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THE EFFECTS OF MONTHWISE SEASONAL INSTABILITY OF ROAD ACCIDENTS - A CASE STUDY OF TIRUCHIRAPALLI DISTRICT

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Abstract

The major objective of this study is to examine the seasonal instability of road accidents in Tiruchirappalli District. The relevant data were obtained during the year 2011-2015 and the victims of accidents were registered in month wise. In this study has been intended Multiplicative Seasonal decomposition to fatal accidents, Non-fatal accidents, Person died and Person injured. Using the method of time series decomposition, the road accidents were categorized to have an upward trend and significant seasonal influences. Based on the results were proffered on when to increase the phenomenon of road accidents and its consequences in the district.

Key Word: Fatal Accidents, Multiplicative Model, Non-Fatal Accidents and Seasonal Instability.

Introduction

Road accident can be said to be an unexpected occurrence of motor vehicles crash that may result in injuries, loss of lives and properties. Road accidents are having a worsening effect on our society and economy. It claims the largest toll of human life and tends to be the most serious problem all over the world (Kuel et al., 2005). Almost three-quarters of deaths causing from motor vehicles crashes happen in developing countries (Odero, 1998) and this problem seems to be growing rapidly in these countries (Jacobs et al., 2000). According to the study conducted by National Transportation Planning and Research Centre, New Delhi, a person is killed or injured in every 4 min in road accidents in India (Tirpude et al., 1998).

India has the world's most unsafe roads and the situation seems to be getting worse by the year. Over 400 people were killed in road accidents every day in 2015, government data reveals. Fresh data submitted by the Ministry of Road Transport and Highways in the Rajya Sabha 1st week of May 2016 indicates just how alarming the situation. There are 1,46,133 people were killed in road accidents in 2015, a 4.6% rise over 2014 when 1,39,671 people were killed. In the past one decade, over 1.3 million people have been killed in road accidents but there is still no comprehensive road safety legislation in the country. According to the 234th report of the Standing Committee on Transport, Tourism and Culture which has recently been tabled in Parliament, there are several stumbling blocks for replacing the existing Motor Vehicles Act with a proposed Road Transport and Safety Bill, 2015.

According to the report, the Ministry wanted to change the entire architecture over road transport and road safety in the whole country, basically, setting up a set of authorities at the Central level and the State level to control all aspects of transport and public transport including driving licenses.

While it is well established that our roads and highways are deadly to travel on, according to the data, the states with the highest number of road accidents in 2015 are Tamil Nadu, Maharashtra, Madhya Pradesh, Karnataka and Kerala. These states contribute 29.66% to the total number of accidents recorded nationwide. The same states also recorded the highest number of injuries at 2,75,873 in 2015 (Vishnu Som, 2016).

Inadequate traffic planning control is one of the causes in India. The rise in number of vehicles and rate of vehicular accidents could be judged on the basis of the heavy postmortem rate, reported in India in recent years (Ramakant et al., 2014). It is related to vehicular injuries and eventually death of victims may call upon the entire spectrum of Forensic expertise.

