JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

MODELING OF TRAVEL TIME UNDER HETEROGENEOUS TRAFFIC CONDITION IN CHANDIGARH- A CASE STUDY

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Abstract: The case study aims to investigate the elements that influence trip generation in Chandigarh City and design a trip generation model. A trip generation model is created which considers all of the influencing characteristics to forecast future travels. The model was created using multiple linear regression analysis with the Statistical Package for the Social Sciences (SPSS), which finds a link between respondents' travel time and Socio-economic characteristics. A general model for trip generation has been developed. The model resulted in a practical value of R^2 as 0.385, suggesting that the variables included within the model considered explanatory variables, such as age, occupation, average daily distance traveled, mode of transportation, the purpose of visit, and frequency of visit explains 38.5% of the dependent variable. MAPE value calculated as 44.694% shows that the forecasting is legitimate. The Root Mean Square Error is 0.407, which shows that the model can relatively predict data accurately. Further extensive research is required to apply this model for planning purposes. This model may be used to estimate future journeys accurately.

KEYWORDS–Trip generation, Multiple Linear Regressions, Statistical Package for the Social Sciences; Mean Absolute Percentage Error, Root Mean Square Error.

INTRODUCTION

Chandigarh is a city, district, and Union Territory of India that serves as the capital of two neighboring states, Haryana and Punjab. It has a total size of 114 square Kilometers. Chandigarh's current population is roughly 11.91 lakhs, representing a 40.33 percent rise in decadal growth since the 2011census. According to the 2011-2012 census, country, with 702 vehicles per 1,000 people. The road network of the city is divided into eight zones Chandigarh has the most registered vehicles in the i.e. from V1 to V8 serving different needs of the people like V1 roads connect Chandigarh's main roadways, Madhya Marg and Dakshin Marg, to other cities in the region, whereas V8 roads are cycle track roads that are still being built. To forecast future travel demand, transportation planning procedures have been extensively adopted. The forecasted travel demand is used to prepare for future transportation infrastructure and services.

It is necessary to quantify the system's inputs and outputs in the case of transportation. Future transportation demand projections are employed as system inputs, while system outputs are the system features that will be used to meet that growth shortly (Hutchinson, 1974).

According to the Urban Traffic Management Method, a well-known and frequently used planning system, four analytical processes are employed to obtain the total demand in the horizon year and quantify the inputs and outputs. The analytical steps include trip formation, trip distribution, modal split, and route assignment.

A Trip Generation study comprises estimating the number of trips generated in various traffic territories in an urban setting. For the purposes of analysis, a journey is defined as a one-way transit from an origin to a destination.

The entire city is frequently divided into smaller traffic zones, with the zone center being its source and destinations. The fundamental purpose of trip generation analysis is to link travel frequencies (the number of trips taken from one

location to many others) to and from traffic zones in addition to assessing the kind and intensity of land use in these areas, as well as other Socio-economic factors.

There are few specialist studies in Chandigarh that deal with quantifying and estimating travel demand. Several causes have contributed to significant increases in trip generation in Chandigarh, resulting in an increase in the number of automobiles as well as a growing need for mobility as a result of population growth. The city's strictly controlled transportation network expansion, and also the perceived overcrowding and congestion of current mobility networks, perpetuate the problem.

Transportation planning appears to be vital for these localities as the number of cars on the road is predicted to rise in the future. Trip generation, trip distribution, modal split, and route assignment are the four analytical steps that are insufficient for proper modeling.

This study investigates the need for research in this area by looking at the trip production stage of the trip producing stage, as well as its various categories, to provide a solid foundation for the traffic network.

OBJECTIVE OF THE STUDY

The purpose of this research is to build trip generation models that can forecast how many trips people will need in Chandigarh, which will be used as a case study. Multiple linear regression analysis is used to create the models, which reveals a direct link between the number of routes taken by households and some Socio-economic attributes.

