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Developing Industrial Trip Generation Model for Himatnagar Industrial Area

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***Abstract*—This work is to determine the factors affecting trip generation for the selected groups of industries within the region and to develop trip generation model. 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 several regression analyses by means of Statistical Package for the Social Sciences (SPSS), which establishes relationship between numbers of trips each activity produce or attract by the employees. A 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, raw material and finished material included in the model explain 99% of the dependent variable. Income of employee and raw material are the main factors affecting trip generation. A detailed work is necessary to use this model for planning purpose. Reliable forecasting of future trips using this model can be done.**

Keywords*— *Regression, Trip Generation, SPSS

I. INTRODUCTION

Urban transportation covers the movement of both people and goods within an urban area. At the individual level, urban transportation can be characterized by a trip Personal trips are commonly classified based on their main purpose (Barber, 1995); work trips, shopping trips, social trips, recreational trips, school trips, home trips and business trips. This study focuses on industrial trips, and the factors that determine the aggregate number of industrial trips generated in urban areas. The transportation planning process can be split up into four stages like trip generation, trip distribution, mode choice, and route assignment. 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 technique.

Due to urbanization process developing cities are surrounded by different types of industrial and recreational activities. These activities giving impact on existing road network by increased vehicular trips. It can create traffic congestion, delay, air and noise pollution etc. Hence, it is necessary to estimate these types of vehicular trips generated by industrial or recreational activities. In India few researches have been carried out to develop the industrial trip generation model. Keeping this in view the study is aimed to develop industrial trip generation model for the developing city like Himatnagar. Himatnagar city is facing urbanization problems due to increased outer growth of the area. Due to ceramic industries, packaging industries, laminates industries, agriculture industries, GIDC, and Sabar Dairy, trips by industrial employees, goods vehicle trips for raw material (in coming trips) and finished material (outgoing trips) creating traffic congestion on existing road network.

The scope of the work is confined to development of trip generation model for the Himatnagar city area. The following are the objectives:

To get the information of the existing locations of the industries near by the Himatnagar. Their types, numbers of workers, floor area, details of raw materials and finished material. To understand the trip making characteristics of various industrial workers and generating trip attraction model (employee trips).To determine the independent variables for the trips generated by goods/freight transport vehicles for the different types of industries and developing their trip generation models.

The study is mainly focused on industrial trip generation behavior of the employees and goods/freight transport vehicles for the different types industries near by the Himmatanar city. This study enables to understand the significant parameters for the industrial trip generation. This study also facilitates to understand the tendency of trip makers for choosing particular time, route, location, cost etc. This study also enables to estimate the workers trips and goods/freight vehicle trips for any new industry established in future.

II METHODOLOGY AND DATA COLLECTION

The study region for this paper is Himatnagar Industrial region, one of the most important industrial estates of Gujarat, located in district Sabarkatha of Gujarat state in India.

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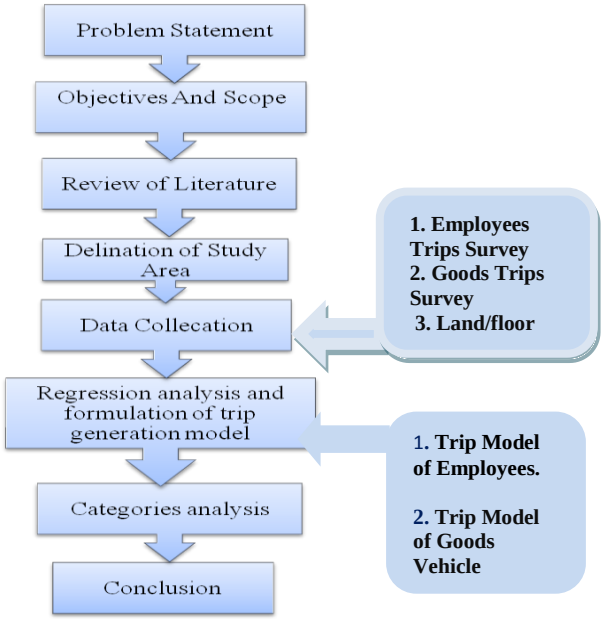

Fig.1: Methodology chart for study

Employees Trips Data collection

Industrial survey had taken at five categories of industries divided into study area. The process consist collection of origin and destination data. The information on the travel pattern includes number of trips made, their origin and destination, purpose of trip, travel mode, travel time and so on. The information on industrial employee interview survey characteristics includes type of Employee name, age, salary, vehicle ownership and so on. Based on these data it is possible to relate the amount of travel to industry and zonal characteristics and develop equations for trip generation rates.