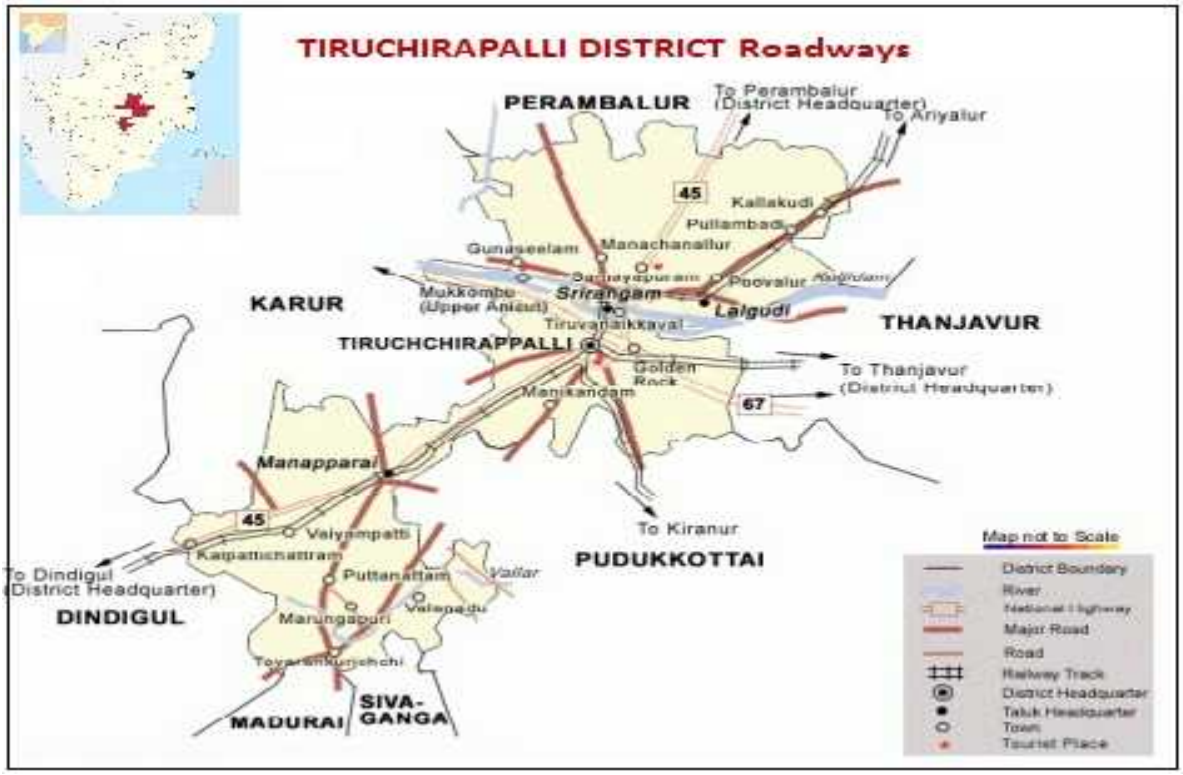
In 2014, Tamil Nadu had the highest number of road accidents in the country and the highest number of deaths. Media reports invariably say that the Indian roads are considered some of most dangerous in the world. The state also topped the list of most accidents in a state for all previous ten years from 2002 to 2012.

A few political leaders have vehemently opposed the state-run TASMAC shops that sell alcohol and have called for a total prohibition of alcohol in the state, but opposing government has maintained that prohibition would lead to illegal liquor,

which in the past has claimed hundreds of lives. The increase in number of vehicles from 82 lakh (8.2 million) in 2007 to 1.6 crore (16 million) in 2012 without appreciable change in the road infrastructure is also believed to the reason for most road accidents.

For the purpose of the study and better understanding of seasonal variations of road accidents, monthly records of road accidents were examined for in Tiruchirappalli District on seasonal basis for the periods of 5 years (2011 - 2015).

Study Area



Tiruchirappalli district is situated in the centre of Tamil Nadu state, on the banks of river Cauvery. It has a moderately dry climate, with humidity slightly above normal. The city experiences mild winters and humid summers. The monsoon rains in this part of the country over the past few years have become unpredictable, with the rainy season starting between mid-October and early-November and extending until early or mid-January. This district has an area of 11,095 square kilometers, bounded on the north by Namakkal district, to the east by Thanjavur district, to the south by Sivaganga and Madurai districts and to the west by Karur district.

According to the National Urban Sanitation Policy, Tiruchirappalli is listed as the third-cleanest city in India in 2016. It has a well-developed transport infrastructure. The National Highways NH 45, NH 45B, NH 67, NH 210 and NH 227 pass through the city. As of 2013, approximately 328,000 of two-wheelers, 93,500 of cars and 10,000 of public transport vehicles operate within the city limits apart from the 1,500 inter-city buses that pass through Tiruchirappalli daily (Muthiah, 2012). Tiruchirappalli suffers from traffic congestion mainly because of its narrow roads and absence of an integrated bus station.

