Vehicular Growth & Road Use Pattern Analysis for Traffic Planning of a Mid-Sized City using SPSS

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Abstract- Planning the traffic & transport facility for a mid-sized city or semi-urban city needs lots of traffic related components to be evaluated such as traffic volume, future vehicle demand, road use pattern, etc. This paper quantitatively examines the effect of traffic volume, vehicular growth and road use pattern in the movement of traffic. Traffic survey has been conducted to obtain the traffic volume and DTO vehicle record has been obtained to observe the vehicle data. DTO vehicle data has been used to analyze the future vehicle demand on the roads of the city as a part of the future traffic by applying MLR method for traffic forecasting using SPSS. The peak hour traffic volume data helps to identify the road use pattern during the morning & evening peak hours of a particular roads which helps to formulate a better traffic movement plan. An improved conclusion based on the quantitative methods is designed to solve the problems of existing traffic systems. The influence of some important parameters on the traffic analysis results was observed through a sensitivity analysis.

Index Terms- Traffic Volume, PCU, Mid-sized city, Road use pattern, Vehicle growth.

1. INTRODUCTION

[JEAN-PAUL RODRIGUE & Dr. BRAIN SLACK, 2013] Transport planning is most developed in the urban sphere, and it is there where most experience has been gathered. The predictions of future traffic flows produced by the four-stage sequence are then used to identify planning options. Study of traffic condition of Madhubani city have been done to enhance and provide a better traffic planning approach to improve the traffic problems of the city and reduce the traffic congestion, accidents, etc. For this purpose, the major traffic operated roads have been observed to calculate traffic volume. These roads have been surveyed to understand the traffic volume and road use pattern. The case study of Madhubani city have been used just for observing, analyzing and formulation a good traffic planning system for a mid-sized city. As Madhubani is a mid-sized city having no any traffic planning system, it had huge growth in traffic in last decade. It doesn't matter whether the city is small or large, where there is extreme traffic growth, there must need a traffic planning approach to maintain the proper traffic system of city. Lots of deficiencies are found in small cities regarding traffic. So, to overcome on the deficiencies of traffic, two of parameters in this paper have been analyzed. Traffic survey is very useful for understanding the traffic conditions. DTO vehicle record helps us to analyze or forecast the traffic of the city. The number of vehicles running on the roads of Madhubani have been obtained from the District Transport Office as shown in Table 3 and represented

in graphical form in Figure 3 to analyze the vehicle growth in past decades and to forecast the vehicle growth in the future decade. This will be considered a major factor for planning the traffic system of the city. The data are analyzed by SPSS. On the basics of results obtained, improvement methodologies and recommendations have been made.

2. STUDY AREA

Madhubani District is one of the thirty-eight districts of Bihar state, India. This semi-urban city has high traffic operations through-out the city area. There are lots of road connecting the different junctions, intersections, crossings, etc. shown in Figure 1.

International Journal of Research in Advent Technology, Vol.7, No.1, January 2019
E-ISSN: 2321-9637
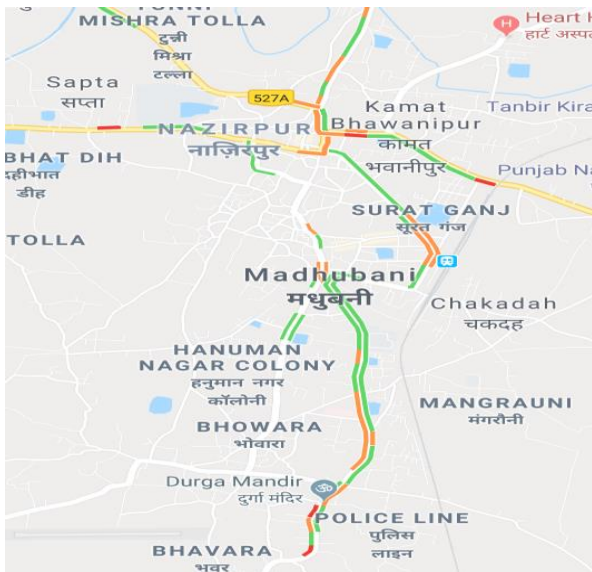*Available online at www.ijrat.org*

Fig.1. Study Area Traffic Route

The city has very less participation of public transport traffic for in/out through city to different destinations. Out of the total Madhubani population for 2011 census, 3.60 percent lives in semi-urban regions of district. In total 161,495 people lives in semi-urban areas of which males are 85,026 and females are 76,469. Though the Madhubani city is the key place for major marketing and employment of the district, there is always a huge traffic moving throughout the city. There are lots of road network on which the traffic condition is very serious, but there are certain roads with high traffic operations through-out the city. A study of the transport infrastructure for Madhubani is crucial for the understanding and analyzing micro level (within the different zones of the city – linkages between the different parts of city and the market).