The sections are described below:

Category 1: Ceramic Industries

Category 2: Agriculture Industries

Category 3: GIDC Industries and Sabar Diary

Category 4: Packaging Industries

Category 5: Laminates Industries

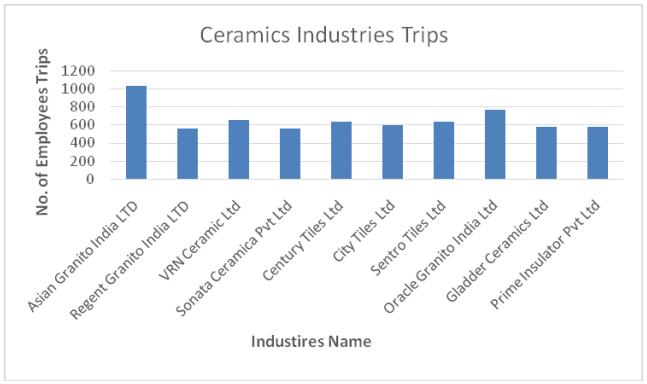

Fig.2: Distribution of daily trips to Ceramics industries.

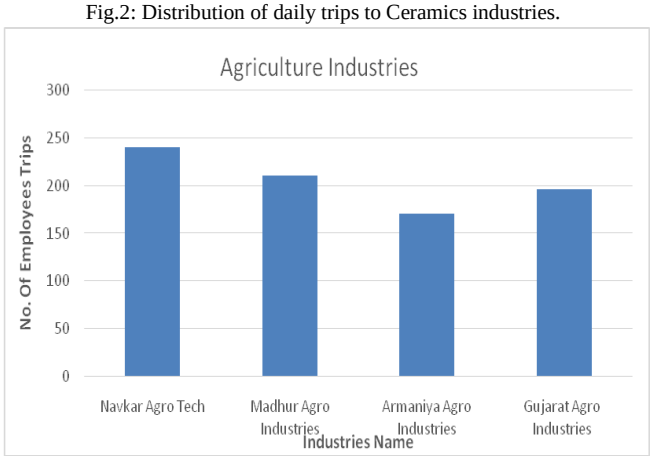

Fig.3: Distribution of daily trips to Agriculture Industries.

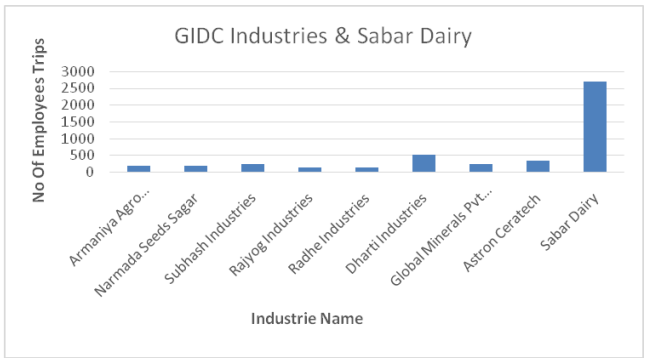

Fig.4: Distribution of daily trips to GIDC &Sabar dairy industries

Fig.5: Distribution of daily trips to Packaging industries.

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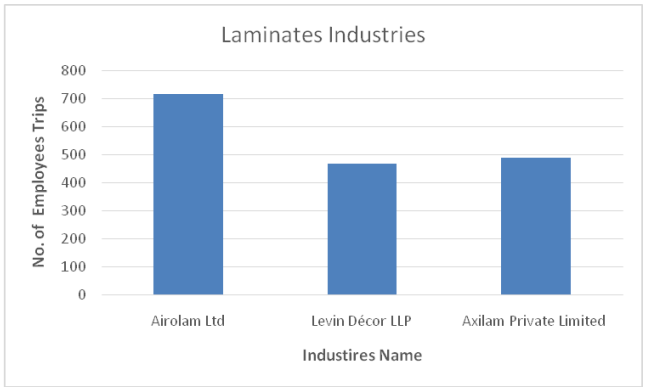

Fig.6: Distribution of daily trips to Laminates industries.

Goods/Freight Vehicle Trips Data collection

The information on industrial goods/freight survey characteristics includes type of workers name, age, salary, row materials, finished materials, vehicle type, and commodity bulk and so on. Based on these data it is possible to relate the amount of travel to industry and zonal characteristics and develop equations for trip generation rates.

