity, which are exacerbated by variables such increasing urbanization, insufficient infrastructure, uneven traffic law enforcement, and socioeconomic inequality.

In addition to their severe human cost, road accidents in India often result in large financial outlays for healthcare, property damage, and missed production [3]. Families, communities, the country's response to emergencies and healthcare systems are all impacted by these costs. Thus, a full grasp of the financial effects of traffic accidents is necessary in order to prioritize expenditures in road safety measures and advocate for the allocation of resources [4].

This book aims to contribute to the conversation about highway safety throughout India by providing trustworthy information about the complex mechanics of collisions. Our goal is to provide stakeholders, academics, and politicians with the knowledge they need to put focused initiatives and regulations into place that will drastically lower both the severity and frequency of traffic accidents. Careful statistical analysis and perceptive data interpretation will be used to achieve this.

Objective

1. To study the cause of accidents corrective measures.
2. To analyse road severity trends over time (yearly).

Data and Methodology

The first step in the process of evaluating traffic accidents in India is gathering a wide variety of information from sources like traffic authority, police files, and hospital reports[5]. This data is thoroughly cleaned and prepared to guarantee correctness and dependability. The incidence and distribution of occurrences, as well as temporal patterns like daily and seasonal fluctuations, are then summarized using descriptive statistics[6]. While causal inference explains how elements like vehicle characteristics, traffic patterns, and driver behavior affect accidents, spatial analysis and regression analysis are used to pinpoint accident hotspots. While grouping aids in identifying underlying trends, predictive modeling makes use of historical data and projected changes. Interventions to lower traffic accidents in India are guided by policy evaluation.

Analysis and result

National data of road accident

Annually released by the Administration Research Department of the Indian Ministry of Transportation and Highways of India, the "Road Injuries in India" report provides an extensive overview of vehicle registration data from the relevant State or Union Territories. The study was produced as part of the United Nations Economic and Cultural Committee for Asia and the Pacific's (UN-ESCAP) Asia Pacific Road Accidents Data (APRAD)/Indian Road Injury Data (IRAD) project. The "Road Transportation Yearbook" offers an overview of all cars that are registered. Comprehensive data on deaths resulting from accidents and suicides may be found in the study "Unplanned Fatalities and Suicides in India". A wide range of stakeholders are served by these publications, including policymakers, law enforcement officials, transportation departments, experts in road safety, academics, the media, non-governmental organizations, and others.

Indian statistical trends in road accidents, injuries and fatalities

The nation's increasing road network, rising motor vehicle usage, and growing population are all contributing factors to the rise in traffic accidents, injuries, and fatalities.All the union territories and states reported an overall of 4,61,312 traffic accidents in 2022[figure-1]. At 19% in 2005 to 33.8 percent in 2022, the percentage of fatal accidents in all traffic incidents has increased consistently. Furthermore, form 21.6 in 2005 to 36.5 in 2022, the percentage of fatalities per 100 incidents indicates the severity of traffic accidents[Table1].

Year	Number of Accidents		Number of Persons		
	Total	Fatal	Killed	Injured	Severity
2005	439255	83491	94968	465282	21.6
2006	460920	93917	105749	496481	22.9
2007	479216	101161	114444	513340	23.9
2008	484704	106591	119860	523193	24.7
2009	486384	110993	125660	515458	25.8
2010	499628	119558	134513	527512	26.9
2011	497686	121618	142485	511394	28.6
2012	490383	123093	138258	509667	28.2
2013	486476	122589	137572	494893	28.3
2014	489400	125828	139671	493474	28.5
2015	505770	132138	146555	503608	29.0
2016	484756	136459	151192	497806	31.2
2017	469242	134796	150003	467389	31.8
2018	470403	137726	157593	464715	32.4
2019	456959	145332	158984	449360	34.8
2020	372381	127307	138383	346747	37.2
2021	412432	142163	153972	384448	37.3
2022	461312	155781	168491	443366	36.5

[Table-1] Total number of road accident, fatal, persons killed, and persons injured during 2005 to 2022

