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ANALYSIS OF ROAD TRAFFIC ACCIDENTS IN INDIA WITH SPECIAL FOCUS ON UTTAR PRADESH

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ABSTRACT

Road traffic accidents (RTAs) have turned out to be a huge global public health and development issues. The present paper studies the trend of RTAs in India, with special focus on Uttar Pradesh, through time series analysis. The data pertaining to RTAs and RTA fatalities has been procured from Open Government Data Platforms. Study of U.P. has been done taking the Six "Million Plus" cities of U.P. into account while states having maximum share of RTAs and RTA fatalities have been considered for intra state analysis. Accidents due to Month and Time of occurrence have been indexed while fatalities due to Mode of Transport and Type of Road have been compared.

KEYWORDS: Road Traffic Accident, Ratio to Moving Average, SPSS, t-test, Mann Whitney-U, ANOVA, Kruskal Wallis.

I. INTRODUCTION

Road traffic injuries are a prominent albeit somewhat neglected public health challenge that requires intense efforts for effective and sustainable prevention. Road traffic systems are one of the most complex and perhaps dangerous systems with which people have to deal with every day.

India ranks 1st in the number of road accident deaths across 199 countries reported in the World Road Statistics, 2018 followed by China and US. As per the WHO Global Report on Road Safety 2018, India accounts for almost 11% of the accident related deaths in the World.[6] In the year 2015, the total number of RTA was 5,01,423, which increased by 2.5% in 2014. These accidents were responsible for a death toll of 1,46,133 in the year 2015. The available data translate into 29.9% persons killed per hundred accidents in the year 2015 in India. Furthermore, about 1374 accidents and 400 deaths take place every day on Indian roads, which translate into 57 accidents and loss of 17 lives every hour on an average in our country.[4] [5] [7]

Maximum cases of RTAs have occurred in July, August and September; which correspond to the rainy season. Most accidents occurred either between 4:00 p.m. – 7:59 p.m. or between 8:00 p.m. - 11:59 p.m. Whereas, a continuous rise in the number of accidents, with respect to the time of day was also witnessed, noticeably beginning from morning and continuously progressing till the end of the day, while peaking at 4:00 p.m. - 7:59 p.m. [2]

Fatal RTAs are more prevalent on the secondary road system (47.97 per cent) and especially involve pedestrian and two-wheeler vehicle users.[1] An increased number of vehicles on the road, and reduced attention of drivers and pedestrians related to fatigue; failure in following traffic rules, associated with absence of proper infrastructure like the absence of footpaths are the greatest cause of accidents.[3]

Thereby, our study focuses on various objectives, namely; the interstate comparisons of RTAs in India, the Compound Annual Growth Rate (CAGR) and Accident Severity (AS) for Uttar Pradesh as well for India and the comparison across six "Million Plus" cities of Uttar Pradesh. The number of RTAs during 2001-2014 according to month and time of occurrence, the number of fatalities in RTAs by mode of transport during 2001-2013 and the number of RTAs by type of road and place of residence during 2013-2016 have also been taken into account.

Secondary data for the same has been taken from Open Government Data Platform and has been analyzed using Statistical Package for the Social Sciences (SPSS) software. Time series analysis using Method of Simple

Average and Method of Ratio to Moving Average has been incorporated to compute the Trend as well as the Seasonal variations. Independent sample t-test, ANOVA, Mann Whitney U test and Kruskal Wallis tests have been used to examine the differences in the RTAs and Road Accident Fatalities.

II. MATERIAL AND METHODS

A. NATURE OF DATA:

The present study is entirely based on Secondary Data contributed by the Ministry of Road Transport and Highways (MoRTH) and the Ministry of Statistics and Programme Implementation (MoSPI). Seventeen years of data (2001 - 2017) for RTAs according to month, time and place of occurrence as well as for RTA fatalities due to type of road and mode of transport has been acquired.

B. STUDY AREA:

The intra-state analysis for RTAs has been performed for the six "Million Plus" cities of U.P., i.e. (Urban Agglomerations/Cities having population of one million and above); viz; Agra, Lucknow, Meerut, Varanasi, Allahabad (Now Prayagraj) and Kanpur,

The inter-state analysis of RTAs has been done for the states in India that have the maximum share in Total RTAs as well as for the states that have the maximum share in the Total Road Accident Fatalities.

Additionally, AS and CAGR for Uttar Pradesh have been compared to that of the country as a whole.

C. STATISTICAL ANALYSIS:

Statistical Package for Social Sciences (SPSS) version 20 has been used to analyze the data and p-value below 0.05 has been considered statistically significant.