Table 1 Model Variables

Individualist Variables used in the model	
X1	Age
X2	Occupational status
X3	Average distance travelled per day
X4	Usual mode of transport
X5	Purpose of visit
X6	Frequency of visit
Dependent Variable used in the model	
Y	Average travel time per day

METHODOLOGY

The first step is to see the relevant literature, which includes publications on travel demand analysis using methodological approaches, including linear regression. The second phase is determining the research area's boundaries and splitting the city into traffic zones based on predefined criteria. The third step includes specifying whatever information is required and creating a questionnaire that will collect relevant socioeconomic characteristics and trip data. Obtaining field data from a sample of families in various traffic zones is the fourth phase. The overall number of travels made by household members, as well as the number of journeys made by the household for each category of trip production, whether by trip purpose or trip time, is required to be filled into a Google form survey. The final phase is carried out with the help of specialized software tools. This requires estimating a credible hypothesis for the total number of trips produced by the family, as well as the total number of trips for each classification of home-based excursions, using the linear regression method (either according to a trip purpose or trip time).

LITERATURE REVIEW

Kumar M; Shabana Thabassum (2021) looked at four different calculation procedures (prior vehicle registration, transport demand elasticity approach, single exponential smoothing approach, ARIMA methodology) to see which one was the best fit. As a result, ARIMA models can predict traffic growth rates for future horizon years in the planning. Onyemaechi J.Nnamani, Victor A. Ijaware, Joseph O. Olusina, Timothy O. Idowu, (2020) used geometry and traffic data gathered from segmented sections of the Adesida Road in Akure Metropolis to develop a multiple linear regression model to estimate journey duration. For data analysis and model building, SPSS 16 was employed. The study was successful in determining travel time for various periods on various days of the week based on the analysis of the results acquired. The accompanying peak volumes, spot speed, density, and traffic flow were mostly determined. Dr. Kumar Molugaram; Bollini Prasad (2018) presented the findings using a trip generation model was constructed for the data, which shows that the trips attracted to and produced from a zone are reliant on population, employment, and the registered number of vehicles in the area, as determined by multiple regression analysis. To assess trip inter-changes, a gravity simulation with an RMSE of fewer than ten was established. Alaa Mohammad Yousef Dodeen (2014) developed a questionnaire used to conduct home interviews with the selected samples to collect the necessary information. The multiple linear regression method was used in this study, and it is one of the most commonly used methods for estimating the number of trips generated. Moussa (2013) conducted research in Gaza City, Palestine, to develop a trip generating model and estimate the study area's home travel characteristics pattern. The study's focus in Gaza City was to compare trip rates predicted using the Multiple Cross Classification (MCA) approach to those predicted using the Conventional Cross Classification (CCA) method. In addition, the researcher wanted to use

Multiple Linear Regression to create a trip attraction model (MLR). The original information was acquired through a household interview survey. Rushikesh (2013) published a study on journey time variations for a corridor in Surat, India, based on traffic volume on a license plate database under mixed traffic conditions. Anil Kumar Bachu; L. Vanajakshi; Shankar Subramanian (2013) conducted a pattern analysis study and a parametric statistical test to discover the most significant travel time patterns for each day of the week independently (Z-test). The study looked at trip-by-trip, daily, and weekly patterns of public transport bus travel time under various traffic situations. According to the findings, all weekdays followed a similar pattern; however, Sunday followed a different one. In the Iraqi city of Al-Diwaniyah, Sofia G., Abed Ali H., and Al-Zubaidy (2012) established a relationship between daily household outings and socioeconomic indices. The authors used the stepwise regression technique after putting the collected data into the SPSS software (MLR). In the Al-Karkh area of Baghdad City, Iraq, Sarsam, and Al-Hassani (2011) developed a statistical model for predicting trip volumes for a given calendar year. The modeling method considered non-motorized commuting. According to Bhaskar et al. (2009), regression-based models are quick to compute and suitable for transportation planning and policy applications. However, using license plate approaches or a videography strategy, data collecting is time-consuming. There has been a microscopic study on travel time modeling in the Indian context to examine the impact of mixed traffic on journey time variations considering various associated characteristics. In terms of demographic and travel characteristics, Georggi N.; Pendyala R. (2001) compare the old and low-income sectors of the population to another group. The purpose of the journey, mode of transportation, distance, trip duration, and frequency were all examined in the comparison of travel behavior. Furthermore, regression models of long-distance trip generation were created independently for each group to assess differences in trip generating tendency.

DATA COLLECTION

Research Design facilitates the research study by serving as a framework which is created to arrive at conclusive junctures or to attain the objectives of the study. It is like a roadmap that governs the data collection, interpretation, and analysis. Although for the research analysis, the descriptive research design was employed. The survey was carried out by using a questionnaire as a data collection tool/instrument. The strategy of sampling was employed in the first information assortment, through a form approach. This questionnaire was used to collect the primary data from the respondents who were broadly categorized into the four groups according to their travel time of the respondents.