Source: Data Taken from Ministry of Road Transport and Highways

Year-wise Number of Accidents and Fatal cases

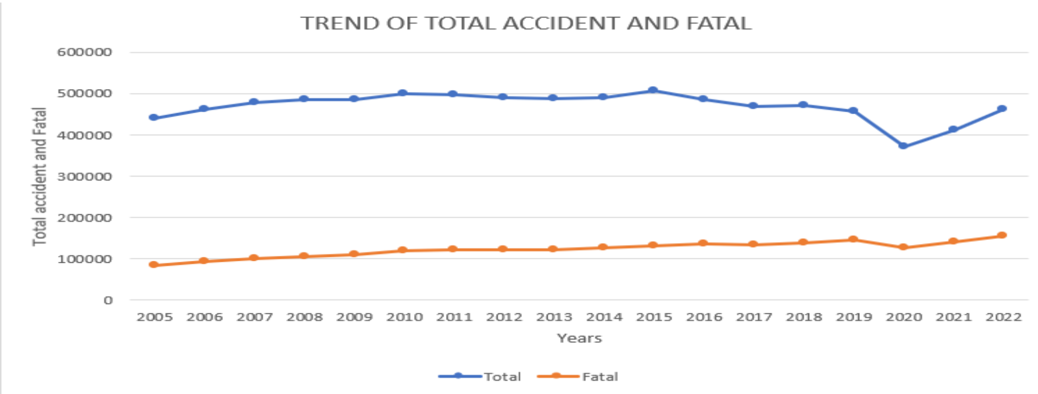


Fig (1)

From 2005 to 2022, the graph displays India's traffic accident and death trends. After a gradual fall until 2010, the COVID-19 pandemic caused a precipitous plunge in 2020. But after 2020, there was a discernible uptick, suggesting that traffic levels had returned to what they were before the pandemic. Particularly between 2020 and 2022, there has been a steady rise in the number of fatal incidents. The graph indicates that traffic control and road infrastructure upgrades have not substantially decreased fatalities, underscoring the need for more all-encompassing road safety programs.

Year-wise Total Accidents, Killed and Injured cases

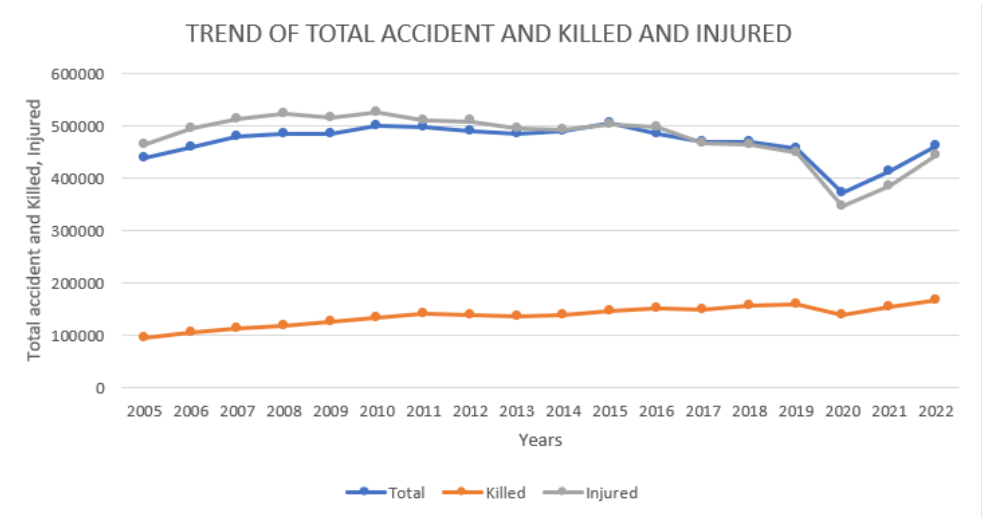


Fig (2)

India has had a consistent rise in traffic accidents, fatalities, and accidents between 2005 and 2022, primarily as a result of urbanization and car ownership. Deaths have not declined in spite of advancements in traffic management and infrastructure. In 2020, accidents significantly decreased as a result of the COVID-19 lockdowns. The rise in fatalities emphasizes the necessity of stronger car safety laws, more stringent traffic enforcement, and public awareness campaigns. Accidents have been gradually declining as a result of government initiatives including better bridges, highway designs, and traffic lights.