D. METHODOLOGY:

a) Accident Severity (AS): Road accident severity is measured by the number of persons killed per 100 accidents.

$$\text{Accident Severity} = \frac{\text{Number of persons killed}}{\text{Total number of accidents}} \times 100$$

b) Compound annual growth rate (CAGR):

$$\text{CAGR} = \left\{ \left(\frac{\text{Present value}}{\text{Previous Value}} \right)^{\left(\frac{1}{\text{Years}}\right)} \right\} \times 10$$

c) Tools Used for Examining the Trend are:

i. Simple Average Method: In this method, the data is averaged by hours or months or quarters or years and then the average for the period is calculated. Then we find out, what percentage it is to the grand average.

$$\text{Seasonal Index} = \frac{\text{Hourly/ Monthly/ Quarterly Average}}{\text{Grand Average of Hours or Months or Quarters}} \times 100$$

ii. Ratio to Moving Average Method: The Ratio to Moving Average method is an improvement over the Simple Average method because it assumes that the seasonal variation for a given month/ hour is a constant fraction of trend. It presumably isolates the seasonal factor. A seasonal index computed by this method ordinarily does not fluctuate as much as the index based on straight-line trends. This is because the 12-month moving average follows the cyclical course of the actual data quite closely. Therefore, the index ratios obtained by this method are often more representative of the data from which they are obtained.

d) Tests for Normality: The Shapiro–Wilk test is more appropriate method for small sample sizes (i.e. <50 samples) although it can also be handling on larger sample size, while Kolmogorov–Smirnov test is used for large sample sized (i.e. n ≥50). For both of the tests, the null hypothesis states that data for the variable in consideration has been taken from a normally distributed population.

e) Levene's test: This test is used to test if k number of samples have equal variances. Equal variances across samples is called homogeneity of variance

f) Independent Sample t-Test: The independent sample t test is used to test the hypothesis that means of two populations are the same.

g) One-way Analysis of Variance (ANOVA): is a procedure for testing the hypothesis that K population means are equal, where K > 2. The One-way ANOVA compares the means of the samples or groups in order to make inferences about the population means.

h) Kruskal - Wallis Test: The Kruskal-Wallis H test is a rank-based nonparametric test that is used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. The following table provides the Kruskal-Wallis H test values:

i) Mann Whitney U test: The Mann–Whitney U test is a nonparametric test of the hypothesis that it is equally likely that a randomly selected value from one sample will be less than or greater than a randomly selected value from a second sample. The results obtained for this Mann–Whitney U test are provided in the following table:

III. ANALYSIS

A. Time Series Analysis of Number of RTAs in Uttar Pradesh During 2001-2014 According to Month and Time of Occurrence

Table-1: No. of RTAs in U.P. in 2001-2014 according to Month of Occurrence - Simple Average Method

Time	Total	Monthly Average	Seasonal Index
January	24819	1772.79	108.49
February	23644	1688.86	103.35
March	23888	1706.29	104.42
April	22178	1584.14	96.94
May	24403	1743.07	106.67
June	22808	1629.14	99.70
July	21504	1536.00	94.00
August	21282	1520.14	93.03
September	20672	1476.57	90.36
October	21328	1523.43	93.23
November	22978	1641.29	100.44
December	25024	1787.43	109.38

Table-2: No. of RTAs in U.P. in 2001-2014 According to Time of Occurrence - Simple Average Method

Time	Total	Hourly Average	Seasonal Index
0000hrs -0300hrs	25390	1813.57	73.99
0300hrs - 0600hrs	32858	2347.00	95.75
0600hrs - 0900hrs	35622	2544.43	103.81
0900hrs - 1200hrs	40033	2859.50	116.66
1200hrs - 1500hrs	35298	2521.29	102.86
1500hrs - 1800hrs	37916	2708.29	110.49
1800hrs - 2100hrs	38768	2769.14	112.97
2100hrs - 2400hrs	28643	2045.93	83.47

Table 3: **No. of RTAs in U.P. in 2001-2014 according to Month of Occurrence -** Ratio to Moving Average Method

TIME	SEASONAL INDICES	ADJUSTED SEASONAL INDICES
January	109.9029	109.93
February	103.9611	103.99
March	104.9177	104.94
April	95.9108	95.93
May	106.0825	106.11
June	101.4925	101.52
July	93.4613	93.48
August	92.9787	93.00
October	92.8802	92.90
November	99.1986	99.22
December	108.0622	108.09
Total = **1199.7231**		
Correction Factor (C.F.) = **1.0002308**		

