Indian Journal of Science and Technology, *Vol 9(44), DOI: 10.17485/ijst/2016/v9i44/105291, November 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

MATLAB Adaptive Study of Traffic Related Accidents and Travel Demand Forecasting Case Study: Jalandhar

D. Sai Kiran Varma, Ankit Bansal and Lalrinzuala Bawitlung

Department of Civil Engineering, Lovely Professional University, Phagwara, India;
saikiran.lpu@gmail.com., ankit.19432@lpu.co.in., lal.bawitlung@gmail.com.

Abstract

The present studies arises with a need of elaborate computer adaptive simulation of traffic variables and provide models for accidents and travel demand using various variables and respective graphical representations, which would augment the conventional methods of forecasting providing rationality and validation of models. **Objectives:** 1. Improving the substantiality of traffic accidents forecasting by using Mathematical modeling and Computer programming such as MATLAB. 2. Understanding inter-dependence of traffic components. **Method/Analysis**: Taking in view of the constraints and resource availability, the study is subjected to the area of Jalandhar city. Changes in transportation system have its links attached to change in traffic characteristics and travel demand. Such effects have also been considered. MATLAB, a high level language of technical computing is used for mathematical modeling of various traffic related data and analyzing it by creating algorithms. The output of model gave relationship of total number of accidents and travel demand (values of coefficient of variables using 95% confidence limits) with respect to the traffic variable with r-square value (Coefficient of Determination) of the model comparing the actual values with simulated values to be 0.82, which shows the fitness of the model and assures the model to be good. **Applications/Improvements**: The study has resulted in providing a model for forecasting the total number of accidents and the travel demand of the study area. Various factors have been judged to perform the analysis inferring the significant impact of factors in predicting total number of traffic related accidents in Jalandhar.

Keywords: Accidents, MATLAB, Simulation, Traffic, Travel Demand

1. Introduction

Study of traffic characteristics and traffic components forecasting has become a crucial need for cautious investment in projects related to transport and its planning. It is essential to analyze traffic behavior and forecast it for a specific period provided with desired accuracy. With the trend of development and increase in national economy, there's an importance to evaluate traffic characteristics and forecast traffic volumes and behavior such that it could result in better planning and control of road projects. Thus, study of traffic patterns, characteristics and forecasting has become equally relevant which arises the need of rational evaluation of traffic behavior and it's forecasting.

The growth in vehicular ownership numbers with respect to population has resulted in great change in traffic trends especially in business driven cities like Jalandhar,

**Author for correspondence*

which is consistently been an economic hub for Punjab. There is a need for macro-level understanding of these traffic trends subjected with appropriate data collection and analysis for prediction of future trends of traffic.

In[1] studied critical considerations of Travel Demand Forecasting (TDF) on National Highways. In[2] studied connections between accidents and traffic characteristics revealed that median speed, volume, and variations in co-efficient of it has a strong impact in likelihood of an accident. Mathematical model was used to analyze accidents from the data extracted on city of Vadodara. In[3] studied traffic characteristics of India-East and analyzed the change in trends of traffic compositions, travel patterns and speed characteristics with respect to case studies. The impact of traffic composition and its changing trends were also discussed. In[4] relation between Real Time Traffic Characteristics and crashes which gave the effects of various traffic components on crash occurrence, the summary of the speed variation was found out to be 1.226, indicating there would be 22.6% increase in crash occurrence with each unit of increase of speed variation. Speed difference was found out to be 1.032, indicating there would be 3.2% increase in crash occurrence with each unit of increase of speed difference.

2. Methodology

Taking in view of the constraints and resource availability, the study is subjected to the area of Jalandhar city. Changes in transportation system have its links attached to change in traffic characteristics and travel demand. Such effects have also been considered. Study area of Jalandhar city in shown in Figure 1 and according to census, Decadal Variation in Population in Jalandhar district is shown in Figure 2. Jalandhar's road network is of ring and radial type. It consists of narrow roads, lack of pedestrian pathways, zigzag street patterns, mixed traffic movement, more dependence on private vehicles which often results in disorganized condition of Jalandhar city.