Year-wise Severity Rate

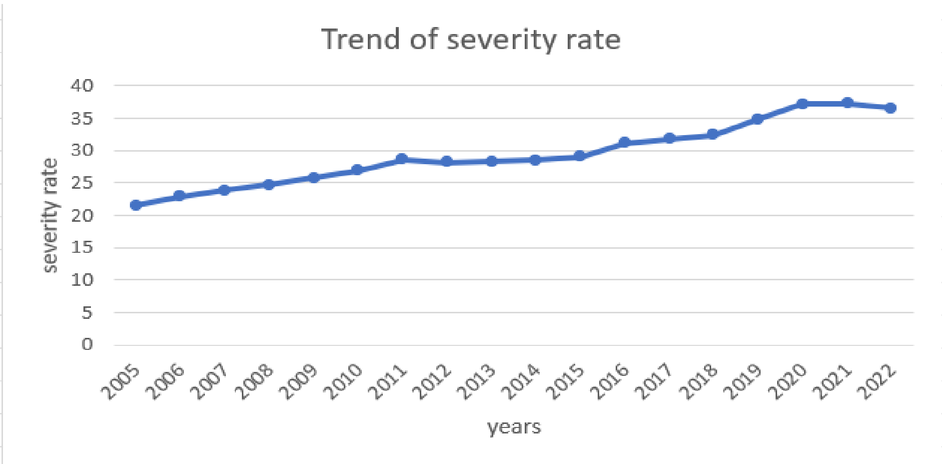


Fig (3)

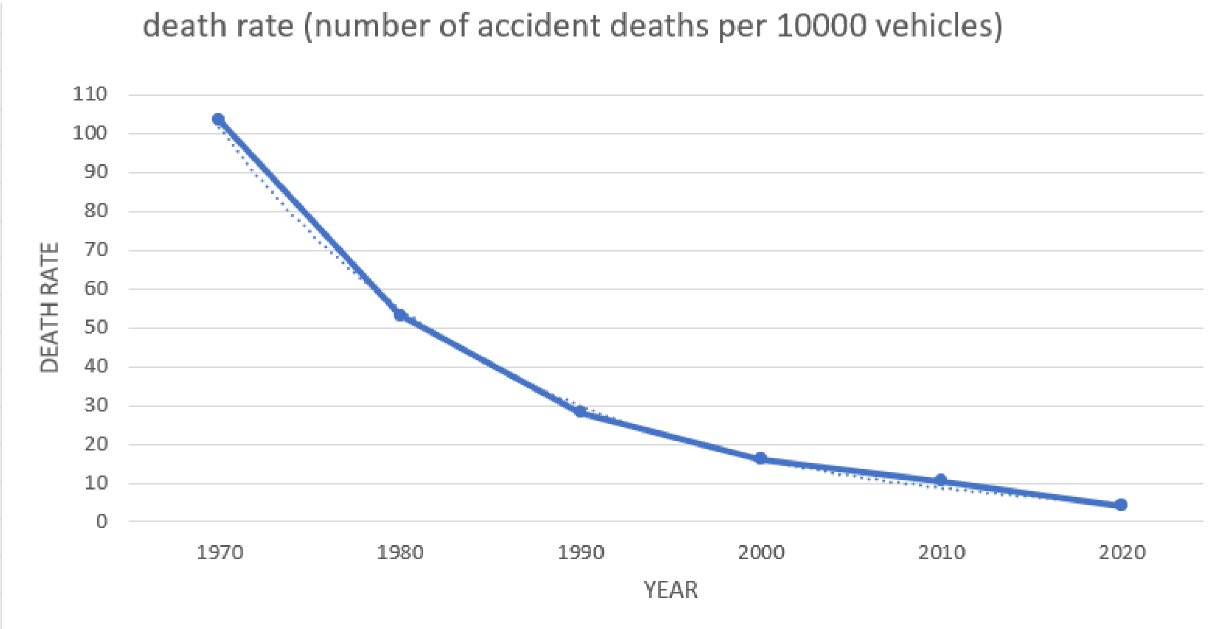
The graph indicates that the accident seriousness rate increased steadily from 2005 and 2022, with minor variations from 2012 to 2016. Despite efforts to minimize frequency, the rate increases more quickly in 2017 and peaks around 2020, indicating rising severity. The fact that the peak is close to 40 suggests that factors influencing accident severity are becoming more significant. After 2020, the rate slightly declines but is high at 35.