The sampling technique used in this study was Simple Random Sampling (SRS). SRS was suitable because the interpretation of the data collected becomes easier. Also, it is best suited for circumstances where limited information about the sample's population is present. As the sampling was done through the online circulation of the forms on the different social media platforms, and a total of 1975 forms were assumed to be circulated. Out of which 1962 responses were received in total.

DATA ANALYSIS AND RESULTS

A questionnaire with 18 questions related to a home interview survey was used to collect data from respondents of ages ranging. The questions included origin, destination, and the purpose of visit, mode of travel, total distance per day, the total number of licensed members in the family, frequency of using the public transport system, and so on. By creating the Origin and Destination Matrix, it is seen that the maximum number of people are going towards Sector 14, Sector 17, Sector 22, Sector 34, and IT Park, Chandigarh. It is seen from the responses that out of the 1962 responses 970 respondents have their destination as one of them.

"P-value" signifies that if the null hypothesis is valid, the likelihood of getting outcomes is at least as extreme as the observed findings of a statistical hypothesis tests. It is calculated as 0.0001.

The regression equation formed as

$$y = 0.124x_1 - 1.257x_2 + 0.957x_3 + 4.352x_4 + 9.647x_5 + 0.178x_6 - 366.691 \quad (1)$$

where, x_1 =Age

x_2 =Occupational Status

x_3 =Average distance traveled per day

x_4 =Usual mode of transport

x_5 =Purpose of visit

x_6 =Freq. of visit on weekly basis

DEVELOPMENT OF MODEL

The number of daily travel time is regarded as a dependent variable, while age, occupational status, the average distance traveled per day, the usual mode of transport, the purpose of visit, and frequency of visit are considered independent factors. The regression findings for the estimated generic trip generation model are summarized in the table. The final SPSS developed general trip generation model is:

Table 2 Results for the general Trip Generation Model

Intercepts and Variables	Coefficients	Standard Error	t-value	Significance
Intercept	-366.691	23.426	-15.653	0.0001
Age	0.124	0.031	3.950	0.0001
Occupational Status	-1.257	0.649	-1.938	0.0530
Average distance travelled per day	0.957	0.035	27.425	0.0001
Usual mode of transport	4.352	0.770	5.653	0.0001
Purpose of visit	9.647	0.599	16.098	0.0001
Frequency of visit	0.178	0.275	0.649	0.5160
		R- Squared-	0.38500	
		F- Value	203.568	
		Sample Size	1962.00	

Conclusions

- In this study, a trip generation model is developed from the collected data using linear regression analysis. In linear regression analysis, the average travel time per day is used as a dependent variable (Y), and other descriptive variables such as distance traveled, age, mode of transportation, and so on are used as independent variables (X's).
- 14 origins and 21 destinations are chosen at random from the Google Form responses. From this, we conclude that the maximum traffic flows in 5 parts of the city.
- The generalized trip generation model has reasonable explanatory power, with an R^2 value of 0.385, suggesting that the explanatory factors included in the model explained 38.5 percent of the average travel time. To get more accurate data we have to get more responses thus covering maximum respondents. We can also increase the number of independent variables to get a more authentic value near one.
- P-values can be used to assess whether the associations you detect in the sample are also present in the general population. The p-value for each independent variable tests the null hypothesis that the explanatory variables do not affect the dependent variable. The P-value determined with SPSS is 0.0001.
- In statistics, the MAPE value (Mean absolute percentage error) is an indicator of a forecasting method's prediction accuracy. The result was 44.694 percent.

Recommendations

- Trip generation models should be created as the significant instrument for travel demand forecasting in the future to achieve better simulation of traffic flow for superior transportation planning processes in the city.
- Since the model built in this study is based on data from a home interview survey, a more thorough investigation of this process is needed to develop a model that can be used to anticipate future travels and applied in the transportation planning process for industrial trips.
- By creating a decent questionnaire and using a more extensive survey approach, data should be collected with great precision.
- We need to enact tough legislation surrounding lane driving systems in order to save travel time.
- People should be aware that traffic is increasing daily, which is the most significant cause of congestion in the city and, as a result travel time increases. As nothing more than a consequence, taking public transportation or riding in a shared vehicle will be preferable.

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