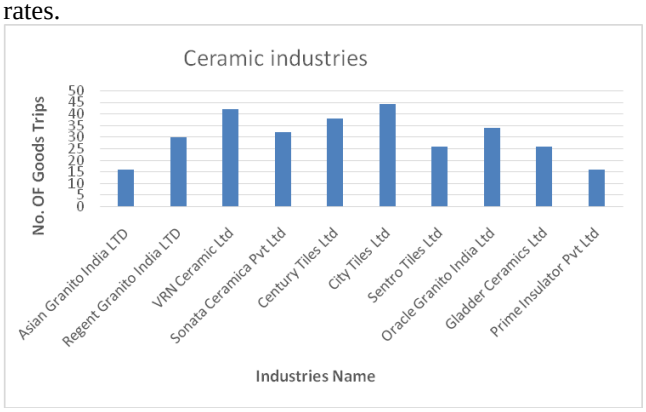

Fig.7: Distribution of daily goods vehicle trips to Ceramics industries

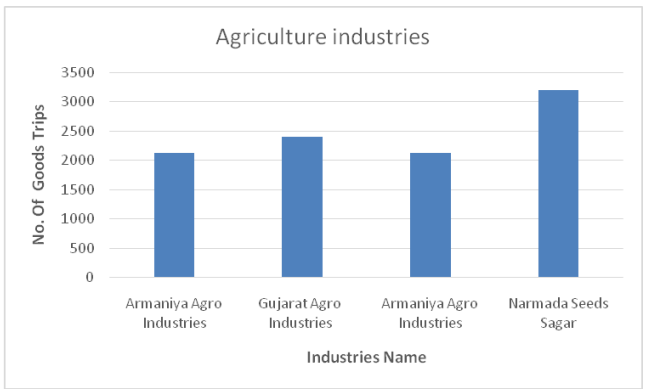

Fig.8: Distribution of daily goods vehicle trips to Agriculture Industries.

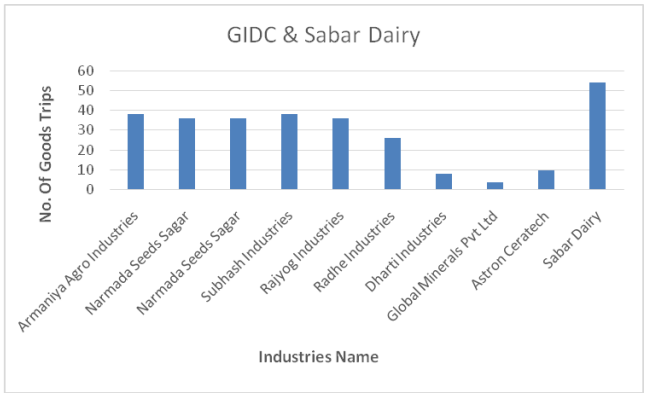

Fig.9: Distribution of daily goods vehicle trips to GIDC &Sabar dairy industries.

Fig.10: Distribution of daily goods vehicle trips to Packaging industries.

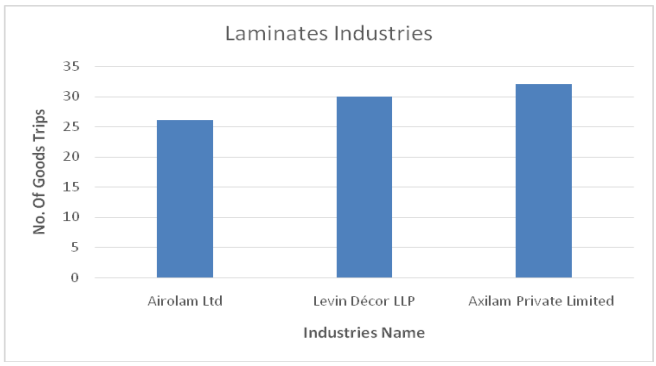

Fig.11: Distribution of daily goods vehicle trips to Laminates industries.

Category Analysis of Employees Trips/Day

From the Employees trips survey, it is clear vision about the share of Industries size with respect to total trips per day as a various types of mode and travel time.

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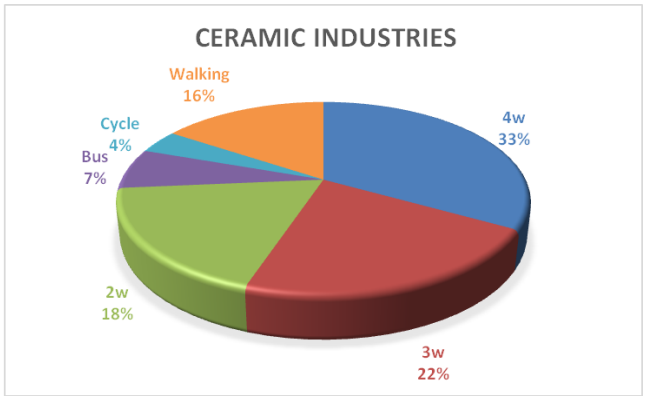