3. METHODOLOGY

Traffic survey is the best method to collect the traffic data for the planning strategies. [HENSHER, 1982] If survey data is to be used to develop predictive models of travel and activity behavior, it therefore appears that longitudinal data, which can account for dynamic changes in behavior, is the preferred type of data to collect for further arguments to this effect. [JUSTO & TULADHAR, 1984] developed mathematical models to derive PCU values for vehicles on urban roads based on empirical data under mixed traffic flow. The PCU method have been adopted to convert the traffic survey data into a single unit for the uniformity of the traffic counts. DTO vehicle record also has been included for the data analysis. To analyze the Vehicular growth rate,

SPSS has been used to generate the equations of regression analysis. Traffic volume data is used to identify the road use pattern by analyzing the traffic volume data in SPSS for t-test.

4. DATA COLLECTION METHODOLOGY

4.1. *Traffic Volume Study*

[Udit Batra, Mandar V Sarode, 2013] Traffic survey gives us the different analytical results such as traffic volume, road use pattern, future traffic growth, roadway capacity and Level of Service. After conducting traffic survey for the peak hour in morning & evening session on the roads identified (Thana Chowk Road) as the major traffic operations, traffic survey data summarized as shown in Table 1 & Table 2 for one of the roads among all the identified roads of major traffic operation. Figure 2 shows the variation of volume & PCU of different peak hour session wrt time on Thana Chowk Road. Likewise, traffic survey was conducted on all the roads and the data was used to analyze the various traffic related analysis.

Table.1. Motor Vehicle Volume for Thana Chowk Road in 1st Session

Time	09:00-09:15	09:15-09:30	09:30-09:45	09:45-10:00	10:00-10:15	10:15-10:30	10:30-10:45	10:45-11:00
Volume	116	124	130	151	139	119	118	113
PCU	96.1	95.8	86.9	109.1	89.7	86.9	101.7	93.7

Table.2. Motor Vehicle Volume for Thana Chowk Road in 2nd Session

Time	04:00-04:15	04:15-04:30	04:30-04:45	04:45-05:00	05:00-05:15	05:15-05:30	05:30-05:45	05:45-06:00
Volume	111	113	136	146	158	152	145	158
PCU	69.6	62.3	83.5	88.1	93.4	94.8	81	96.2

International Journal of Research in Advent Technology, Vol.7, No.1, January 2019
E-ISSN: 2321-9637
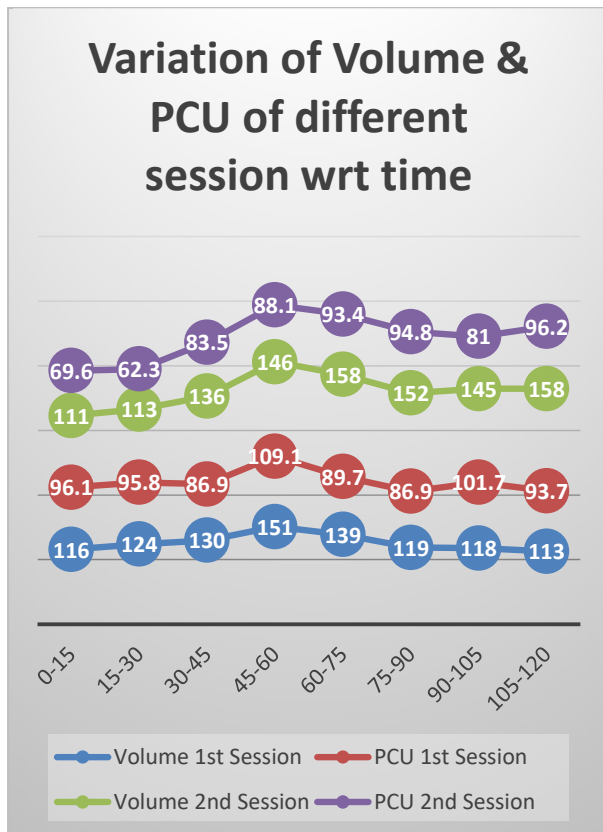*Available online at www.ijrat.org*

Fig.2. Variation of Volume & PCU of different session wrt time on Thana Chowk Road