Materials and Methods

Data for the study were collected on monthly basis from the District Police Office Tiruchirapalli for the period January 2011 December 2015. The data were classified into Fatal accidents, Non-fatal accidents, Person died and Person injured. The respective time-sequence data were collected at regular interval (monthly), we would adopt the technique of time series analysis in analyzing the data. Descriptive statistics would also be used to summarize the data.

Time series analysis refers to that body of principles and techniques, which deal with analysis of the observed data X_t , t = 1, 2, ...n. Usually the data are analyzed in order to gain an understanding of the underlying generating mechanism of the

process, X_t, $t \in Z$ (Delurgio, 1998; Priestley, 1981). Since the emphasis on time series analysis is on model building, the following model is always considered.

Additive model : $X_t = T_t + S_t + C_t + I_t$ (1)

Multiplicative model : $X_t = T_t \times S_t \times C_t \times I_t$ (2)

Multiplicative with additive error model : $X_t = T_t + S_t \times C_t \times I_t$ (3)

Where for time t, X_t denotes the observed value of the series, T_t is the trend, S_t is the seasonal component, C_t is the cyclical component and I_t is the irregular component of the series (Chatfield, 2004; Kendall and Ord, 1990).

In the following Table (1) indicates that the standard deviation is not stable and mimics the mean. It increases with the mean suggesting a multiplicative model. The statistical software STATGRAPHICS Centurion was used to decompose the data into its components namely; the trend, seasonal and irregular (Residuals) components as well as plotting the respective graphs by using Origin software.

Result and Discussion

The seasonality decomposition data (Fatal, Non-fatal, Person died and injured) contain for a period of n=60 months from January 2011 through December 2015. Road accidents data were presented in a two dimensional table. A time series plots of the yearly mean and standard deviations are shown in the following table (1).

Table 1: Descriptive Statistics

Variable		Sum	Mean	S.E.	S.D.
Fatal Accidents	2011	497	41.42	1.86	6.44
	2012	513	42.75	1.81	6.27
	2013	511	42.58	1.49	5.16
	2014	553	46.08	1.29	4.48
	2015	619	51.58	1.00	3.45
Non Fatal Accidents	2011	1360	113.33	4.15	14.39
	2012	1199	99.92	3.49	12.08
	2013	1117	93.08	2.99	10.35
	2014	1226	102.17	4.43	15.35
	2015	1208	100.67	4.57	15.82
Person Died	2011	538	44.83	163.87	567.68
	2012	553	46.08	163.86	567.62
	2013	555	46.25	163.94	567.91
	2014	623	51.92	163.52	566.45
	2015	659	54.92	163.34	565.84
Person injured	2011	2780	231.67	149.16	516.7
	2012	2602	216.83	149.72	518.65
	2013	2346	195.5	151.7	525.51
	2014	2534	211.17	150.36	520.85
	2015	2793	232.75	148.87	515.72

The multiplicative seasonal the decomposition is used to separate into trend-cycle, seasonal, and random components. The data cover 60 time periods. The following tables show that the seasonal decomposition of Fatal accidents and person died, Non-fatal accidents and person injured.