Decadal Trend of Death per 10000 Vehicles in India (1970-2020)

Year	**Death rate (Number of accident deaths per 10000 vehicles)**
1970	103.5
1980	53.1
1990	28.2
2000	16.2
2010	10.5
2020	4.2

Table-2 Decadal trends of death per 10000 Vehicle in India

Source: Ministry of Road Transport and Highways



The graph shows a significant decrease in fatal crashes per 10,000 vehicles between 1970 and 2020, with a peak of 105 fatalities per 10,000 vehicles in 1970. This trend continued, dropping to about 50 injuries per 10,000 vehicles by 1980, and to around 10 fatalities per 10,000 vehicles by 2010 and five fatalities per 10,000 vehicles by 2020. Advances in automobile safety, including air bags, anti-lock braking systems, electronic stability control, seat belt laws, and advanced driver aid systems, have contributed to this decline.

Trend analysis of Severity in India

Year	Severity
2005	21.6
2006	21.9
2007	23.9
2008	24.7
2009	25.8
2010	26.9
2011	28.6
2012	28.2
2013	28.3
2014	28.5
2015	29
2016	31.2
2017	31.8
2018	32.4
2019	34.8
2020	37.2
2021	37.3
2022	36.5
2023	38.0
2024	38.9
2025	39.8
2026	40.7
2027	41.6
2028	42.5
2029	43.4
2030	44.3

Table-3 Severity in different years

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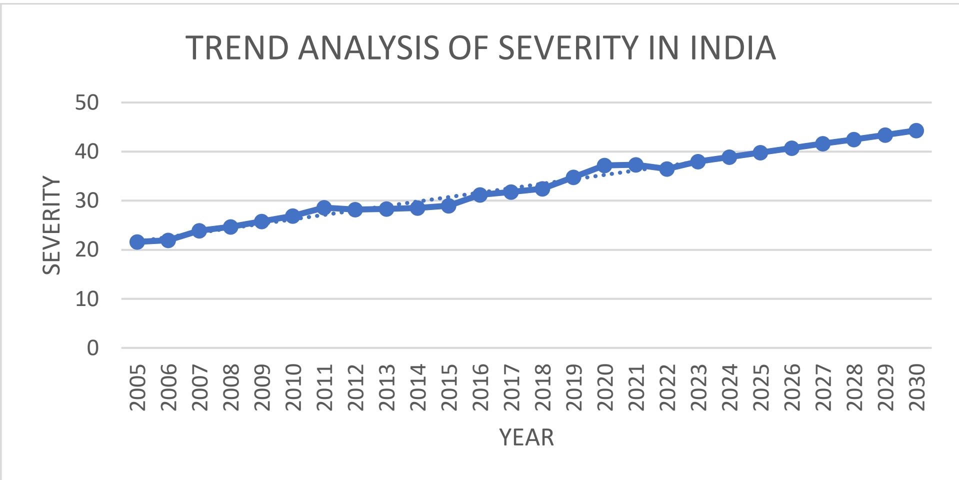


Fig (5)

According to the "Trend Analysis of Severity in India" graph, severity increased steadily between 2005 and 2030 after first somewhat increasing between 2005 and 2015. Between 2015 and 2020, growth picks up speed, and by 2030, it is expected to reach 45. This emphasizes the necessity of focused interventions and legislative actions.