Fig.12: Ceramic industries trips/day (Mode wise)

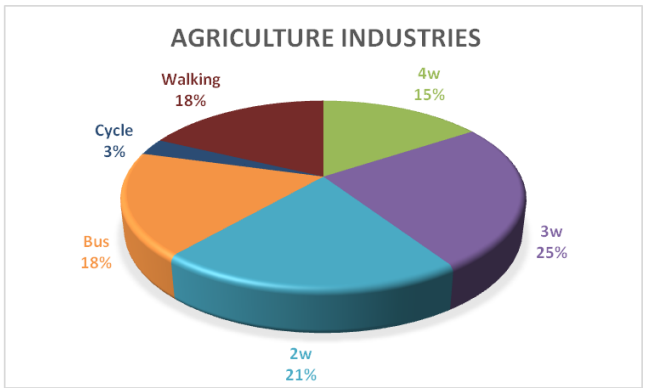

Fig.13: Agriculture industries trips/day (Mode wise)

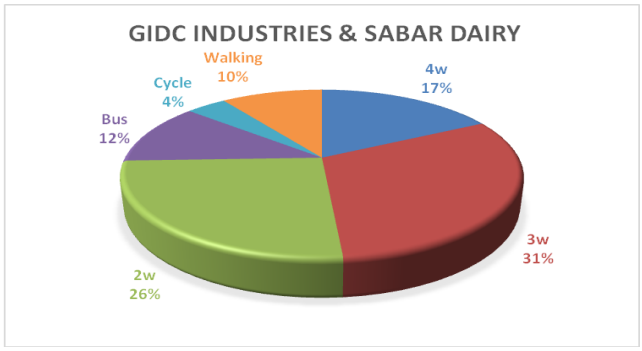

Fig.14: GIDC & Sabar Dairy industries trips/day (Mode wise)

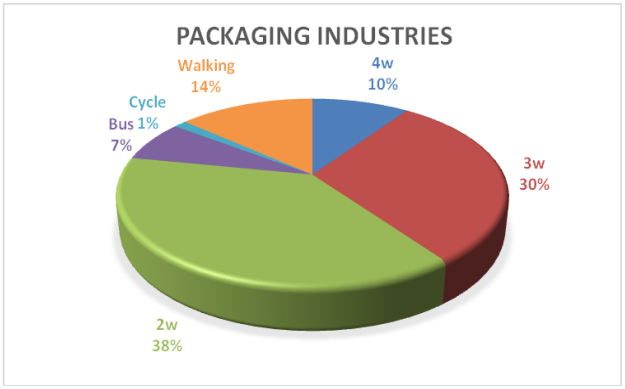

Fig.15: Packaging industries trips/day (Mode wise)

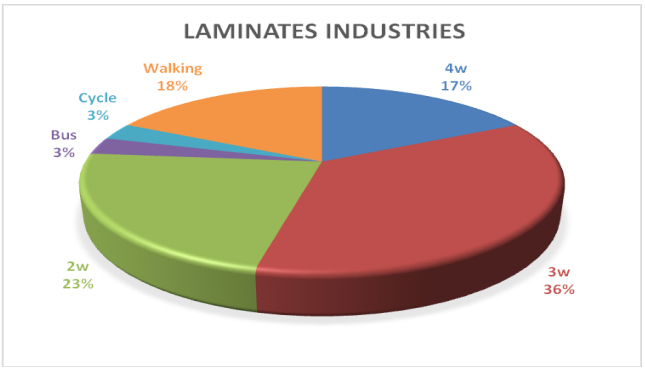

Fig.16: Laminates industries trips/day (Mode wise)

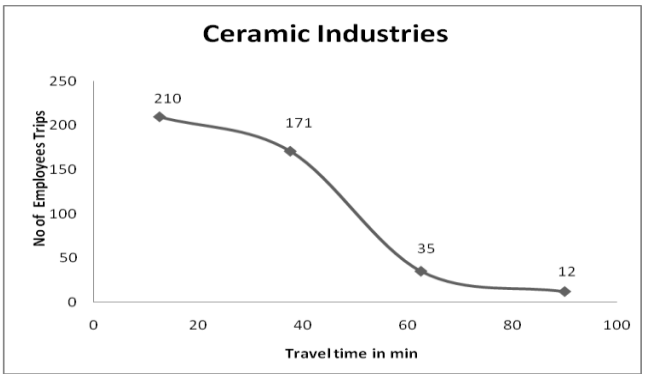

Fig.17: Ceramic industries trips/day (Time wise)