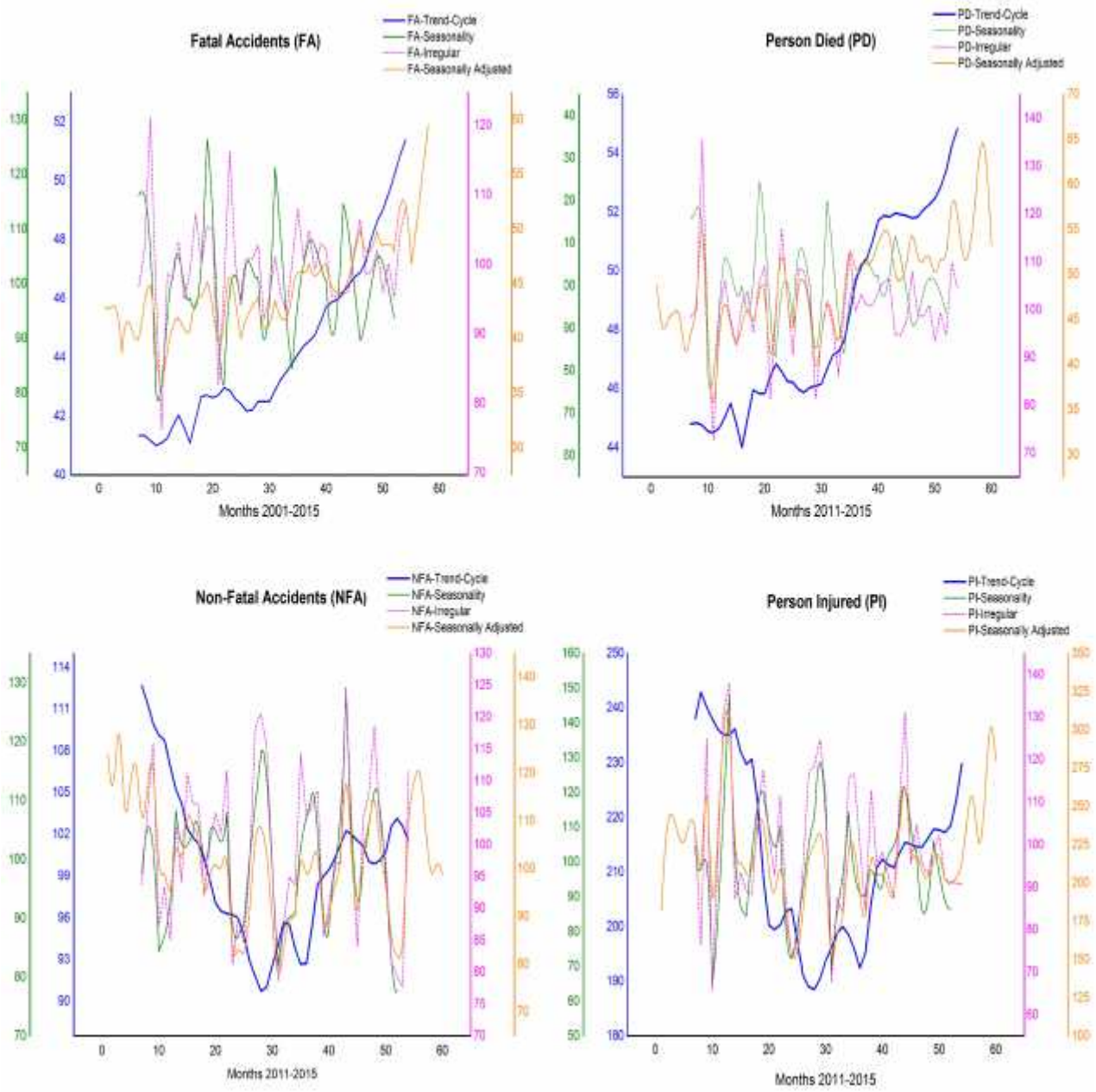
Table 2: Seasonal Decomposition of Road Accidents

