

Development of Regional Industrial Trip Generation Model Using SPSS

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Abstract

Background/Objectives: To determine the factors influencing the trip generation for the selected industrial groups within the study area and to develop trip generation model. **Methods/Statistical Analysis:** To develop trip generation model considering all the affecting parameters for the future trips estimation, the industries are classified based on the plot area and numbers of employee. The model has been developed using multiple linear regression analysis using Statistical Package for the Social Sciences (SPSS), which establishes relationship between number of trips generated by the employees and the socio-economic attributes. **Findings:** A general model for trip generation has been developed. The model result gave an effective value of R² equal to 0.99, indicating that the explanatory variables such as area of industries, income of employee, travel distance, travel time and travel cost included in the model explain 99% of the dependent variable. Travel cost and travel time are the main factors affecting trip generation. **Applications/Improvements:** A more detailed research work is necessary to use this model for planning purpose. Reliable forecasting of future trips using this model can be done.

Keywords: Kadi, Trip Attraction, Trip Generation, Trip Production, Regression, SPSS

1. Introduction

The decisions on transportation policies and programs depends on transportation planning process. With increasing industrialisation, urbanisation and e-commerce growth efficient transportation facility required and demanded by population¹. It is involved with planning, design and evaluation of transport facilities. Good transportation permits the specialization of industry or commerce, reduces cost of raw materials or manufac-

tured goods, and increases competition between regions, thus resulting in reduced prices and greater choices for the consumer. Thus, the most efficient and cost-effective system is created, while assuring that the environment is not compromised or destroyed^{2,3}. The transportation planning process can be split up into four stages like trip generation, trip distribution, mode choice, and route assignment. Though, these four stages are obviously inter-related, the conventional approach has been to treat each

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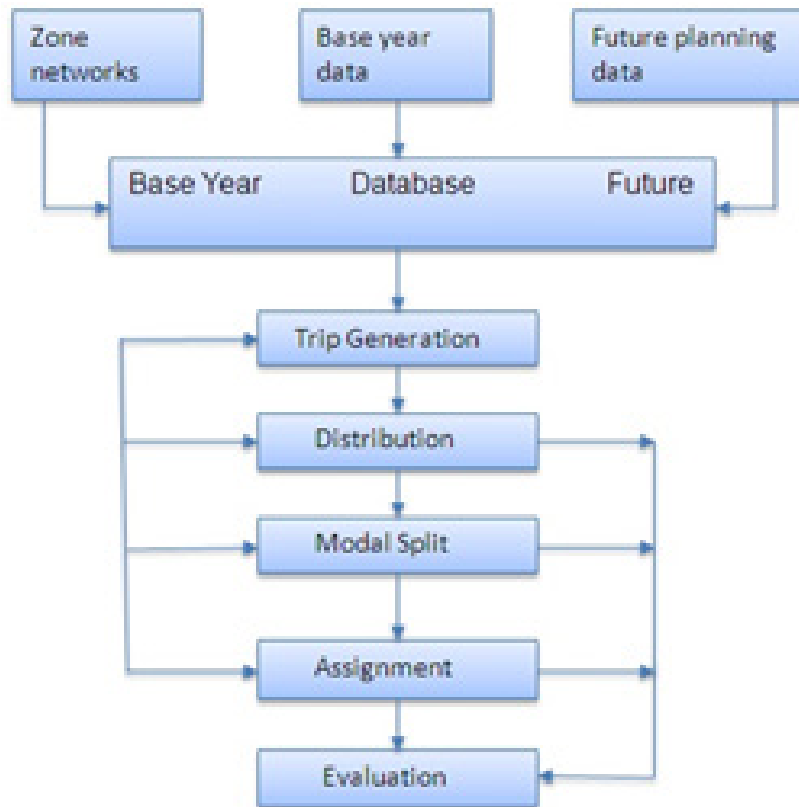


Figure 1. The Four Stage Transport Model.

stage more or less as a separate entity (Figure 1)⁴. This is true for trip generation, which is the subject of this paper.

Employment opportunities exist in several areas of transportation, including business logistics or supply chain management, vehicle design and manufacture, provision of services related to transportation, and the provision of the infrastructure required if commercial vehicles are to function as intended. Trip production and trip attraction are important in that it establishes the scale of movement and hence has an important bearing on optimization level and cost-effective of transport infrastructure which needs to be provided in order to cater for the expected demand.

As on date majority of the research on trip generation have been concentrated on home based person trip

generation, using either regression analysis or cross classification analysis as the mathematical technique⁵⁻⁷. The factors which affect the trip generation of zone are the number of potential trip-makers, the propensity of a potential trip maker to make a trip and accessibility of the zone to potential destinations for a given trip purpose satisfaction.