Table 4: **No. of RTAs in U.P. in 2001-2014 According to Time of Occurrence -** Ratio to Moving Average Method

TIME	SEASONAL INDICES	ADJUSTED SEASONAL INDICES
0000hrs - 0300hrs	74.6036	74.9689
0300hrs - 0600hrs	92.5046	92.9576
0600hrs - 0900hrs	105.3315	105.8472
0900hrs - 1200hrs	118.6610	119.2420
1200hrs - 1500hrs	102.0631	102.5629
1500hrs - 1800hrs	109.3134	109.8486
1800hrs - 2100hrs	110.7673	111.3097
2100hrs - 2400hrs	82.8574	83.2631
Total = 796.1019		
Correction Factor (C.F.) = 1.004896		

B. Analysis of Number of Fatalities in RTAs, By Mode of Transport, during 2001-2013.

Table-5: K-S test and **Shapiro-Wilk test** values for the parameters with their respective level of significance

S. No.	Parameters	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	d.f.	Sig.	Statistic	d.f.	Sig.
1.	**No. of Fatalities, by Mode of Transport (2001-13)**	.134	117	**0.000***	.879	117	0.000*
2.	**No. of RTAs, by Type of Road (2013-16)**	.114	42	0.199	.959	42	**0.133**
3.	**No. of RTAs, by Place of Residents (2013-16)**	.132	22	0.200	.92	22	**0.075**

Table-6: Kruskal Wallis test with chi square statistic and asymptotic significance.

	Mode of Transport	N	Mean Rank	Chi Square	df	Asymptotic Significance
Number of Fatalities, by Mode of Transport	Three-Wheeler	13	16.54	86.308	8	**0.000***
	Two-Wheeler	13	89.77			
	Bicycle	13	19.46			
	Pedestrian	13	45.31			
	Truck/Lorry	13	107.92			
	Bus	13	69.54			
	Tempo/Vans	13	51.23			
	Jeep	13	81.19			
	Car	13	50.04			
	Total	117				

Table-7: Mann Whitney-U test for all the possible combinations of States.

S. No.	Mode of Transport	Mean Rank	Mann-Whitney U	Asymp. Sig. (p-value)	S. No.	Mode of Transport	Mean Rank	Mann-Whitney U	Asymp. Sig. (p-value)
1.	Three-Wheeler	7.23	3.000	**0.000***	19.	Bicycle	8.08	14.000	**0.000***
	Two-Wheeler	19.77				Tempo/Vans	18.92		
2.	Three-Wheeler	12.15	67.000	0.369	20.	Bicycle	7.00	0.000	**0.000***
	Bicycle	14.85				Jeep	20.00		
3.	Three-Wheeler	8.31	17.000	**0.001***	21.	Bicycle	9.23	29.000	**0.004***
	Pedestrian	18.69				Car	17.77		
4.	Three-Wheeler	7.00	0.000	**0.000***	22.	Pedestrian	7.00	0.000	**0.000***
	Truck/Lorry	20.00				Truck/Lorry	20.00		
5.	Three-Wheeler	7.00	0.000	**0.000***	23.	Pedestrian	8.69	22.000	**0.001***
	Bus	20.00				Bus	18.31		
6.	Three-Wheeler	8.23	16.000	**0.000***	24.	Pedestrian	12.15	67.00	0.369

	Tempo/Vans	18.77		
7.	Three-Wheeler	7.00	0.000	**0.000***
	Jeep	20.00		
8.	Three-Wheeler	8.62	21.000	**0.001***
	Car	18.38		
9.	Two-Wheeler	19.77	3.000	**0.000***
	Bicycle	7.23		
10.	Two-Wheeler	18.92	14.000	**0.000***
	Pedestrian	8.08		
11.	Two-Wheeler	9.92	38.000	**0.017***
	Truck/Lorry	17.08		
12.	Two-Wheeler	17.08	38.000	**0.017***
	Bus	9.92		
13.	Two-Wheeler	18.54	19.000	**0.001***
	Tempo/Vans	8.46		
14.	Two-Wheeler	16.54	45.000	**0.043***
	Jeep	10.46		
15.	Two-Wheeler	18.23	23.000	**0.002***
	Car	8.77		
16.	Bicycle	8.08	14.000	**0.000***
	Pedestrian	18.92		
17.	Bicycle	7.00	0.000	**0.000***
	Truck/Lorry	20.00		
18.	Bicycle	7.00	0.000	**0.000***
	Bus	20.00		

