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FREIGHT TRIP GENERATION MODEL VALIDATION: CASE STUDY OF MAKARPURA GIDC

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Abstract— Rapid urbanization has been taking place in India, as it is among one of the developing countries. Urbanization results in a shortage of various facilities within urban area and transportation being the key component need arises to pre-plan the area for such rapid urbanization. Keeping about a problem in mind research has been done on Makarpura GIDC, which is one of the fastest developing urban areas in a Vadodara. The urban transportation planning process can be split into four stages which are trip generation, trip distribution, modal split and route assignment. Trip generation is essential to predict the total number of trips generated and attracted in the study area. There was multiple linear regression model are generated for the trip generation process. To test the ability of the model to predict future behavior, validation is required. The standard process of the validation is used to validate the regression models are reasonableness checks and sensitivity tests. The detail process of validation for the trip generation model are described in this research paper.

Keywords— validation; Reasonableness Checks; Sensitivity Tests

I. INTRODUCTION

The research work of the model making process is done with proper well-defined research path. The work from problem definition to data collection are basic depend on inventory survey. For the trip generation model for freight, there was site selection of makarpura than the inventory survey was done for the basic data for the geographical condition and to visualize the real condition of movement of the freight. The data collection was used to done by interview method of industries and truck driver questioners with volume count survey. The data was analyses and derived as dependent and independent variables for specific multiple linear regression. From data

collection and analysis there was there a major category of industries are derived Engineering industries, Chemical industries and Wooden industries. And there was two regression model of each type of categories which LCV (light commercial vehicle) and HCV (heavy commercial vehicle). Then the validation process of the model have been done.in this research paper the model validation process of the trip generation model are derived briefly.

Two major categories of validation checks are used:

1. Reasonableness Checks
2. Sensitivity Tests

Reasonableness Checks:

These incorporate a correlation of rates and boundaries, complete provincial qualities, sub-local qualities, rationale tests, and so forth. Boundaries ought to be checked against watched esteems, boundaries assessed in different locales, or auxiliary information hotspots for consistency. The models ought to be assessed as far as satisfactory degrees of blunder, their capacity to perform as per hypothetical and intelligent desires, and the consistency of model outcomes with the presumptions used to create them.

Sensitivity Tests:

These incorporate reactions to the transportation framework, financial, or strategy changes. Affectability is regularly communicated as the versatility of a variable. For instance, one may inspect the effect on movement request if leaving costs were to twofold or if transport degrees of progress were decreased drastically. Affectability examination ought to be utilized for all parts of the demonstrating procedure, before the utilization of the model for estimating. It is significant because anticipated approaches (for example costs) or conditions (for example high blockage levels) probably won't exist in the base year.

II. METHODOLOGY

Reasonableness Checks:

Model validation is the standard process to verify the model which has been generated by the data analysis process. The validation process is the specific standard terms to validate the research model. in this type of trip generation model, the total data should be divided into two sets. The ratio of the divided data set is have been 70% data which is estimating data or estimate set and another remains 30% of data set are prediction set or virgin data set. Now the model has been generated from the estimated data set and the result as the

regression equation is validated with the prediction or virgin data set. This process is called as manual or reasonableness checks. The results are accepted under standard error criteria.

Sensitivity Tests:

In a sensitivity analysis, there are such variables. The independent variable which uses for getting a result on dependent variables. for this particular trip generation model raw material, finished goods and floor area are independent variables and the number of trips is a dependent variable. The sensitivity of variables is checked with fluctuating in a number of trips and make future outcomes.

III. VALIDATION PROCESS

There are a total of three categories of industries are

- There are three types of categories in Makarpura GIDC.
 1. Engineering industries
 2. Chemical industries
 3. wooden industries
 and each category has two regression model are for LCV (light commercial vehicle) and HCV (heavy commercial vehicle) are used to found.

A. Reasonableness Checks:

1. Engineering industries:

Now the validation is begun with the first LCV model.

$$Y=0.526427+1.04195(X1) +0.968323(X2) +0.000301(X3)$$

Here, X1=Raw material in(tonne)

X2=finished goods material in (tonne)

X3=floor area in(sq.m)

Y= Number of trips

This equation is used to find out the number of a trip for the raw data set.