Regression analysis between Severity and time (years)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.980075329
R Square	0.96054765
Adjusted R Square	0.958081879
Standard Error	0.992772081
Observations	18

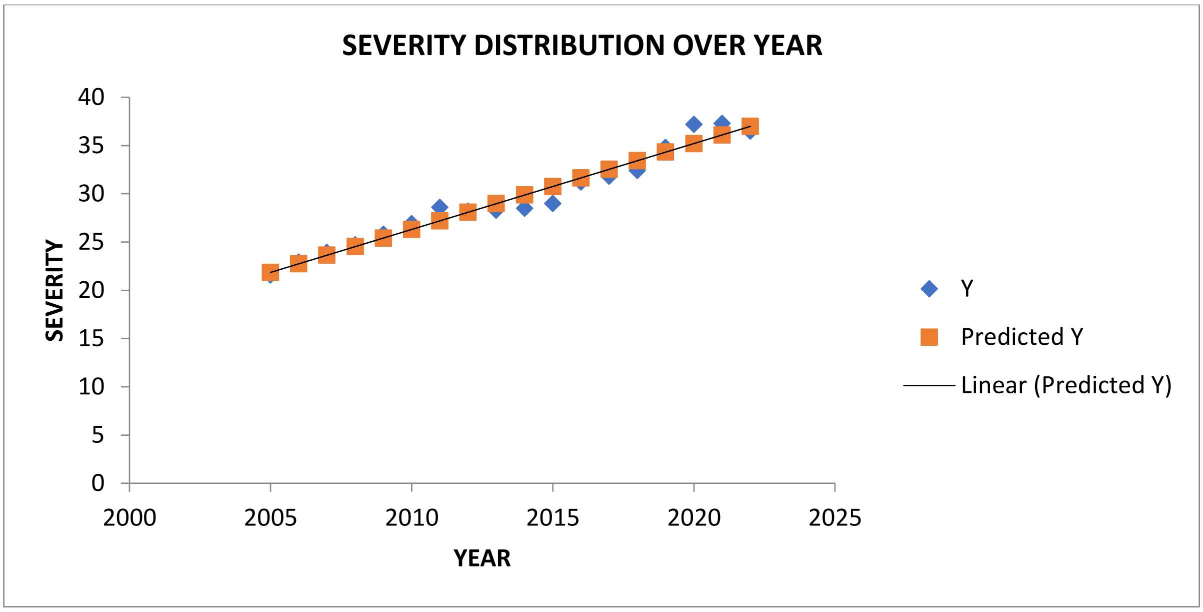
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	383.9415686	383.9416	389.552525	1.17337E-12
Residual	16	15.76954248	0.985596		
Total	17	399.7111111			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1762.98758	90.81461379	-19.413	1.514E-12	-1955.505963	-1570.469201	-1955.505963	-1570.469201
X Variable 1	0.890196078	0.045102713	19.73709	1.1734E-12	0.794582598	0.985809558	0.794582598	0.985809558

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*
1	21.85555556	-0.255555556
2	22.74575163	0.154248366
3	23.63594771	0.264052288
4	24.52614379	0.173856209
5	25.41633987	0.383660131
6	26.30653595	0.593464052
7	27.19673203	1.403267974
8	28.0869281	0.113071895
9	28.97712418	-0.677124183
10	29.86732026	-1.367320261
11	30.75751634	-1.75751634
12	31.64771242	-0.447712418
13	32.5379085	-0.737908497
14	33.42810458	-1.028104575
15	34.31830065	0.481699346
16	35.20849673	1.991503268
17	36.09869281	1.20130719
18	36.98888889	-0.488888889



Fig(6)

The "Severity Distribution Over Year" graph illustrates how severity levels in India increased from 2005 to 2025. The pattern started in 2005 and increased steadily until 2010. After 2010, the growth became more apparent, suggesting a quicker tendency. In order to address the root reasons of increasing severity levels, the graph emphasizes the necessity of swift action and changes to policy. To manage and maybe reverse this tendency and stop future high severity levels, proactive measures are required.