	Tempo/Vans	14.85		
25.	Pedestrian	7.62	8.000	**0.000***
	Jeep	19.38		
26.	Pedestrian	13.15	80.000	0.817
	Car	13.85		
27.	Truck/Lorry	19.92	1.000	**0.000***
	Bus	7.08		
28.	Truck/Lorry	20.00	0.000	**0.000***
	Tempo/Vans	7.00		
29.	Truck/Lorry	19.92	1.000	**0.000***
	Jeep	7.08		
30.	Truck/Lorry	20.00	0.000	**0.000***
	Car	7.00		
31.	Bus	16.77	42.00	**0.029***
	Tempo/Vans	10.23		
32.	Bus	10.50	45.000	**0.045***
	Jeep	16.50		
33.	Bus	15.96	52.500	0.101
	Car	11.04		
34.	Tempo/Vans	8.38	18.000	**0.001***
	Jeep	18.62		
35.	Tempo/Vans	13.62	83.000	0.939
	Car	13.38		
36.	Jeep	18.15	24.00	**0.002***
	Car	8.85		

C. Analysis of Number of Road Accidents, By Type of Road, During 2013-2016

Table-8: Levene's Test of Homogeneity of Variances

		Levene's Statistic	d.f. 1	d.f. 2	Sig.
No. of RTAs, by Type of Road	Based on Mean	.388	2	39	**0.68**

Table-9: ANOVA Table for Number of RTAs, by Mode of Transport

	Sum of Squares	d.f.	Mean Square	F	Sig.
Between Groups	250672682.714	2	125336341.357	16.283	**0.000***
Within Groups	300189702.357	39	7697171.855		
Total	550862385.071	41			

Table-10: Multiple Comparisons for number of RTAs, by Mode of Transport

	(I) Type of Road	(J) Type of Road	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**National Highways**	State Highways	1548.071	1048.616	0.148	-572.96	3669.10
		Others	5780.071	1048.616	**0.000***	3659.04	7901.10
	State Highways	National Highways	-1548.071	1048.616	0.148	-3669.10	572.96
		Others	4232.000	1048.616	**0.000***	2110.97	6353.03
	Others	National Highways	-5780.071	1048.616	**0.000***	-7901.10	-3659.04
		State Highways	-4232.000	1048.616	**0.000***	-6353.03	-2110.97

D. Analysis of Number of RTAs by Place of Residence During 2013-2016.

Table-11: Levene's test and Independent t-test statistics

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
No. of RTAs, by Place of Residents	**Equal variances assumed**	0.02	**0.89**	2.68	20	**0.014***
	Equal variances not assumed			2.68	19.88	**0.014***

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IV. RESULTS

Fig-1. Share of five States having maximum RTAs in 2017

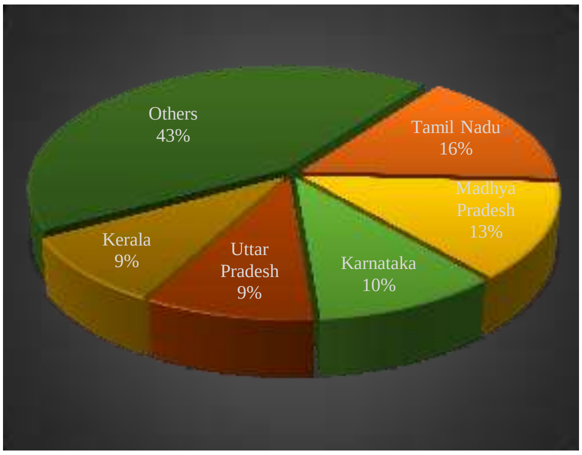
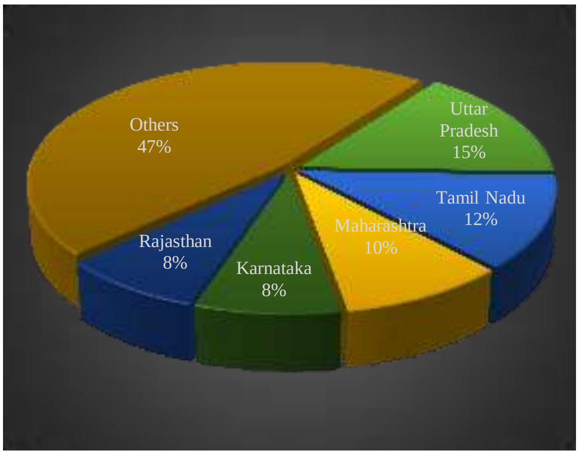


Fig-2. Share of five states having maximum RTA Fatalities in 2017



- We conclude from Fig. 1 and 2 that in 2017, the top 5 States accounted for 57% of the total RTAs and 53% of the total RTA fatalities. Tamil Nadu had the maximum number of RTAs while the maximum number of RTA fatalities were in Uttar Pradesh. Kerala and Madhya Pradesh had a high number of RTAs but the fatalities were relatively less. Maharashtra and Rajasthan had high number of fatalities even when the RTAs were comparatively less.