The trip generation stage of the cross-classification model aims at predicting the total number of trips produced by (O_i) and attracted to (D_j) each zone of the region. This can be achieved in several ways starting with the trips of the individuals or households who reside in each zone or directly with some of the properties of the zones: population, employment, number of cars, etc⁸⁻¹⁰. The accuracy of the future trip distribution in forecast-

ing design year trip interchange cannot be any better than the accuracy of the trip generation forecasts, except due to chance. The sole purpose of the trip generation analysis is to turnup an estimate of the trip ends generated at each analysis unit of the region^{11,12}. Trip generation techniques try to establish a relationship between the socio-economic and demographic characteristics of the population of an analysis unit and its trip generation¹³. Similarly, the intensity, character, and location of different land uses are related to trip making of the analysis units. These procedures are based on the hypothesis of a causal relationship between population characteristics, land use, and the trip making behaviour of people. Usually, trip generation models are used for prediction of future trips independently of any direct consideration to the transportation network^{14,15}. This, states that trips produced at,

or attracted to a zone are a function only of the characteristics of the zone itself; and are not directly a function of the road network trips.

2. Study Region and Methodology

The study region for this paper is Gujarat Industrial Development Corporation (GIDC) Kadi region, one of the most important industrial estates of Gujarat, located in district Mehsana of Gujarat state in India. The total area of the entire Kadi GIDC comprises 6,00,728 Sq.mt. There are in all 92 industries within the GIDC, out of which major industries are Polymer and Ceramic industries. Various steps involved in formulation of model are shown in Figure 2.

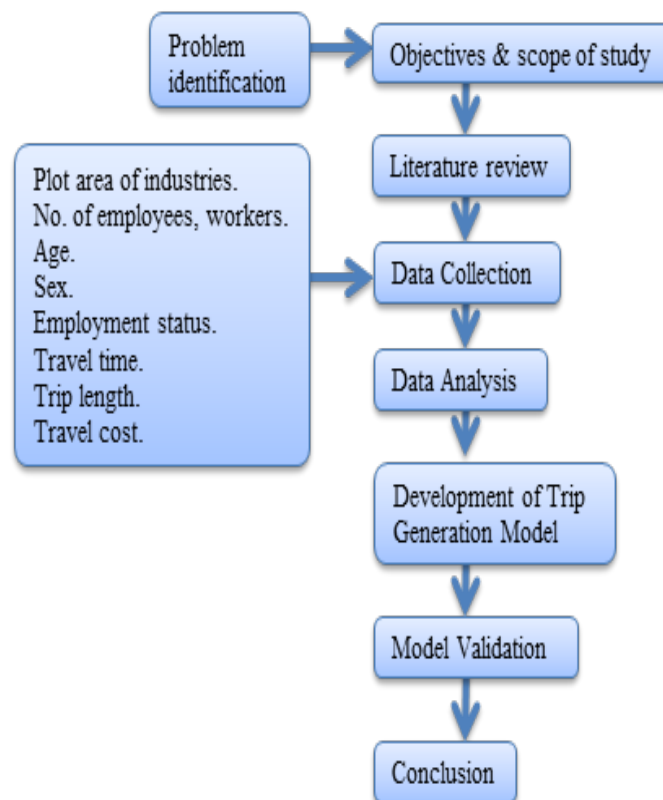


Figure 2. Methodology flow-chart.

Table 1. Model variables

Explanatory Variables Used in the Model	
X1	No. of employees in the industry.
X2	No. of males in the industry.
X3	No. of females in the industry.
X4	Employment status.
X5	Age of the employee.
X6	Travel distance.
X7	Travel time.
X8	Income of the employee.
X9	Plot area of the industry.
X10	Travel cost.
Dependent Variable Used in the Model	
Y	No. of daily trips made to the 7 TAZ industries within the GIDC

3. Data Collection

The primary data of firms in the GIDC, Kadi has been taken from the GIDC, Kadi Companies Association. The inbound outbound survey carried out with the assistant of undergraduate engineering students.