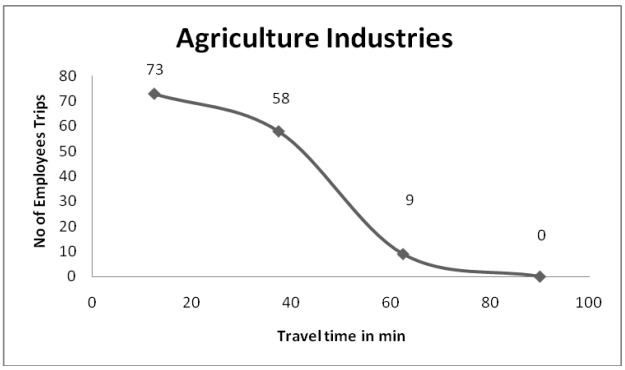

Fig.18: Agriculture industries trips/day (Time wise)

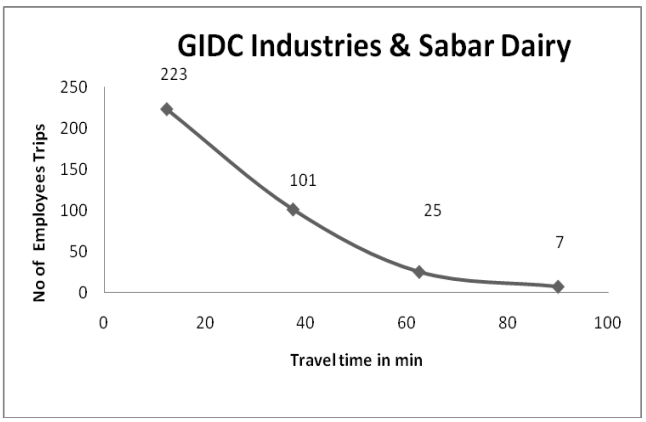

Fig.19: GIDC & Sabar Diary industries trips/day (Time wise)

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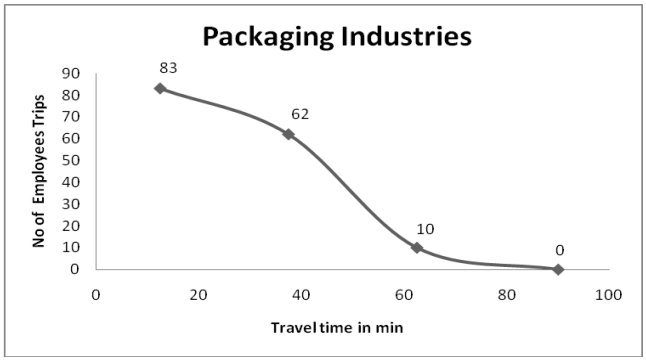


Fig.20: Packaging industries trips/day (Time wise)

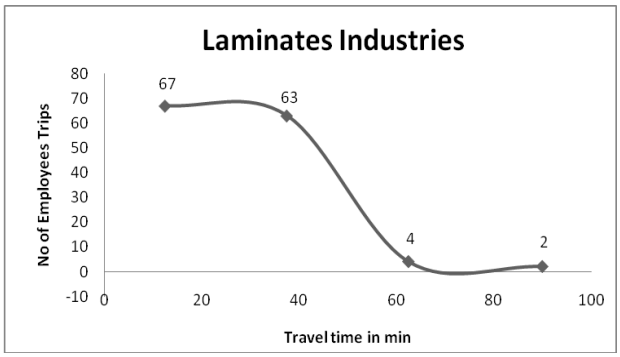
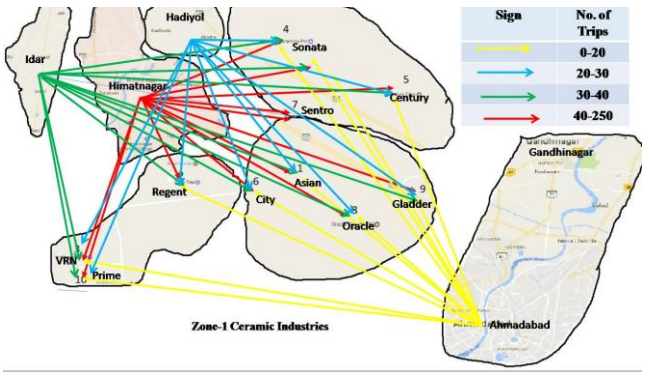


Fig.21: Laminates industries trips/day (Time wise)

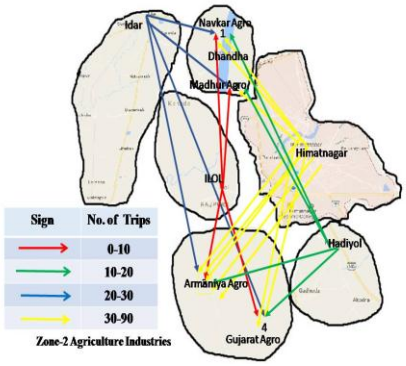
Ceramic Industries Design line Diagram

Figure Design line diagram to indicate the origin and destination of the employees trips for ceramic industries.