Fig-3. Share of RTAs for the six "Million Plus" Cities in U.P. from 2012 - 2016

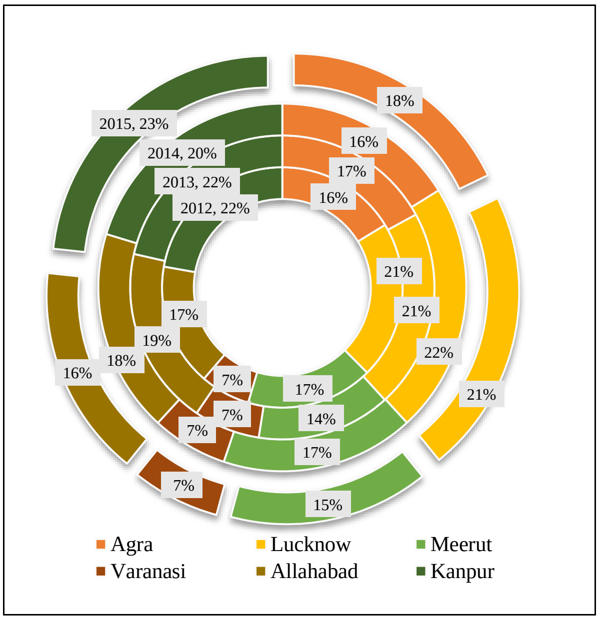
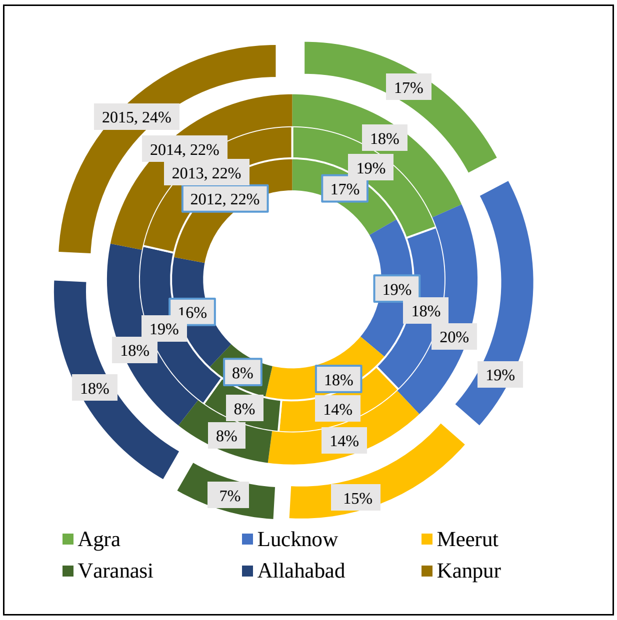


Fig-4. Share of RTA Fatalities for the six "Million Plus" Cities in U.P. from 2012 - 2016



- Fig. 3 shows that the maximum number of RTAs occurred in Kanpur in 2012, 2013 and 2015, while for the year 2014, maximum number of RTAs took place in Lucknow. On the other hand, Varanasi accounted for the least number of RTAs in each year.

It can be seen from Fig. 4 that the maximum number of RTA fatalities were noted in Kanpur and the least were accounted for in Varanasi. Comparison across these six "million plus" cities shows that the share of Kanpur in the number of RTAs as well as in the number of road accident fatalities is the highest while in the case of Varanasi, it is the least.