4.2. *DTO Vehicle Data*

Table.3. DTO Vehicle Data Record

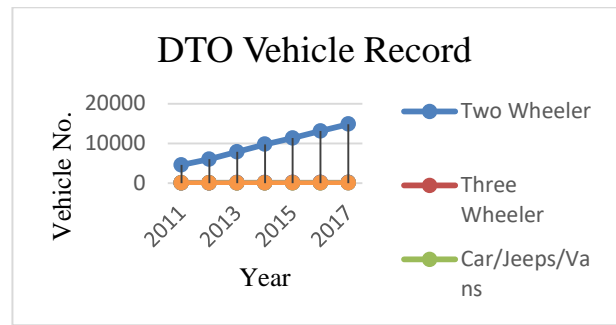| Year	Two Wheelers	Three Wheelers	Cars, Jeeps	Tractors	LMV	Bus/ Truck	Total
2011	4534	12	00	29	00	00	4575
2012	5988	23	11	37	09	00	6068
2013	7855	28	19	48	11	00	7961
2014	9767	37	26	52	15	00	9897
2015	11322	42	32	63	21	00	11480
2016	13100	51	41	71	26	00	13289
2017	14835	58	49	79	30	00	15051
Total	67401	251	178	379	112	00	68321

Fig.3. DTO Vehicle Record

5. DATA ANALYSIS & RESULT

5.1. *Vehicular Growth Analysis*

Vehicle growth rate signifies the growth of motor vehicle in the city. The maximum participation of the traffic movement in the city is the vehicle registered with the district transport authority. District transport authority have made available the data of the number of registered vehicles in the city. Refer Table.3. The significance of the analysis of motor vehicle registered data is to find the number of vehicles moving on the city road in the upcoming years. It will help in the estimation of the growth of the road network as per the vehicles moving on the road. Multiple regression analysis method best suit for this type of data analysis. MLR general expression: $Y = a + bX$

$$b = (\Sigma X_i Y_i - n\bar{X}\bar{Y})/(\sum X_i^2 - n\bar{X}^2)$$
$$a = \bar{Y} - b\bar{X}$$

Mathematically, this formula can also be used for the data analysis, more ever, I had used SPSS for the analysis of the data. DTO Vehicle Data Record, the following regression analysis have been done and equations have been found for the different vehicle class shown in Table.4. Regression analysis of 2-wheeler vehicle is shown below. Likewise, regression analysis of all the category of vehicle have been done as given in Table.3.

Regression Analysis For 2-Wheeler:

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	VAR00002[b]	.	Enter

a. Dependent Variable: VAR00001

b. All requested variables entered.

International Journal of Research in Advent Technology, Vol.7, No.1, January 2019
E-ISSN: 2321-9637
Available online at www.ijrat.org

Linear	.999	66 23. 39 1	1		5	. 0 0 0	- 146 68. 286	17 35. 50 0

The independent variable is VAR00001.

Table.4. Regression equations for Vehicle growth rate

Sr.No.	Vehicle Class	Regression Equation
01	Two Wheelers	Y = -14668 + 1735.5 X
02	Three Wheelers	Y = -68.1 + 7.4 X
03	Cars, Jeeps, Vans	Y = -84.5 + 7.9 X
04	Tractors	Y = -62.3 + 8.3 X
05	LMV	Y = -51.4 + 4.8 X

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	.999	.999	.06499

a. Predictors: (Constant), VAR00002

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.979	1	27.979	6623.391	.000[b]
	Residual	.021	5	.004		
	Total	28.000	6			

a. Dependent Variable: VAR00001

b. Predictors: (Constant), VAR00002

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.456	.072		116.774	.000
	VAR00002	.001	.000	1.000	81.384	.000

a. Dependent Variable: VAR00001

Model Summary and Parameter Estimates

Dependent Variable: VAR00002

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1

After inserting the year (X) in the different equation shown in Table.4. for the specific vehicle class, we found the future number of vehicles estimated to be registered with district transport office and will be running on the roads of city as shown in Table.5.

Table.5. Future estimated vehicle record

Year	Two-Wheeler	Three-Wheeler	Cars, Jeeps, Vans	Tractors	LMV	Total	Growth Factor
2018	16571	65	58	87	35	16816	1.11726795
2019	18306	72	66	95	40	18579	1.10484062
2020	20042	80	73	104	45	20344	1.09499973
2021	21777	87	81	112	49	22106	1.08661030
2022	23513	95	89	120	54	23871	1.07984257
2023	25248	102	97	129	59	25635	1.07389719
2024	26984	105	105	137	64	27395	1.06865613
2025	28719	117	113	145	69	29163	1.06453732
2026	30455	124	121	153	73	30926	1.06045331
2027	32190	132	129	162	78	32691	1.05707172
Total	243805	979	932	1244	566	247526	Av.=1.098