Correlation: Analysis between time (Year) and Severity

	Column 1	*Column 2*
Column 1	1	
Column 2	0.980075	1

The provided correlation matrix indicates a strong positive correlation between the variables "Year" (Column 1) and "Severity" (Column 2). The correlation coefficient of 0.980075 suggests that as the year progresses, the severity tends to increase. This high correlation coefficient, close to 1, implies a strong linear relationship between the two variables, meaning that changes in the year are closely associated with changes in the severity. This relationship could be useful for predicting future severity based on the year or for understanding how severity has trended over time.

Correlation: Analysis between time (Year) and Total Accidents:

Year	**Total accidents**
2005	439255
2006	460920
2007	479216
2008	484704
2009	486384
2010	499628
2011	497686

2012	490383
2013	486476
2014	489400
2015	505770
2016	484756
2017	469242
2018	470403
2019	456959
2020	372381
2021	412432
2022	461312

Table-4 Total accidents in different years

	Column 1	*Column 2*
Column 1	1	
Column 2	-0.39979105	1

The two variables in the correlation matrix, "Column 1" and "Column 2," have an exact correlation with one another. On the other hand, their -0.39979105 Pearson correlation suggests a fairly negative relationship. It is essential to comprehend this inverse relationship in order to forecast the potential effects of changes in one variable on the other. If, for example, "The column 1" and "Column 2" reflect speed and accident rate in the context of highway safety, then this negative connection indicates that, either as fatalities increase, speeds may be decreasing, or greater speeds are slightly associated to fewer accidents. When making judgments on policies and specific measures to improve road safety, this knowledge can be very helpful.

Correlation: Analysis between time (Year) and Fatal cases

Year	**Fatal**
2005	83491
2006	93917
2007	101161
2008	106591
2009	110993
2010	119558
2011	121618
2012	123093
2013	122589
2014	125828
2015	132138
2016	136459
2017	134796

2018	137726
2019	145332
2020	127307
2021	142163
2022	155781

Table-5Fatal in Different years

	Column 1	*Column 2*
Column 1	1	
Column 2	0.937902	1

The correlation matrix indicates a highly substantial positive relationship between the first column and Column 2, with a mean correlation coefficient of around 0.94. The high correlation suggests that the numbers in Column 2 tend to grow together with a rise in Column 1 values, and vice versa. When two variables are strongly correlated, it is likely that they are related and are going in the exact same direction.

Correlation: Analysis between time (Year) and killed cases

Year	**Killed**
2005	94968
2006	105749
2007	114444
2008	119860
2009	125660
2010	134513
2011	142485
2012	138258
2013	137572
2014	139671
2015	146555
2016	151192
2017	150003
2018	157593
2019	158984
2020	138383
2021	153972
2022	168491

Table-6Killed in different years

	Column 1	*Column 2*
Column 1	1	
Column 2	0.905958	1

The correlation matrix demonstrates a very high positive relationship between Columns 1 and 2, with an average correlation coefficient of nearly 0.91. This robust association suggests that the values in the second column climb in tandem with increases in Column 1 values, and vice versa. The two factors are most likely connected and will most likely move in the exact same direction, according to such a high correlation.

Correlation: Analysis between time(Year) and Injured cases

Year	Injured
2005	465282
2006	496481
2007	513340
2008	523193
2009	515458
2010	527512
2011	511394
2012	509667
2013	494893
2014	493474
2015	503608
2016	497806
2017	467389
2018	464715
2019	449360
2020	346747
2021	384448
2022	443366

Table-7 Injured in different years

	Column 1	*Column 2*
Column 1	1	
Column 2	-0.68421	1

The correlation matrix demonstrates a strong negative relationship between Columns 1 and 2, with a mean correlation coefficient of about -0.68. This strong negative correlation indicates that the values in the second column tend to decrease as the values in Column 1 rise and vice versa. Despite moving in separate directions, the two variables are nevertheless closely related, according to the considerable inverse connection.

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