Fig-5. Comparison of AS in U.P. & in India

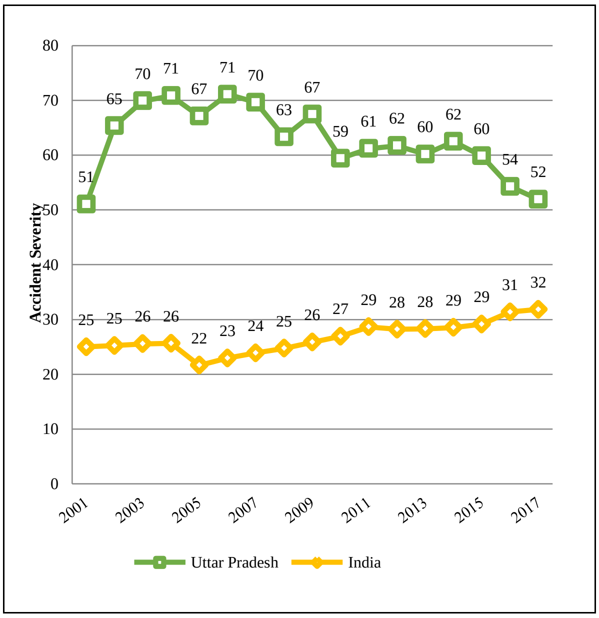
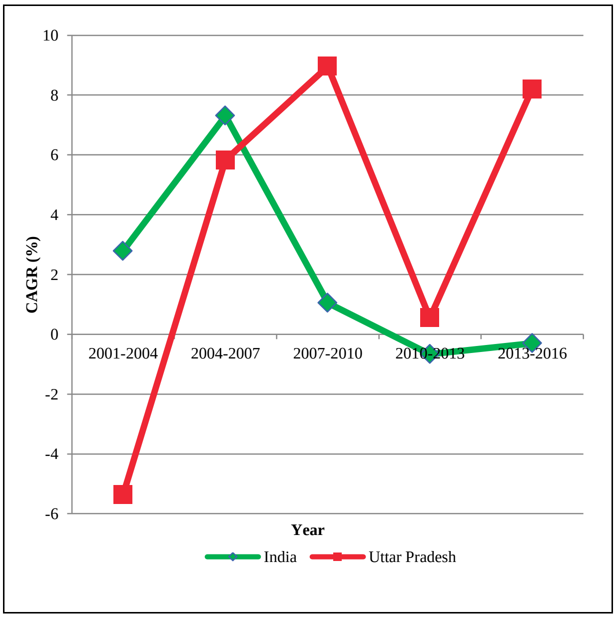


Fig-6. Comparison of CAGR of RTAs in U.P & in India



- Fig. 5 shows an increasing trend in the AS in India from 2001 to 2017 except for a decline in 2005. The AS was the highest in 2017 with 32 people being killed per 100 accidents.

- On the other hand, the AS for U.P. was the highest in 2004 and 2006 and a decreasing trend can be seen after 2014. Overall, an improvement in AS is seen in U.P. but not at the national level despite the fact that AS for U.P. is very high as compared to the national level. Thus, more people are losing lives (per RTA) in U.P. as compared to India.

Also, from Fig. 6, it can be noted that the CAGR of RTAs for India shows a decreasing trend with a slight increase between 2013 and 2016 whereas an increasing trend for Uttar Pradesh for the same time period with a decline from 2010 to 2013. It was highest from 2004 to 2007 at the national level and from 2007 to 2010 for U.P.

Fig 7. Number of Road Accidents according to day and night hours

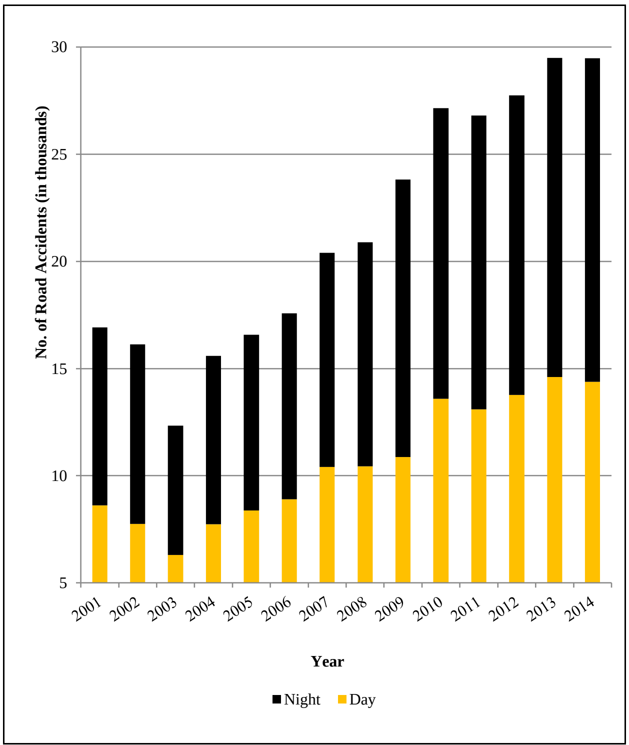
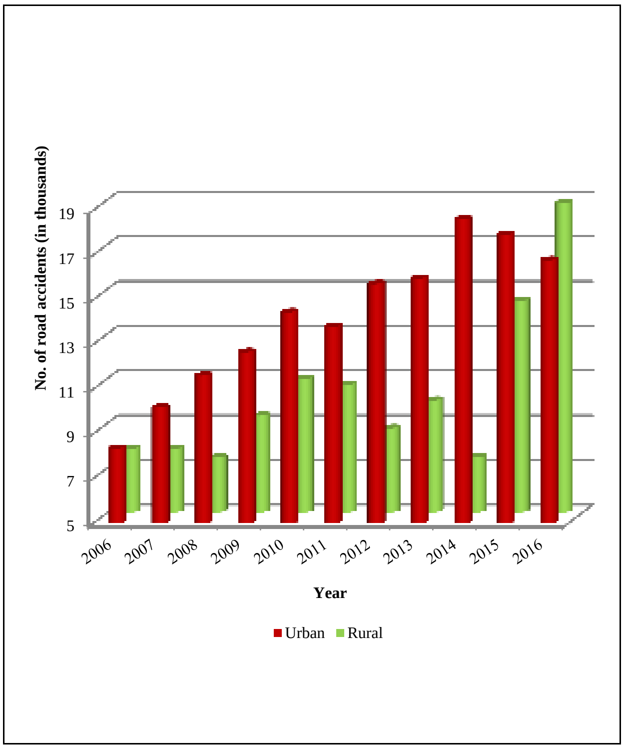