Month	Fatal accident				Person died				Non-fatal accident				Person injured			
	Trend-Cycle	Seasonality	Irregular	Seasonally Adjusted	Trend-Cycle	Seasonality	Irregular	Seasonally Adjusted	Trend-Cycle	Seasonality	Irregular	Seasonally Adjusted	Trend-Cycle	Seasonality	Irregular	Seasonally Adjusted
1				42.9166				48.7539				123.934				181.811
2				41.7004				42.6501				111.521				244.692
3				45.6921				45.4263				137.866				246.724
4				38.6911				45.5133				105.232				229.754
5				45.0281				46.7171				119.019				222.652
6				38.548				39.5413				125.442				242.001
7	41.3333	116.129	97.0702	40.1224	44.7917	116.093	98.4963	44.1181	112.667	97.6331	93.7491	105.624	238.042	104.183	102.12	243.089
8	41.3333	118.548	102.32	42.2923	44.8333	113.755	99.8448	44.7637	111.417	109.499	105.24	117.255	242.875	80.6999	76.0316	184.662
9	41.1667	116.599	121.351	49.9581	44.75	136.313	135.588	60.586	109.917	110.083	116.017	127.522	240.167	131.159	124.907	299.985
10	41	80.4878	93.8062	39.2806	44.5417	78.5781	93.5049	41.6486	109.125	84.307	87.1281	95.0786	238	64.7059	65.4086	155.673
11	41.0833	70.7882	76.5841	31.4633	44.5	65.1685	72.4958	32.2606	108.75	87.3563	93.3786	101.549	236.083	76.6678	98.6131	232.809
12	41.25	101.818	99.1436	40.8967	44.6667	102.985	99.7637	44.5611	106.875	86.0819	85.019	90.8641	235.083	117.831	130.885	307.69
13	41.6667	100.8	98.318	40.9658	45.0417	106.588	106.033	47.7589	105.208	108.356	103.3	108.681	235.125	148.006	137.996	324.464
14	42.0417	114.372	103.501	43.5135	45.5	107.692	97.7252	49.465	104.25	98.801	94.1741	98.1765	236.125	83.0069	87.1723	205.836
15	41.5833	93.7876	95.23	39.5998	44.7917	91.5349	92.4021	41.3884	102.417	102.522	111.294	113.983	231.958	86.6535	93.3601	216.557
16	41.0833	97.3631	99.1339	40.7275	44	100	101.141	44.5019	101.75	104.177	106.434	108.297	229.708	84.4545	89.0086	204.46
17	41.875	93.1343	107.53	45.0281	45	88.8889	103.816	46.7171	101.333	113.487	106.355	107.773	230.625	102.764	88.3424	203.74
18	42.6667	93.75	100.38	42.8289	45.9583	91.3871	95.0957	43.7035	100.167	90.8486	91.905	92.0581	222.792	122.536	107.832	240.241
19	42.7083	126.439	105.688	45.1377	45.8333	124.364	105.513	48.3603	98.6667	104.392	100.239	98.9025	209.042	120.072	117.684	246.03
20	42.625	121.994	103.294	44.8816	45.8333	124.364	109.157	50.0301	97.0417	109.231	104.983	101.877	200.25	108.365	102.096	204.447
21	42.7083	79.6098	82.854	35.3856	46.4167	81.8671	81.3115	37.7421	96.4583	96.4147	101.611	98.0126	199.417	97.2837	92.6464	184.752
22	42.9583	81.4743	96.9805	41.6612	46.8333	83.274	99.0928	46.4085	96.2917	108.005	111.619	107.48	200.333	110.316	111.514	223.4
23	42.875	107.289	116.402	49.9073	46.5833	105.188	117.015	54.5094	96.2083	75.877	81.1079	78.0326	202.75	67.0777	86.2778	174.928
24	42.5833	103.327	100.613	42.8442	46.25	100.946	102.632	47.4675	95.9583	89.6222	88.5157	84.9382	203.25	65.9287	73.2332	148.846
25	42.4167	96.6801	94.2801	39.9905	46.2083	90.8927	90.4362	41.789	94.75	88.6544	84.5176	80.0804	197.25	81.6223	76.1019	150.111
26	42.1667	111.462	101.044	42.6069	45.9583	119.674	108.598	49.9096	92.875	101.211	96.4715	89.5979	191.083	90.0131	94.5301	180.631
27	42.2083	99.5064	101.037	42.6459	45.875	106.812	107.824	49.4642	91.7917	108.542	118.263	108.556	189	108.466	116.86	220.866
28	42.5	101.176	101.017	43.7821	46.0417	99.9095	101.049	46.5247	90.7083	117.96	120.517	109.319	188.5	112.467	118.531	223.431
29	42.5	80	92.3652	39.2552	46.0833	89.4394	81.1001	37.3736	91	123.077	115.343	104.962	190.5	145.407	125.001	238.126