Which is followings:

Table 1 Calculation of LCV Model for Engineering Industries

y	x1	x2	x3	Y(from the equation)
7	3	3.5	167.2241	7.091742
9	5	3	418.0602	8.766982
19	10	8.5	418.0602	19.30251
15	7	7	650.3159	14.79408
10	5	4	464.5113	9.749287
24	12	11.5	696.767	24.37527
4	2	1.5	120.7729	4.099164
2	1	0.98	120.7729	2.553686
7	3	3	167.2241	6.60758
12	6	5	204.385	11.68126
35	18	16	929.0227	35.05433
37	20	16	696.767	37.06832
7	4	2	260.1263	6.709171
16	8	7	418.0602	15.76612
17	9	7.5	418.0602	17.29224

Here, the prediction data set the numbers of trips are dependent variable is already taken from the sites and the model equation is applied to another independent variable and the answer of calculating a number of trips from the equation are accurately validate with present data that show the validation of the model.

For engineering industries HCV model are followings:

$$Y= 0.663987+ 0.063031(X1) +0.048026(X2) +0.00024(X3)$$

Table 2 Calculation of HCV Model for Engineering Industries

y	x1	x2	x3	y (predict the trip from the equation)
6	47	44	1114.827	6.007279
5	35	31	929.0227	4.581935
4	28	23	696.767	3.700744
8	60	50	2322.557	7.404704
3	25	19	278.7068	3.2192

2. Chemical industries:

The data of chemical industries have been verified with predict set. LCV truck data are the following:

$$Y= -0.1886 +0.8498(X1) +1.07472(X2) +0.01188(X3)$$

Table 3 Calculation of LCV Model for Chemical Industries

Y	x1	x2	x3	Y (calculated trips)
13	6	6	102.1925	12.57344
10	5	4	88.25715	9.408525
22	10	11	120.7729	21.56729
9	3	5	88.25715	8.783534

From this LCV model equation calculate the trips of a predicted data set.

Now, looking for another chemical industries model is about HCV trucks model which are the following:

$$Y= -0.1431 +0.1563(X1) +0.1368(X2) -0.0045(X3)$$

Table 4 Calculation of HCV Model for Chemical Industries

y	x1	x2	x3	y(calculated trips)
7	50	55	1858.045	6.709173
4	25	28	696.767	4.412838

This equation is derived from the estimation data set of HCV trucks model of chemical industries. from this equation calculate the total trips for prediction data set to validate.

3. Wooden industries:

The wooden industries data also have the same process as the above categories of industries. for small vehicle LCV trucks equation start the validate the model.

$$Y = 0.3017 + 0.5696(X1) + 1.5805(X2) + 0.0015(X3)$$

The model which are made for prediction for wooden LCV trucks is use estimated data set which are 70% reserve from core data set.

The prediction data is the following:

Table 5 Calculation of LCV Model for Wooden Industries

y	x1	x2	x3	y(calculated trips)
15	8	6	102.1925	14.49929
46	27	18	603.8647	45.06102
9	5	3	102.1925	8.048866
31	17	13	325.1579	31.03291

Now, the HCV truck model validate from the equation is:

$$Y = 1.6661 - 0.09310(X1) + 0.18670(X2) + 0.00045(X3)$$

The prediction data is:

Table 6 Calculation of HCV Model for Wooden Industries

y	x1	x2	x3	y(calculated trips)
7	47	52	929.0227	7.449446
2	15	8	325.1579	1.920972

These tables are used to derive the mathematical result of the equation and compare it with the data of the prediction data set. The validation process of this data is studied with the help of MS excel tool by whom the trip generation model means data analysis also be done.

B. Sensitivity test:

For this particular research work their major three independent variable raw materials, finished goods and floor area. For sensitivity analysis, there are raw material and finished goods are such variables which are used to get increase or decreases and results are shown in the behavior of trips increases or decreases. For particular floor area sensitivity for that is not seems so practical.

The sensitivity analysis is done for every type of regression model in this research work.

1. Engineering industries

now, we show that each category has a two type of regression model that because sensitivity analysis also be done in such same pattern.

- **The LCV trucks sensitivity analysis of engineering industries**

Table 7 The LCV trucks sensitivity analysis of engineering industries

		% increase
Y = Predicted (x1=10%, x2=10%, Average Floor Area)	430	
Y =observed	408	5.39
Y = Predicted (x1=15%, x2=15%, Average Floor Area)	448	9.89
Y =observed	408	
Y = Predicted decreases (x1=5%, x2=5%, Average Floor Area)	371.2894441	-8.82
	372	
Y =observed	408	

The effects of increases and decreases of such variables on trips are notes and describe in the table as well as the graph.

In this graph is analysis easily that how variables like raw material and finished goods are sensitive to impact on trips are generated of LCV trucks from engineering industries. The increases or decreases of percentage in variables in LCV trucks model there are significant are measure on trips which are generated in engineering industries as we show that if variables are increases as 10% and 15% the trips are increases 5.39% and 9.86% and if variables are decreases 5% the trips are decreases 8.82%.