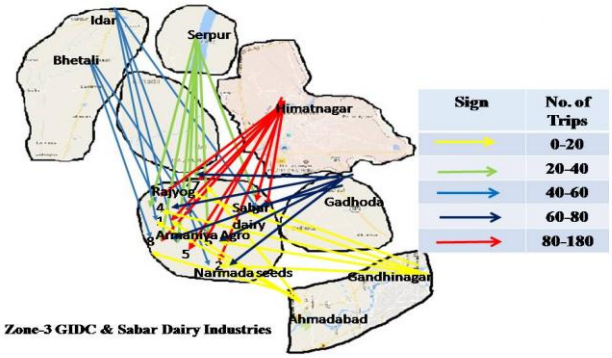
Agriculture Industries Design line Diagram

Figure Design line diagram to indicate the origin and destination of the employees for agriculture industries.



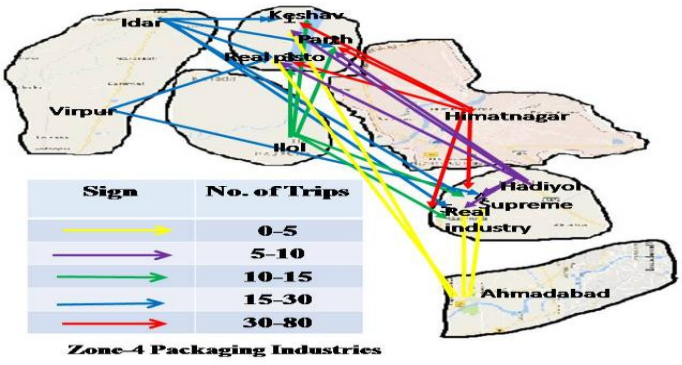
GIDC & Sabar dairy Industries Design line Diagram

Figure Design line diagram to indicate the origin and destination of the employees for GIDC and Sabar dairy industries.



Packaging Industries Design line Diagram

Figure Design line diagram to indicate the origin and destination of the employees for packaging industries



Laminates Industries Design line Diagram

Figure Design line diagram to indicate the origin and destination of the employees for laminates industries

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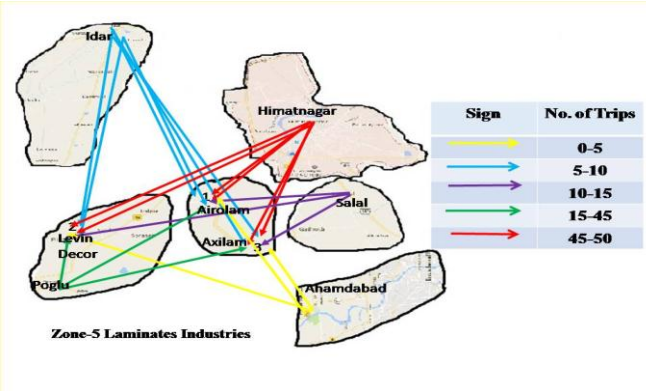

III MODEL DEVELOPMENT

Employees Trips Model Estimation

After understanding the technique of development of regression model, the industrial trip generation models-dependent and independent variables based will be estimated. The model will be formulated using the multiple linear regression method by regression the dependent variable on each of the explanatory variables.

Table 1: List of independent variables used in the Employees trips generation model

X1	Area (sq.m)
X2	Ave. Trip time(min)
X3	Ave. Monthly Salary(thousand)
X4	Ave. Daily Raw material (Ton)
X5	Ave. Daily Finished material (Ton)

Table 2: List of dependent variables used in the Employees trips generation model

Y	Num. of Employees Trips

Employees Trip Generation Model Development from Regression Analysis:

From the collected data and analysis of data, trip generation model developed for some selected base:

Ceramic industrial Trip generation model:

Using the various data from the industries, the trip generation model is developing using the multiple regression analysis. The regression analysis conducted few times. In each stage, the regression model is evaluated according to statistical tests. The final projected ceramic industrial trip generation model is:

(1.) $Y=624.28-0.01X1-14.73X2+0.026X3+1.35X4-0.395X5$ $R^2=0.90$

(2.) $Y=595.86-0.01X1-14.23X2+0.025X3+1.1X4$ $R^2=0.90$

(3.) $Y=648.48-12.2X2+0.01X3+1.12X4-0.45X5$ $R^2=0.86$

(4.) $Y=720.39-0.001X1-15.43X2+0.024X3$ $R^2=0.88$

(5.) $Y=616.08-11.65X2-0.017X3+0.83X4$ $R^2=0.86$

(6.) $Y=159.18+0.017X3-0.23X4+2.18X5$ $R^2=0.82$

(7.)$Y=887.31+0.001X1-12.03X2$ $R^2=0.63$

(8.)$Y=712.02-12.87X2+0.017X3$ $R^2=0.85$

(9.) $Y=223.6+0.019X3+1.25X4$ $R^2=0.80$

(10.) $Y=173.34-4.66X4+9.04X5$ $R^2=0.34$

(11.) $Y=525.7+0.002X1$ $R^2=0.52$

(12.) $Y=1326.86-23.5X2$ $R^2=0.29$

(13.) $Y=310.41+0.019X3$ $R^2=0.77$

(14.)$Y=538.46+1.640X4$ $R^2=0.05$

(15.)$Y=277.2+4.18X5$ $R^2=0.22$

$$Y=223.6+0.019X3+1.25X4$$

Where,

Y=Num. of employees trips

X3=Ave. monthly salary

X4=Ave. Daily Raw material (Ton)

The full SPSS results of the employee trip generation model using the SPSS package. The interpretation of these results is discussed below:

Interpretation of Regression Coefficients

This model (eq. 9) is best because of the coefficient of X3 (Ave. monthly salary) and X4 (Ave. Daily Raw material (Ton)) are 0.019 and 1.25 respectively. These coefficients have positive sign indicate that the monthly salary and Ave. Daily Raw material increases, the daily trips will increases.

Table 3: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Ave. Monthly Salary(thousand)	5.24	.001
Ave. Daily Raw material (Ton)	1.05	.328

Testing Goodness of Fit: R-Squared (R^2)

The R-squared value of 0.80 indicates that the independent variables entered into the model explain about 80% of the variation in the dependent variable. In the case of cross-section data, such an R-squared value is considered practical reasonable.

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Agriculture industrial Trip generation model:
The final projected agriculture industrial trip generation model is:

$$Y=20.02+6.2X4$$

Where,

Y=Num. of employees trips

X4=Ave. Daily Raw material (Ton)

Table 4: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Ave. Daily Raw material (Ton)	16.55	0.004

Testing Goodness of Fit: R-Squared (R^2)
The R-squared value of 0.99 indicates that the independent variables entered into the model explain about 99% of the variation in the dependent variable

GIDC & Sabar Dairy industrial Trip generation model:
. The final projected GIDC & Sabar Dairy industrial trip generation model is:

$$Y=-41.4+0.011X1-41.33X2+0.091X3$$

Where,
Y=Num. of employees trips

X1=Area (sq.m)

X2=Ave. trip time (min)

X3=Ave. monthly salary

Table 5: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Area (sq.m)	9.019	.000
Ave. Trip time(min)	-2.244	.075
Ave. Monthly Salary(thousand)	3.105	.027

Testing Goodness of Fit: R-Squared (R^2)
The R-squared value of 0.97 indicates that the independent variables entered into the model explain about 97% of the variation in the dependent variable.

Packaging industrial Trip generation model:
The final projected packaging industrial trip generation model is:

$$Y=-176.78+0.013X3+4.98X4$$

Where,
Y=Num. of employees trips

X3=Ave. monthly salary

X4=Ave. Daily Raw material (Ton)

Table 6: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Ave. Monthly Salary(thousand)	5.47	.032
Ave. Daily Raw material (Ton)	11.65	.007

Testing Goodness of Fit: R-Squared (R^2)

The R-squared value of 0.98 indicates that the independent variables entered into the model explain about 98% of the variation in the dependent variable.

Laminates industrial Trip generation model:
The final projected laminates industrial trip generation model is:

$$Y=-847.9+27.28X4$$

Where,
Y=Num. of employees trips

X4=Ave. Daily Raw material (Ton)

Table 7: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Ave. Daily Raw material (Ton)	44.70	0.014

Testing Goodness of Fit: R-Squared (R^2)
The R-squared value of 0.99 indicates that the independent variables entered into the model explain about 99% of the *variation in the dependent variable.*

Goods/freight Vehicle Trip Generation Model Development from Regression Analysis:

From the collected data and analysis of data, trip generation model developed for some selected base:

Ceramic industrial Goods Trip generation model:
The final projected ceramic industrial trip generation model is:

$$Y=5.37-0.002X3+0.40X4$$

Where,

Y=Num. of employees trips

X3= Ave. Daily Finished material trips distance (km)

X4=Ave. Daily Raw material (Ton)

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Table 8: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Ave. Daily Finished material trips distance (km)	-2.084	0.076
Ave. Daily Raw material (Ton)	4.458	0.003

Testing Goodness of Fit: R-Squared (R^2)

The R-squared value of 0.75 indicates that the independent variables entered into the model explain about 75% of the variation in the dependent variable.