Fig 8. Number of Road accidents according to Type of Residence



- From Fig. 7, it is clearly visible that almost the same number of RTAs happen during the day and the night hours.

An increasing trend in the number of RTAs can be seen in urban areas between 2006 and 2016 with a decline from 2011 to 2013 in Fig. 8. On the other hand, there are a lot of fluctuations in the number of RTAs in rural areas but recently they seem to be rising.

- Table 1 indicates that highest number of RTAs during 2001 to 2014 occurred in December when calculated through Simple Average Method while in Table 3 it is for the month of January when Ratio-to-moving average method is used. Nevertheless, both the tables show that the major peaks are in the month of January, May and December (as shown in Fig 9).

Table 2 and Table 4 show similar trends, viz; RTAs during 2001 to 2014 prevailed during the day from 9 a.m. to 12 p.m. and dropped during the night from 12 a.m. to 3 a.m. (as shown in Fig 10)

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Fig 9. Number of Road Accidents during 2001-2014

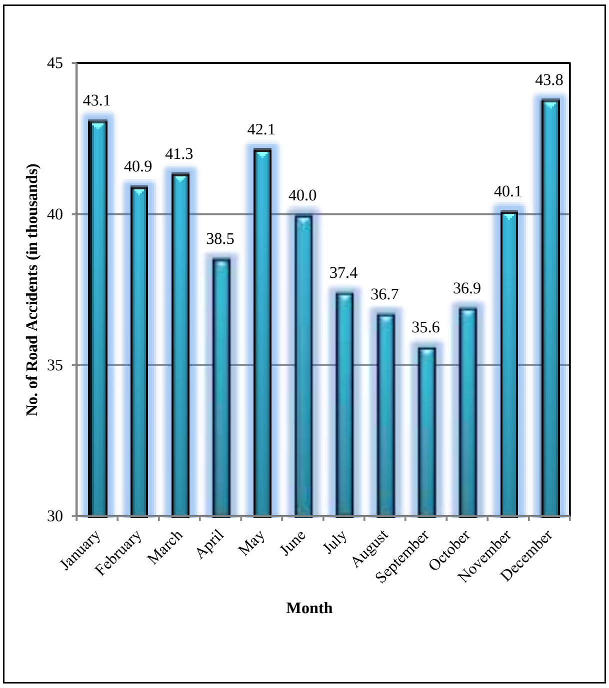
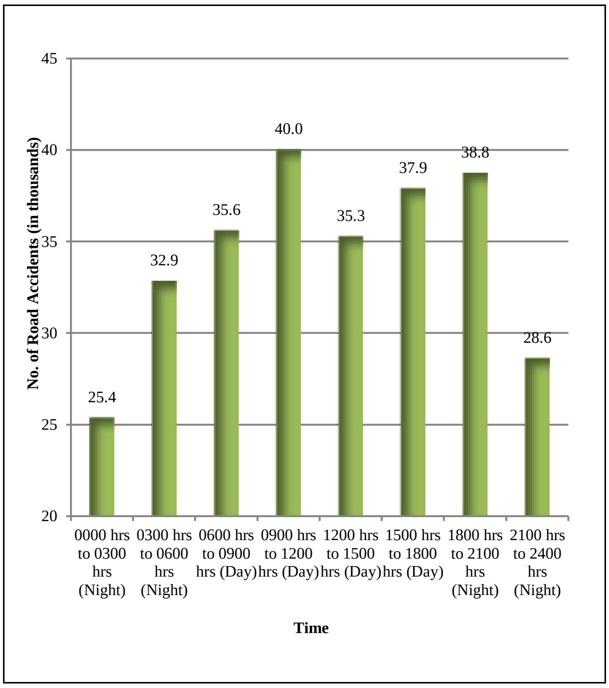