30	42.5	89.4118	95.7352	40.6874	46.1667	90.9747	94.6648	43.7035	92.5833	95.0495	96.1547	89.0233	193.875	126.37	111.206	215.601
31	42.875	121.283	101.378	43.4659	46.6667	120	101.811	47.5118	94	81.9149	78.6562	73.9368	196.125	68.8337	67.4706	132.327
32	43.25	110.983	95.7901	41.4292	47.125	110.345	96.8319	45.6415	95.6667	90.9408	87.4036	83.6161	198.75	93.0818	87.6972	174.298
33	43.5	89.6552	93.3088	40.5893	47.25	86.7725	86.1835	40.7217	95.5	90.0524	94.9061	90.6353	199.958	88.0183	83.8227	167.61
34	43.7917	84.491	100.571	44.0418	47.625	83.9895	99.9442	47.5984	93.7917	90.6264	93.659	87.8443	198.583	114.31	115.551	229.465
35	44.0833	99.811	106.289	47.7374	48.5417	100.944	112.294	54.5094	92.6667	106.835	114.2	105.825	195.958	90.8356	116.836	228.95
36	44.375	103.662	100.939	44.7917	49.625	102.771	99.5561	49.4047	92.7083	105.708	104.403	96.79	192.417	89.9091	99.8704	192.167
37	44.5417	107.764	103.111	46.8181	50.1667	103.654	103.134	51.7388	95.375	111.14	105.954	101.054	195.25	90.1408	84.0443	164.097
38	44.75	109.497	99.2623	44.42	50.4167	111.074	100.794	50.8171	98.4167	113.802	108.472	106.755	204.375	107.645	113.047	231.04
39	45.2083	101.751	103.316	46.7075	51	100	100.947	51.4832	98.9583	78.8211	85.5646	84.6733	210.833	88.2213	95.0493	200.396
40	45.7083	100.638	102.468	46.8366	51.7083	102.498	103.667	53.6046	99.4583	88.4793	90.3965	89.9068	212.292	93.2579	98.2967	208.676
41	45.875	102.8338	97.637	43.8735	51.875	90.6024	105.817	54.8925	100.25	103.741	97.2216	97.4647	211.292	107.908	92.764	196.003
42	45.9583	89.2112	95.5265	43.8996	51.8333	102.251	106.398	55.1497	101.25	95.8025	96.9164	98.1279	210.833	99.1304	87.235	183.92
43	46.2083	114.898	93.874	44.3018	51.9583	111.628	94.708	49.2087	102.25	129.095	123.96	126.749	213.458	111.966	109.748	234.267
44	46.4583	111.928	96.6062	44.8816	51.9167	107.865	94.6755	49.1323	101.958	102.983	98.9777	100.916	215.417	139.265	131.209	282.646
45	46.7083	98.4835	102.497	47.8746	51.875	98.3133	97.646	50.6538	101.542	79.7702	84.0698	85.3658	215.042	100.446	95.6576	205.704
46	46.875	89.6	106.653	49.9934	51.7917	90.7482	107.987	55.9282	101.167	100.824	104.198	105.413	214.625	103.436	104.56	224.411
47	47.25	91.0053	98.7355	46.6525	51.8333	88.746	98.7242	51.172	100.042	100.958	107.918	107.963	214.583	74.0971	95.3065	204.512
48	48.0417	101.995	99.3156	47.7128	52.0833	101.76	98.5769	51.3422	99.875	120.15	118.667	118.518	216.083	83.764	93.0445	201.054
49	48.625	104.884	102.302	49.7442	52.25	101.435	100.926	52.7338	100.125	107.863	102.832	102.961	217.792	106.065	98.8912	215.377
50	49	106.122	96.2032	47.1398	52.4583	102.939	93.4117	49.0022	100.708	102.276	97.4859	98.1765	217.667	97.3966	102.284	222.638
51	49.5417	98.9066	100.428	49.7539	52.8333	98.4227	99.3552	52.4927	102.583	75.0609	81.4828	83.5878	217.208	85.1717	91.7637	199.318
52	50.1667	95.6877	95.3917	47.8548	53.4167	93.6037	94.6713	50.5704	103.125	77.5758	79.2567	81.7335	218.417	86.5319	91.1975	199.19
53	50.8333	90.4918	104.479	53.11	54.25	94.0092	109.796	59.5643	102.542	82.8931	77.6842	79.6586	223.125	105.77	90.9266	202.88
54	51.375	101.217	108.375	55.6778	54.8333	100.304	104.372	57.2308	101.5	110.345	111.628	113.302	229.792	103.137	90.7607	208.561
55				46.8094				50.9055				118.107				247.01
56				50.0603				51.7855				123.021				267.571
57				55.1599				56.6131				108.552				210.465
58				59.516				65.4478				96.112				248.672
59				55.332				64.5213				102.618				318.987
60				52.5815				53.2796				98.7653				279.92