GIDC & Sabar Dairy industrial Trip generation model:

The final projected GIDC & Sabar Dairy industrial trip generation model is:

$$Y=20.81-0.032X3+0.498X4$$

Where,

Y=Num. of employees trips

X3= Ave. Daily Finished material trips distance (km)

X4=Ave. Daily Raw material (Ton)

Table 9: Observed T-test value

Independent variable	T- value	Significance (95% level of significance)
Ave. Daily Finished material trips distance (km)	-2.002	.092
Ave. Daily Raw material (Ton)	2.975	.025

Testing Goodness of Fit: R-Squared (R^2)

The R-squared value of 0.671 indicates that the independent variables entered into the model explain about 67% of the variation in the dependent variable.

Conclusion

In this study industrial trips calculated from the employee trips survey and goods/freight survey. The sample size of industries is 31 i.e., approx 1063 employees. Another sample size is also 31 industries for goods trips survey.

The multiple regression method, which is one of the popular methods used to predict the trip generation, was used in this study. The relevant conclusions are as follows:

Employees trip generation model

Industries Zone	R^2 value	Independent variable	T-value	Significance (95% level of significance)
Ceramic industries	0.80	Ave. Monthly Salary(thousand)	5.24	.001
Agriculture industries	0.99	Ave. Daily Raw material (Ton)	16.55	0.004
GIDC & Sabar dairy	0.97	Ave. Monthly Salary(thousand)	3.105	.027
Packaging industries	0.98	Ave. Monthly Salary(thousand)	5.47	.032
		Ave. Daily Raw material (Ton)	11.65	.007
Laminates industries	0.99	Ave. Daily Raw material (Ton)	44.70	0.014

Goods Vehicle trip generation model

Industries Zone	R^2 value	Independent variable	T-value	Significance (95% level of significance)
Ceramic industries	0.75	Ave. Daily Raw material (Ton)	4.458	0.003
GIDC & Sabar dairy	0.67	Ave. Daily Raw material (Ton)	2.975	.025

REFERENCES

[1] Comi F. and Russo A., (2011). "Measures for Sustainable Freight Transportation at Urban", Journal of Urban Planning and Development.

[2] Divya Priya C., (2014). "Freight Trip Generation Models for Chennai, India", Transportation Research Board Conference.

[3] Eggett D.L., Jin T.G. and Mitsuru S., (2012). "Developing Country-Level Commodity-flow Models Incorporating Land-Use Characteristics and Economic Factors for Utah", Journal of Urban Planning and Development.

[4] Koppelman and Pas, (1984). "Linear regression and categorical analysis techniques are widely used in estimating the aggregate models" (FHWA, 1975; Hobbs, 1979; Koppelman and Pas, 1984; Bruton, 1986; Sheppard, 1995). Discrete choice models are used for disaggregate models (Vickerman and Barmby, 1985).

[5] Leake G.R. and Gray J.E., (1979). "Trip generation of Selected Industrial Groups", Institute of Transport Studies, University of Leeds, Leeds, UK, Paper No.113.

[6] Mirjam H.E., Wilhelm J. and Lóri A., (2002). "Freight trip generation by firms" Transportation Research University of Groningen European, Paper No.113.

[7] Munuzuri J., Pablo C. and Luis O., (2009). "Modeling Freight Delivery Flows: Missing Link of Urban Transport Analysis", Journal of Urban Planning and Development.

[8] Nadezda Z. and Arkady B., (2013). "Regression analysis for transport trip generation evaluation" Transportation Management System Riga Technical University.

[9] Qiuping W., Siying W. and Yifan Y., (2013). "Research on slow traffic forecast based on land use", Transportation Research, Xi'an University of Architecture and Technology study Xi'an city in China.

[10] Starkie D.N.M., (1964). "Industrial trip generation models in transportation", Transportation Research University of South East England in Medway town.

[11] Vinodkumar R., Varia H. R. and Rajpara G., (2016). "Development of Regional Industrial Trip Generation Model", Indian Journal of Transportation Management system.

[12] Williams T.E.H. and Latchford J.C.R., (1962). "Industrial multiple regress models", Institute of Transport Studies, University of North East England.