Fig 10. Number of Road Accidents during 2001-2014



- Parameter no. 1 in Table 5 has 117 observations (>50), thus we check the p-value obtained through K-S test and conclude that it does not follow normal distribution as p-value (0.00) less than 0.05. On the other hand, parameters numbered 2 and 3 have less than 50 observations, thus we check Shapiro-Wilk statistic and conclude that they follow normal distribution as their significant values are greater than 0.05.

- It is evident from Table 6 that there is significant difference in the number of RTA fatalities due to mode of transport as the p-value is 0.00<0.05.

With the help of Post hoc tests performed in Table 7, it is derived, that excluding the five combinations, viz; three-wheeler & bicycle, pedestrian & tempo/ vans, pedestrian & car, bus & car, and tempo/ vans & car, which have no significant difference in the number of RTA fatalities, all the other combinations of Transport have a significant difference in the number of RTA fatalities that they cause.

- With the help of Table 8, the hypothesis for equality of variances is accepted as the p-value for Levene's test is 0.68 (greater than 0.05).

Now, as the p-value in the ANOVA table (Table 9) is 0.00, (less than 0.05), we can establish that the RTAs according to Road Type differ significantly. We thus go forward with Post hoc tests.

From Table 10, we draw the inference that there is no significant difference in the number of RTAs happening on National Highways or State Highways as p-value (0.148) > 0.05. But there is significant difference in the number of RTAs happening on 'Other Roads' from both the State and National highways.

- Through Table 11 we see that the p-value (0.890) for Levene's test is greater than 0.05, inferring that the variances are equal. For the Independent t-test, the p-value (0.014) is less than 0.05, so we reject the null hypothesis and reckon that there is significant difference on the number of RTAs in Urban and Rural areas. Through Fig. 8 we can say that a greater number of road accidents happen in urban area as compared to rural area.

V. CONCLUSION

Uttar Pradesh had the maximum number of road accident fatalities with a share of 15 per cent and a share of 9 per cent in total road accidents in 2017. From 2013 to 2016, both India and U.P. shown an increasing CAGR with the growth rate being steeper for U.P. Keeping in mind the steep rise in the number of road accidents, injuries and fatalities in recent years, many policies related to Road Safety have also been formed.

The highest number of RTAs during 2001 to 2014 occurred in the month of December followed by the month of January which can be attributed to the foggy conditions. Also, the peak in the month of May can probably be due to increase in the number of people who travel during the summer vacations. The rise of RTAs from 9am to 12pm may be accredited to the large number of people attending schools or offices with the fear of being late which makes them less conscious about driving. Not only this, the lowest number of RTAs from 2001 to 2014 happened from 12am to 3am which can be associated with people being more attentive at night because heavy vehicles are on the move during that time.

Additionally, Three-Wheeler has been deduced as the safest mode of transport, while Truck/ Lorry increase the chance of RTA fatalities.

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VI. REFERENCES

[1] Farooqui JM, Chavan KD, Bangal RS, Syed MMA, Thacker PJ, Alam S, Sahu S, Farooqui AAJ, Kalakoti P. (2013). Pattern of injury in fatal road traffic accidents in a rural area of western Maharashtra, India. The Australasian medical journal. 6. 476-82. 10.4066/AMJ.2013.1839.

[2] Khan, M. H., & Kirmani, S. (2014). Epidemiology of road traffic accidents in western Uttar Pradesh, India: A hospital-based study. Annual Research & Review in Biology, 412-422.

[3] Menon, A., Pai, V. K., & Rajeev, A. (2008). Pattern of fatal head injuries due to vehicular accidents in Mangalore. Journal of forensic and legal medicine, 15(2), 75-77.

[4] Road accidents in India issues and dimensions. Ministry of road transport & highways, Government of India; 2015.

[5] Road accidents in India 2016. Government of India, Ministry of road transport & highways transport research wing, New Delhi, www.morth.nic.in

[6] Saluja N. (2019, November 19). Road accidents claimed over 1.5 lakh lives in 2018, over-speeding major killer. The Economic Times. Retrieved from http://tiny.cc/RoadAccidents

[7] Sharma SM. (2016) Road Traffic Accidents in India. Int J Adv Integ Med Sci; 1(2): 57-64.