- **The HCV trucks sensitivity analysis of engineering industries**

Table 8 The HCV trucks sensitivity analysis of engineering industries

		% increase
Y = Predicted (x1=10%, x2=10%, Average Floor Area)	51.64	7.59
Y =observed	48	
Y = Predicted (x1=15%, x2=15%, Average Floor Area)	53.85	12.20
Y =observed	48	
Y = Predicted decreases (x1=5%, x2=5%, Average Floor Area)	45.00	-6.24
	48	
Y =observed	48	

The increases or decreases of percentage in variables in HCV trucks model there are significant are measure on trips which are generated in engineering industries as we show that if variables are increases as 10% and 15% the trips are increases 7.59% and 12.20% and if variables are decreases 5% the trips are decreases 6.24%.

2. Chemical industries

The sensitivity in terms of variables elasticity there is also 2 types of sensitivity model in chemical industries.

- **The LCV trucks sensitivity analysis of chemical industries**

Table 9 The LCV trucks sensitivity analysis of chemical industries

		% increase
Y = Predicted (x1=10%, x2=10%, Average Floor Area)	162.3611	
	163	10.88
Y =observed	147	
Y = Predicted (x1=15%, x2=15%, Average Floor Area)	169.1026	
	170	15.64
Y =observed	147	
Y = Predicted decreases (x1=5%, x2=5%, Average Floor Area)	142.1368	
	142	-3.40
Y =observed	147	

The increases or decreases of percentage in variables in LCV trucks model there are significant are measure on trips which are generated in chemical industries as we show that if variables are increases as 10% and 15% the trips are increases 10.88% and 15.64% and if variables are decreases 5% the trips are decreases 3.4%.

- **The HCV trucks sensitivity analysis of chemical industries**

Table 10 The HCV trucks sensitivity analysis of chemical industries

		% increase
Y = Predicted (x1=10%, x2=10%, Average Floor Area)	25.94089	23.80
	26	
Y =observed	21	
Y = Predicted (x1=15%, x2=15%, Average Floor Area)	28.12039	38.09
	29	
Y =observed	21	
Y = Predicted decreases (x1=5%, x2=5%, Average Floor Area)	19.40239	-4.76
	20	
Y =observed	21	

The increases or decreases of percentage in variables in HCV trucks model there are significant are measure on trips which are generated in chemical industries as we show that if variables are increases as 10% and 15% the trips are increases 23.80% and 38.09% and if variables are decreases 5% the trips are decreases 4.76.

3. Wooden industries

The sensitivity in terms of variables elasticity there is also 2 types of sensitivity model in chemical industries.

- **The LCV trucks sensitivity analysis of wooden industries**

Table 11 The LCV trucks sensitivity analysis of wooden industries

		% increase
Y = Predicted (x1=10%, x2=10%, Average Floor Area)	287.2729	8.67
	288	
Y =observed	265	
Y = Predicted (x1=15%, x2=15%, Average Floor Area)	300.0734	13.58
	301	
Y =observed	265	
Y = Predicted decreases (x1=5%, x2=5%, Average Floor Area)	248.8716	-6.03
	249	
Y =observed	265	

The increases or decreases of percentage in variables in LCV trucks model there are significant are measure on trips which are generated in wooden industries as we show that if variables are increases as 10% and 15% the trips are increases 8.67% and 13.58% and if variables are decreases 5% the trips are decreases 6.03%.

- **The HCV trucks sensitivity analysis of wooden industries**

Table 12 The HCV trucks sensitivity analysis of wooden industries

		% increase
Y = Predicted (x1=10%, x2=10%, Average Floor Area)	12.13945	18.18
	13	
Y =observed	11	
Y = Predicted (x1=15%, x2=15%, Average Floor Area)	12.54281	18.18
	13	
Y =observed	11	
Y = Predicted decreases (x1=5%, x2=5%, Average Floor Area)	10.92939	-0.64
Y =observed		

The increases or decreases of percentage in variables in LCV trucks model there are significant are measure on trips which are generated in wooden industries as we show that if variables are increases as 10% and 15% the trips are increases 18.18% and if variables are decreases 5% the trips are decreases 0.64%.

CONCLUSION

The validation process is used to identify the model is workable in a real situation or not for the Reasonableness Checks method for this models and the results of the checks are sawn that the model should correct for the real-time scenario and also be sawn that is ready to use for forecasting the trip from the Makarpura GIDC. Now, sensitivity analysis is used to denote that if the future scenario the independent variables are increases or decreases the what effect is made on the trip. Hence, both processes are used to validate and forecast the trip.

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