From Table (2), the series is can be seen to have seasonal effects with a slight upward trend. There is an upsurge of the series, though of varying magnitude in the months of January and December. As we compare the Table (2) with Table (1), it is seen that the standard deviation is not stable and mimics the mean. It increases with the mean, so that we suggest a multiplicative

model. It indicates that the four aspects of seasonal decomposition such as Fatal accidents, Non-fatal accidents, Number of person died and Number of person injured.

Figure 1: Seasonal Decomposition



The trend-cycle column shows the results of a centered moving average of length 12 applied to fatal accidents. The seasonality column shows the data divided by the moving average and multiplied by 100. Seasonal indices are then computed for each season by averaging the ratios across all observations in that season, and scaling the indices so that an average season equals 100. The data is then divided by the trend-cycle and seasonal estimates to give the irregular or residual component. This component is then multiplied by 100.

The above figure (1) shows that a plot of the accident data with its trend line while the monthly seasonal indices are given in Table (3). By the trend line, it is clear that the Road accidental increased by a factor of approximately July over the constant level of October over the period of study.

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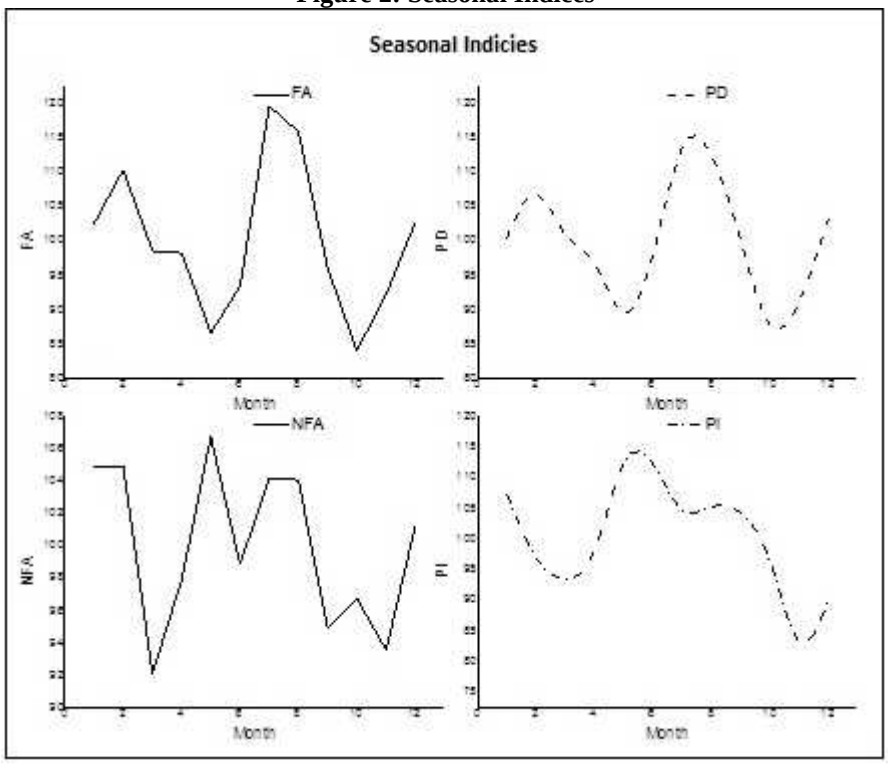
Table 3: Seasonal Indices