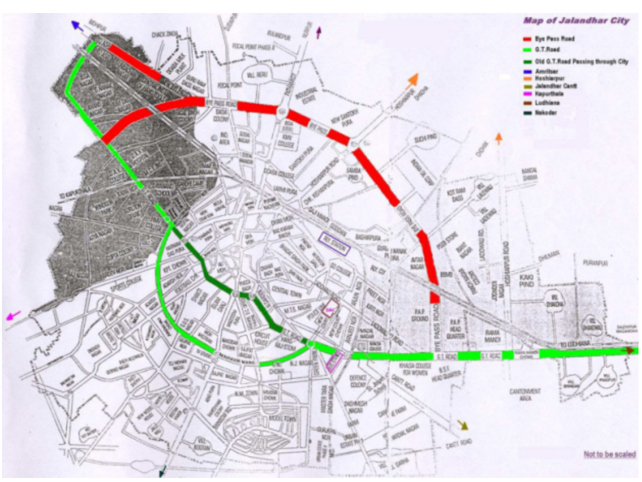

Figure 1. Study Area - Road Network of Jalandhar City.

3. Results and Discussion

3.1 MATLAB Program (Simulation-ANN Based) Code for finding ACCI Jalandhar (No. of Accidents in Jalandhar in Input Year)

The following program is used for predicting the number of accidents to be occurred:

clc;

/clearing command window/

r = [2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014];

/inputting year/

s = [2033042 2056136 2079230 2102324 2125418 2148512 2171605 2194699 2217793 2240886 2263980];

/inputting population/

t = [72718 81499 89618 96707 105353 114951 127746 141866 152187 165742 180129];

/inputting no. of vehicles nos./

yr1k = r. /10000;

/formatting year to use in ANN/

Ppmil = s. /1000000;

/formatting population to use in NN/

Accidents = [123 148 154 162 154 157 160 177 175 182 204]

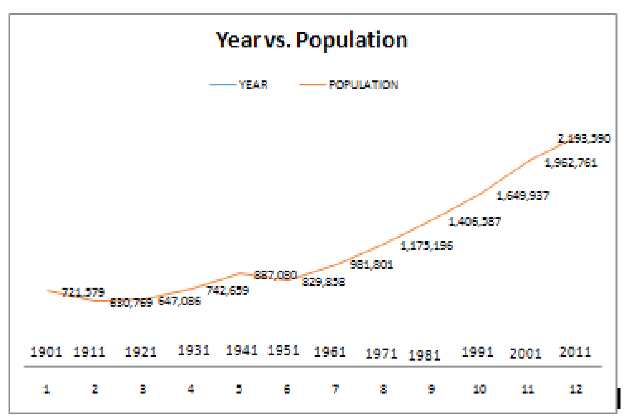

Figure 2. Decadal Variation in Population in Jalandhar District. Source: Census, 2011.

```
*/Accident nos. In Jalandhar/*
Population = newrb (yr1k, ppmil, 0.01, 5.0);
*/ ANN based population between year and vehicles/*
Vpmil = t/1000000;
t0 = (t./s)*1000;
Vehiclesr = newrb (yr1k, vpmil, 0.01, 5.0);
A = log (accidents);
T = log (t0);
g1 = ones (11, 1);
Amat = [g1 T'];
[M] = (pinv (amat)*A');
*/Aprrox. Using least square method & finding l,m/*
l = exp (M (1));
m = M (2);
c = input ('enter year between 2015-2025');
*/inputting year/*
population = sim (populationr, c/10000);
*/population nos. simulation/*
Vehicular population = sim(vehiclesr, c/10000);
*/vehicles nos. simulation/*
Disp ('the population and vehicles')
c;
disp ('are')
Predict pop=population*1000000;
Predictveh =vehicular population*1000000;
Formatlongg;
Disp (predictpop)
Disp (predictveh)
Accijalandhar=(l*(((predictveh/predictpop)*1000)^m));
*/finding total accidents to occur in year by simulation/*
Accijalandhar
*/accijal-accidents nos. in Jalandhar/
```

3.2 Population based Death Rate

According to[5], it is given as deaths per million population i.e. Death Rate (Based on population) = (No. of Deaths occurred *1000000)/Total Population. As per Jalandhar Police records, Death Rate based Population is given in Table 1 and in graphical representation in Figure 3.