3.1 Sampling method

The sample that is drawn from the regional industrial population is a stratified random sample that includes 1109 (Male 909; Female 200) individuals. Stratification reflects geographic locations defined as Traffic Analysis Zone (TAZ). Therefore, the study region is divided into

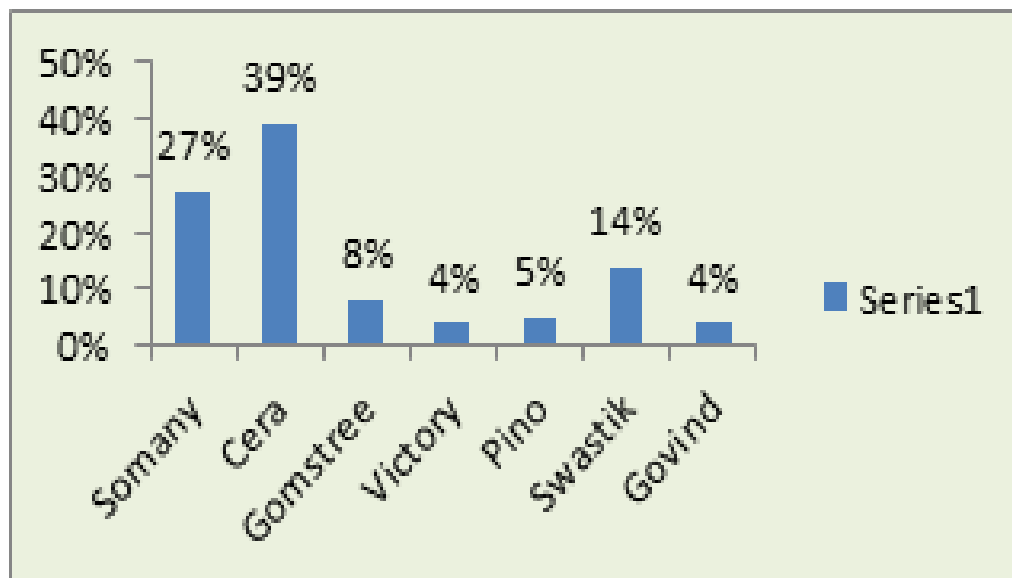
7 TAZ's. The samples are randomly selected from each of the 7 TAZ's. The variable used in the models (Table 1) and sample size of each TAZ are as presented in Table 2.

4. Data Analysis and Result

Descriptive statistics for both the dependent variables as well as the explanatory variables are shown and discussed. It is intended to give an overview of the distribution of various trips according to their purpose as well as to their time. This shows which trips are the most frequent. Figure 3 shows descriptive statistics for the total daily industrial trips.

Table 2. TAZ industrial data

Name of Industries	No.of employees/ shift	Plot area (sq.m)	Sample size	% employees
Somany Ceramics	2000	7632	301	20.20
Cera	2500	64538	432	25.25
Gomstree glass	1000	19554	90	10.10
Victory tiles	700	14943	39	7.07
Pino Bisazza	1000	5019	49	10.10
Swastik Sanetory	1500	50543	158	15.15
Govind Figures	1200	40882	90	12.12
Total	9900	203111	1109	100 %

**Figure 3.** Distribution of daily trips to various industries.

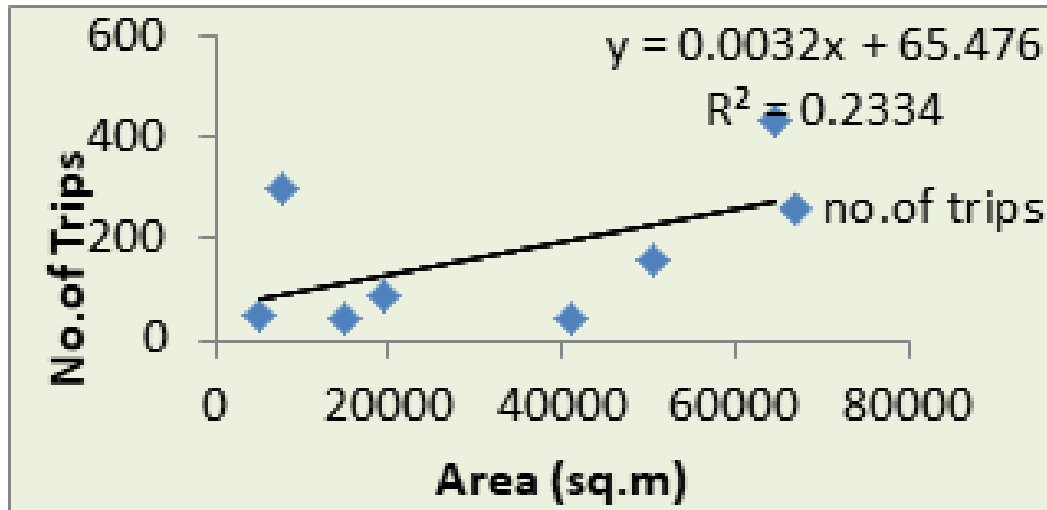


Figure 4. Distribution of trips as per each industry.