International Journal of Research in Advent Technology, Vol.7, No.1, January 2019
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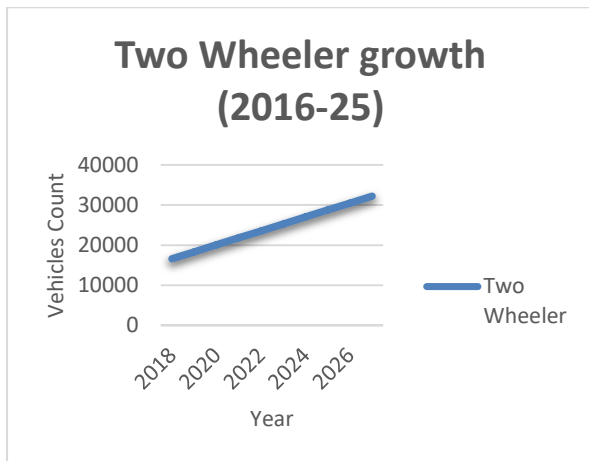*Available online at www.ijrat.org*

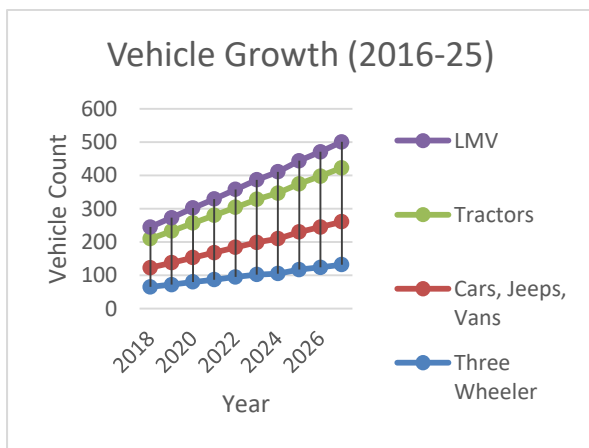Fig.4. Two-Wheeler Growth (2016-25)

Fig.4. Vehicle Growth (2016-25)

It has been found that the average growth in the number of registered vehicles in the city will be 1.098. The Figure 3 & Figure 4 explains better the trends of future growth of vehicles.

5.2. *Road Use Pattern Analysis*

Road use pattern is the hypothetical analysis of the PCU generated on a particular stretch of road section during morning peak hour and evening peak hour. This study gives the analysis of the road use pattern with respect to the survey sessions. [Singh S. K., 2014] Road use pattern gives the analytical observation of the road section weather the pattern of road use by the motorist in morning peak hours is same of different with the evening peak hours. This method uses the researcher approach as the data is limited, Parametric test of two sample will be used as Paired t-test is perfect suit for the analysis of these types of data. At 5 % significance level, t-Critical should be 1.9146. We get t-stat valus 2.033. Now if t-stat will be greater than t-critical then the road use

pattern is different for the both sessions otherwise it will be same road use pattern in 1st session and 2nd session. The road use pattern of the different roads are shown in Table.6.

We have 8 number of samples so,
d.f. = (8+8-2) = 14.
For d.f. = 14 at 5 % significance level, the t-Critical is 1.9146.

T-Test for Thana Chowk Road:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PCU in 1st Session	94.9875	8	7.62092	2.69440
	PCU in 2nd Session	83.6125	8	12.28791	4.34443

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PCU in 1st Session & PCU in 2nd Session	8	-.221	.600

Paired Samples Test

		Paired Differences					t-stat	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PCU in 1st Session - PCU in 2nd Session	11.37500	15.82392	5.59460	-1.85413	24.60413	2.033	7	.082

Table.6. Road Use Pattern Analysis

Sr.No.	Road Section	Significant/Not Significant	Type of Pattern
01	Thana Chowk	Not Significant	Different

International Journal of Research in Advent Technology, Vol.7, No.1, January 2019
E-ISSN: 2321-9637
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	Road		
02	Neelam Chowk Road	Significant	Same
03	Bata Chowk Road	Significant	Same
04	Churi Bazaar Road	Significant	Same
05	Mahila College Road	Not Significant	Different
06	Railway Station Road	Not Significant	Different
07	Ganga Sagar Chowk Road	Significant	Same
08	Old Bus Stand Road	Significant	Same
09	Bara Bazaar Road	Significant	Same
10	Chavaccha Mor	Significant	Same

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6. CONCLUSION

It has been concluded that at peak hour the traffic volume is very much in morning session I.e. 402.7 PCU/hr and in evening session i.e., 372.5 PCU.hr which is slightly more than the normal capacity of smooth traffic operation which cause traffic congestion. By the continuous growth in vehicles at a rate of 1.098 per year, market area road has not been extended cause the major congestion. Traffic volume data is very helpful for identifying the road use pattern of traffic during both peak hours. The major roads have different road use pattern for example; Mahila college road & railway station road which means the road use demand varies from morning session to evening session. Traffic growth analysis is very important for the future planning of transport facilities. Road use pattern helps to identify the trends of usability of roads during different peak hours which helps in identifying the roads used for diversion of traffic during the congestion hours.

Conflict of Interest

The author confirms that there is no conflict of interest to declare for this publication.

Acknowledgments