Table 1. Death Rate Based on Population

S.NO.	Year	Population	Deaths	Death Rate
1	2004	1963761	47	23.93
2	2005	2056136	74	35.99
3	2006	2079230	82	39.44
4	2007	2102323	111	52.80
5	2008	2125417	102	47.99
6	2009	2148511	89	41.42
7	2010	2171605	83	38.22
8	2011	2194699	91	41.46
9	2012	2217793	104	46.89
10	2013	2240886	72	32.13
11	2014	2263980	82	36.22
12	2015	2287074	66	28.86

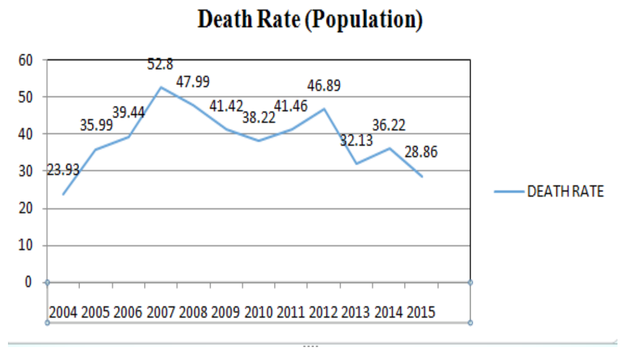

Figure 3. Death Rate based on Population.

3.3 Deaths based on Vehicular Registrations

It is given as deaths per thousand vehicular registrations i.e. Death Rate (Based on vehicular registrations) = (No. of Deaths occurred *10000)/Total vehicular registrations. Following shows the information of the same in Jalandhar. As per Jalandhar Police records, Death Rate based on Vehicular Registrations is given in Table 2 and in graphical representation in Figure 4.

Table 2. Death Rate based on Vehicular Registrations

S.NO.	Year	Vehicles Registered	Deaths	Death Rate
1	2004	72718	47	6.46
2	2005	81499	74	9.08
3	2006	89618	82	9.15
4	2007	96707	111	11.48
5	2008	105353	102	9.68
6	2009	114951	89	7.74
7	2010	127746	83	6.50
8	2011	141866	91	6.41
9	2012	152187	104	6.83
10	2013	165742	72	4.34
11	2014	180129	82	4.55
12	2015	195347	66	3.38

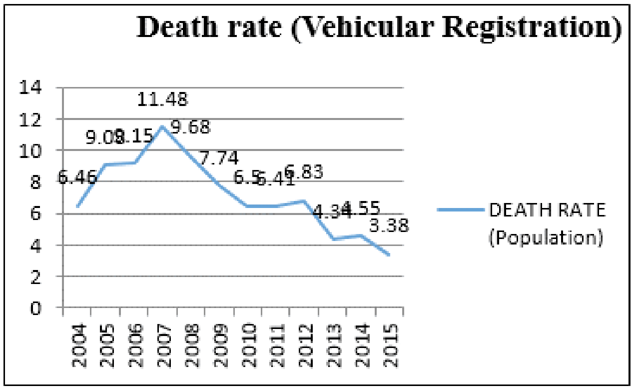

Figure 4. Death Rate based on Vehicular Registration.

3.4 Data Model

Various data used for creating data models using SFTOOL is given in Table 3, which are used as variables for model**.**

Table 3. Data used in SFTOOL Model

Year	Population*	Vehicles Registered**	Accidents***
2004	1963761	72718	123
2005	2056136	81499	148
2006	2079230	89618	154
2007	2102323	96707	162
2008	2125417	105353	154
2009	2148511	114951	157
2010	2171605	127746	160
2011	2194699	141866	177
2012	2217793	152187	175
2013	2240886	165742	182
2014	2263980	180129	204
2015	2287074	195347	211

Source: *CENSUS 2011, growth rates.
**RITES Survey, Punjab Transport Office.
***Police Station, Jalandhar, punjabroadsafety.org

3.4.1 Results of Various Models using SFTOOL

SFTOOL function in MATLAB was used to find the fitness of various models.

3.4.1.1 Linear Fit Model 1 (Degree 1)

Graphical output in MATLAB for Linear Fit Model 1 has been shown in Figure 5, whose parameters are given below:

Function = a + b*x + c*y.

Value of Coefficients using 95% Confidence Limits

a = 167.3, b= 11.16, c =12.26

Correctness of the Model

Sum of Squares due to the Error (SSE): 571.7, R Square Value: 0.9121, Adjusted R Square Balue: 0.8925, Root Mean Square Error: 7.97.

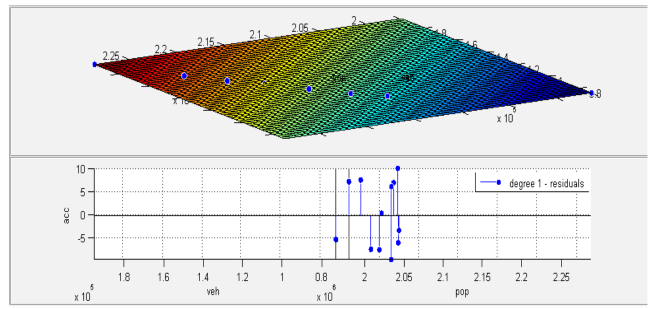

Figure 5. Linear Fit Model Poly11.