Table 3. Descriptive data of explanatory variables

	Mean	Std. Dev.	Max.	Min.	Range
TAZ Industrial area (sq.mt.)	29015.85	23046	64538	5019	59519.00
Income of employee (INR)	10707.0	7131.6	90000	500	85000
Travel distance (km.)	9.23	9.57	60	4	60
Travel time (min.)	19.6	12.51	75	5	70
Travel cost (INR)	11.64	14.21	120	0	120

The relationship between the number of daily trips generated per industry and the plot area of the industry is depicted in Figure 4.

The descriptive statistics for Explanatory Variables are shown in Table 3.

5. Development of Model

The multiple linear regression is developed using SPSS, for that number of daily trips is considered as dependent variables and income, sex, employment, trip length, travel time, travel cost, plot area are taken as independent variables. Table 4 summarizes the regression results for the estimated general trip generation model¹⁶⁻¹⁹.

Table 4. Results for the general trip generation model

Intercept & variables	Coefficient	Standard error	t-value	Significance	VIF
Intercept	519.10	65.41	7.93	0.080	
X ₆	-133.28	0.018	12.69	0.050	12.98
X ₇	76.37	6.039	22.07	0.029	2.94
X ₈	0.22	9.902	7.71	0.082	25.18
X ₉	-0.005	28.91	9.18	0.069	41.54
X ₁₀	-265.70	0.00	9.54	0.066	2.84
R ²			0.99		
F-value			110.871		
Sample Size			1109		

The final SPSS developed general trip generation model is:

$$Y = 519.10 - 133.28X_6 + 76.37X_7 + 0.22X_8 - 0.005 X_9 - 265.70X_{10}$$

where,

Y=Number of daily trips per industry.

X₈=Income of employees.

X₆=Trip length.

X₉=Plot area of the industries.

X₇=Travel time.

X₁₀=Travel cost.

5.1 Model Verification

Model verification tests the modelability to predict future

behaviour. Specifically, inline to verify the estimated general trip generation model, a comparison of the estimated total daily trips per industry (as calculated from the estimated regression model) with the actual total daily trips per industry (from observed values) is included in Table 5 for seven randomly selected TAZ industries.

5.2 Validation of Model

The statistical test is carried out for validation. The model is validated by the chi square test. Hypothesized results are verified by χ^2 tests an experiment. CHITEST returns the value from the chi-squared (χ^2) distribution for the statistic and the appropriate degrees of freedom. The chi square value of model is 0.49. The chi square critical value is 3.84 for degree of freedom 1 and level of confidence 95%.

Observed χ^2 value < χ^2 critical, R²=0.99. Hence, the developed model is statistically validated. But the devel-

Table 5. General trip generation model verification

Industry	Actual Y	Estimated Y	Variance
Somany Ceramics	301	301.72	0.72
Cera	432	430.21	1.79
Gomstree glass	90	98.26	8.26
Victory tiles	39	29.80	9.20
Pino Bisazza	49	57.45	8.45
Swastik Sanetory	158	156.01	1.99
Goving Fagures	40	35.55	4.45
Total	1109	1109	34.86

oped model parameters requires a more detailed study for getting accurate data and for using the model for practical purpose.

6. Conclusions and Recommendations

6.1 Conclusions

The following conclusions are made from this study.

1. In this study, trip generation model is developed using linear regression analysis from the collected data, in linear regression analysis, as a dependent variable (Y) – total daily one-way industrial trips is consider and as the independent variables (X's) attributes of the firms are consider.
2. Seven industrial estates from the GIDC were used in the analysis.
3. The general trip generation model has reasonable explanatory power with R^2 value of 0.99, indicating that the explanatory variables entered into the

model explain 99% of the variation in the daily trips per industry.

4. The variables that mostly affect the number of daily trips per industry are the travel distance, travel time. This result is consistent with the findings of previous studies in developing as well as developed countries.
5. From the developed model it can be concluded that most of the workers travel from the nearby villages within 10 kms of range for work purpose.
6. There is a large variation in travel time and travel cost as the people also travel by walking and bicycle having travel time and travel cost zero.

6.2 Recommendations

The following recommendations can be drawn from the results of this research.

1. It is recommended to develop trip generation models as the primary tool for travel demand modelling process in order to get better modelling

of traffic flow in the future for better transportation planning processes in the GIDC areas.

2. As the model developed in this thesis is developed using data collected from road side interview survey, a more detailed study on this process is recommended for developing model that can be used to predict future trips and can be implemented in the transportation planning process for the industrial trips.
3. Data should be collected with great accuracy by preparing good questionnaire and adopting more detailed survey methodology.

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