Season	Seasonal Index			
	FA	PD	NFA	PI
1	102.324	100.505	104.895	107.254
2	110.311	110.199	104.913	95.2216
3	98.485	99.062	**92.1188**	92.8164
4	98.214	98.872	97.8791	94.884
5	86.613	85.622	**106.705**	**116.325**
6	93.395	96.102	98.8506	113.636
7	**119.634**	**117.865**	104.143	102.02
8	115.860	113.931	104.047	106.14
9	96.084	100.683	94.8857	105.005
10	**84.011**	**84.036**	96.7621	98.9256
11	92.171	89.893	93.5507	**77.7461**
12	102.698	103.229	101.25	90.0257

Figure 2: Seasonal Indices



The above table (3) shows the seasonal indices for each season, scaled so that an average season equals 100. Besides the figure indicates that the following realities,

- The indices range for Number of fatal accidents (FA) from a low of 84.011 in month of October to a high of 119.634 in July. This indicates that FA is a seasonal swing from 84.011% of average to 119.634% of average throughout the year of one complete cycle.
- Similarly, the indices range for Number of persons died (PD) from a low of 84.0364 in season October to a high of 117.865 in July. This indicates that PD is a seasonal swing from 84.0364% of average to 117.865% of average throughout the year of one complete cycle.

- The Number of Non-fatal (NFA) indices range from a low of 92.1188 in the month of March to a high of 106.705 in May. This indicates that there is a seasonal swing from 92.1188% of average to 106.705% of average throughout the year of one complete cycle.
- On the other hand, the Number of persons injured indices range from a low of 77.7461 in the month of November to a high of 116.325 in May. This indicates that there is a seasonal swing from 77.7461% of average to 116.325% of average throughout the year of one complete cycle.

Conclusion

The trends of road accidents by month wise between 2011 and 2015 were examined in this research paper. The maximum of occurrence fatal accidents were seen during October while the lowest rate was in the month of July. Although, the maximum of Non-fatal accidents were happen during the May however the lowest rate was in March. We concluded that the trends and patterns in monthly accidents are absolutely vary significant and is also depending on month. Also the results indicated that there are seasonal variations in occurrence and the person died/injured due to road accidents. Licensing authorities when they issue licenses to aspiring public service vehicles - screen them very carefully for eye sight, mental alertness, good reflexes and Co-ordinations. Nowadays all political parties are occupying the road dividers with placing large size of hoardings, party flags and cutouts. Public will suffer a lot. The Government of Tamil Nadu should completely prohibit the hoardings, banners, cutouts and party flags in public places.

Accidents on the road happen every day and yet many people don't seem to be taking the preventive measures to decrease their occurrence which have definitely affected the accidents outcomes. So we shall concentrate these factors in the supplementary research studies. Therefore, the living safely is a challenge that must be accepted by everyone if were to continue to move forward in an ever-changing society.

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