3.4.1.2 Linear Fit Model 2 (Degree 2)

Graphical output in MATLAB for Linear Fit Model 2 has been shown in Figure 6, whose parameters are given:

Function = a + b*x + c*y + d*x^2 + e*x*y

Value of Coefficients using 95% Confidence Limits

a = 182.2, b = -100.3, c = 109.2, d = -54.71, e = 39.75

Correctness of the Model

Sum of Squares due to the Error (SSE): 137.3, r-Square Value: 0.9789, Adjusted r-Square Value: 0.9668, Root Mean Square Error: 4.43.

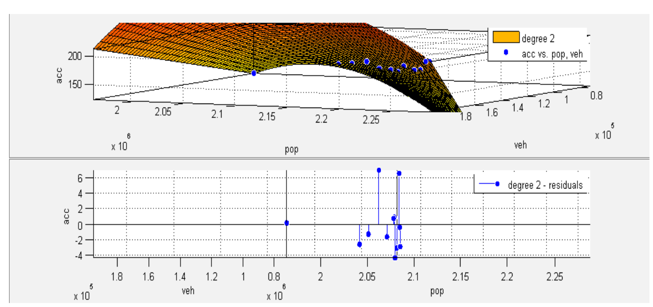

Figure 6. Linear Fit Model Poly21.

3.4.1.3 Linear Fit Model 3_(Degree 3)

Graphical output in MATLAB for Linear Fit Model 3 has been shown in Figure 7, whose parameters are given:

Function = a + b*x + c*y + d*x^2 + e*x*y + f*x^3 + g*x^2*y

Value of Coefficients using 95% Confidence Limits

a = 184.2, b = -117.6, c =117.7, d = -16.23, e = 2.555, f = 12.7, g = -4.273

Correctness of the Model:

Sum of Squares due to the Error (SSE): 135.7, r-Square Value: 0.9791, Adjusted R Square Value: 0.9541, Root Mean Square Error: 5.21.

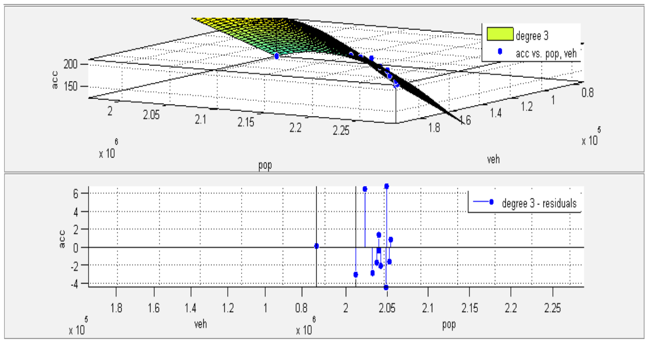

Figure 7. Linear Fit Model Poly31.

3.4.1.4 Linear Fit Model 4 (Degree 4)

Graphical output in MATLAB for Linear Fit Model 4 has been shown in Figure 8, whose parameters are given:

Function = a + b*x + c*y + d*x^2 + e*x*y + f*x^3 + g*x^2*y

Value of Coefficients using 95% Confidence Limits:

a = 181.1, b =-80.6, c =115.5, d = -266.8, e =237.8, f = -14.76, g = -7.383, h = 37.57, i = -37.03

Correctness of the Model

Sum of Squares due to the Error (SSE): 63.19, r-Square Value: 0.9903, Adjusted r-Square Value: 0.9644, Root Mean Square Error: 4.589

Comparison of Various Data Models has been shown in Table 4 depending upon their fitness and errors.

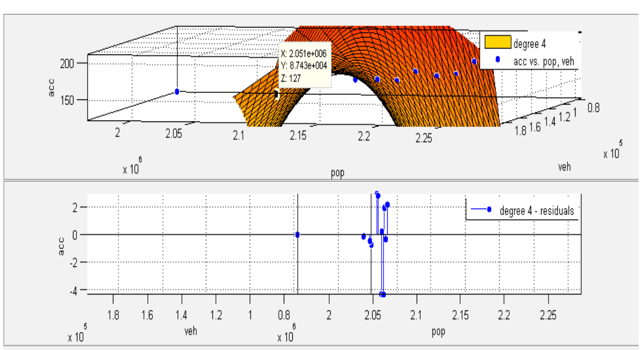

Figure 8. Linear Fit Model Poly41.

Table 4. Comparison of Various Data Models

Fit name	Fit Type	SSE	R-square	DFE	Adj R-sq	RMSE
Model 1	Degree 1	571.7142	0.9121	9	0.8925	7.9702
Model 2	Degree 2	137.3473	0.9789	7	0.9668	4.4296
Model 3	Degree 3	135.6957	0.9791	5	0.9541	5.2095
Model 4	Degree 4	63.1903	0.9903	3	0.9644	4.5895

3.5 Actual Values vs. Simulated Values of Accidents

Comparison of present actual values of number of accidents was compared with that of simulated values via MATLAB model, based on which the future values were predicted. Here, Figure 9 shows the graphical output in MATLAB between actual values vs. simulated values. R-square value (Coefficient of Determination) of the model is 0.82. The closer it is to 1, the better the model tends to be good. In Table 5, Comparison between actual values vs. simulated values is tabulated and subsequently, shown in graphical representation in Figure 10.

Table 5. Comparison between Actual Values vs. Simulated Values

	Actual No. Accidents	Simulated Values
2004	123	135
2005	148	140
2006	154	145
2007	162	150
2008	154	156
2009	157	162
2010	160	168
2011	177	174
2012	175	180
2013	182	187
2014	204	194
2015	-	200
2016	-	213

2017	-	218
2018	-	219
2019	-	226
2020	-	235

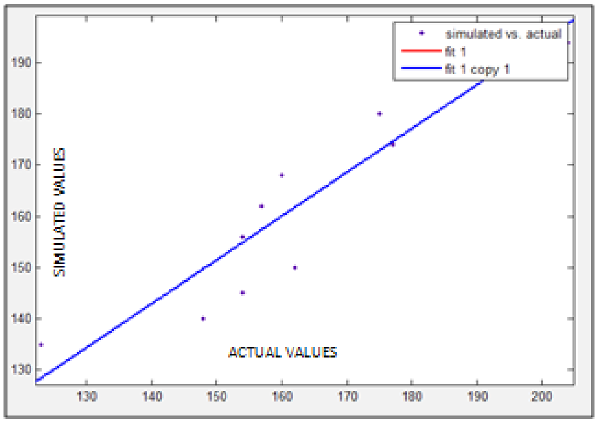

Figure 9. Actual values Vs. Simulated Values.

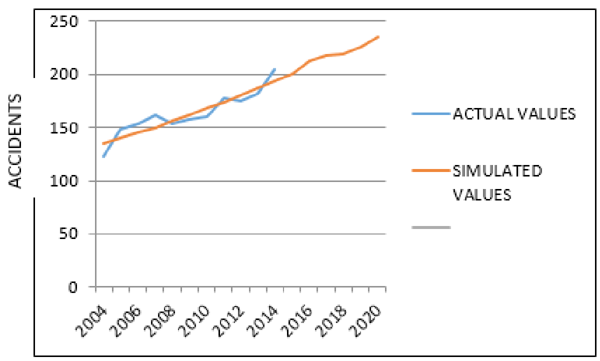

Figure 10. Actual Values of Accidents vs. Simulated Values.

4. Conclusion

Various models were analysed in the study. The study shows that there's significant relationship between the traffic variable and total number of accidents. The model gives the relationship between the same. Coefficient of Determination r-square value of the model is 0.82, which shows the fitness of the variable. The closer it is to 1, the better the model tends to be good. Some of the variables such as fuel prices have inverse relation with number of accidents since it lowers the number of vehicle users. Taking this as a consideration of the future scope more number of variables having directly or indirectly impact on number of accidents could be taken as inputs to the MATLAB program as the increase in number of variables would result in better conviction of result.

5. References

1. Jahar R Sarkar, Bhargab Maitra. Critical considerations of travel demand forecasting in national highways at national highways: A case study. Journal of the Indian Roads Congress. 2009 Oct–Dec.
2. Garber N J, Wu. Stochastic models relating crash probabilities with geometric and corresponding traffic characteristics data. Research project report for the National ITS Implementation Research Centre. U.S. DOT University Transportation Centre. 2001.
3. Jalihal S A, Ravinder K, Reddy T S. Traffic characteristics of India. Journal of Eastern Asia Society of Transportation Studies. 2005.
4. Saman Roshandel. Impact of real-time characteristics on freeway crash occurrence: Systematic review and meta-analysis. M.E. Research Thesis. School of Civil Engineering and Built Environment, Queensland University of Technology. 2014.
5. Kadiyali L R. Traffic Engineering and Transport Planning. Khanna Publishers: New Delhi; 2013.