

Trip Generation

Traffic Engineering of
Transportation planning

Introduction:-

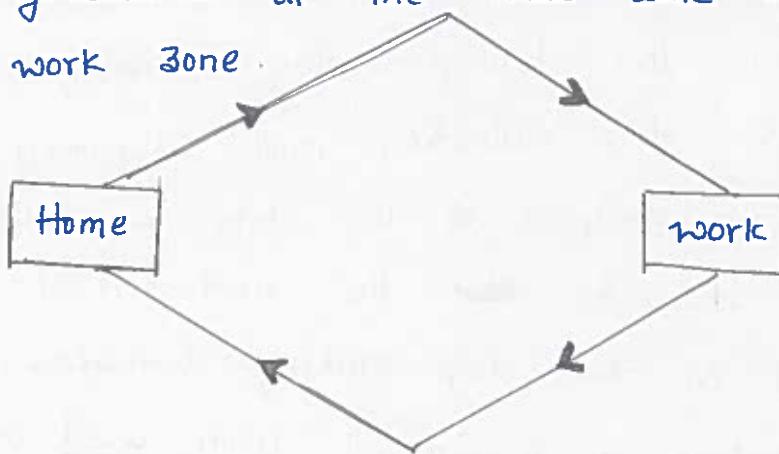
The first phase of the transportation planning process deals with surveys, data collection and inventory. The next phase is the analysis of the data so collected and building models to describe ~~the~~ the mathematical relationship that can be used in the trip making behaviour.

Trip generation is a general term used in the transportation planning process to cover the field of calculating the number of trip ends in a given area. The objective of the trip generation stage is to understand the reasons behind the trip making behaviour and to produce mathematical relationships to synthesise the trip making pattern on the basis of observed trips, land use data and household characteristics.

Trip is a one-way person movement by a different mode of transport. It having two trips ends, an origin (The start of the trip) and destination (the end of the trip). Trips are usually divided into home-based and non-home based. Home based trips having one end at the trip (either origin or destination) at the home of the persons making the trip, while non-home based trips are those having neither end at the home of the person making the trip. The trip ends are classified into generations and attractions. A generation is the home end of any trip that has one end at the home (i.e. of a home based trip) and is the origin of a trip with neither end home based (i.e. of a non-home based trip). An attraction is the non-home end of a home-based trip, and is the destination of a trip with neither end home-based (i.e. of a non-home based trip).

Consider a trip from home to work and the returning trip from work to home. (fig 1) Both these trips

are home-based, because one end of the trips is the home. Both these trips are considered to have been generated at the home zone and attracted to the work zone.



[Fig 1] Home based trips.

Consider a trip from the place of work to shop and return to the place of work as is usual during lunch hours. [Fig 2] Both these trips are non home based because neither end of the trip is the home of the person making the trip. Both these trips are considered to have been generated at the work zone and attracted to the shop zone.

Trip Purpose :

Trips made for different purposes and a classification of trips by purpose is necessary. The following are some of the important classes of trip purpose

- Work
- School or college
- Business
- Social or recreational, Sports
- Others.

Factors Effecting Trip Generation and Attraction

1] Income :- family income which represents its ability to pay for a journey affects the number of trips generated by a household. higher the income the higher is the trip generation rate.

2] Car ownership:- A car represent easy mobility, car owning household will generate more trips than non-car-owning household. By the same reason the more cars there are in a household, the more the number of trips generated. The number of cars owned is itself related to the income of the family.

3] Family size and Composition:-

The bigger the family, the more trips are generated. Apart from the size, the composition of the family itself is important. for example both the husband and wife are employed, the trips generated will be more than when only the husband is employed. If there are many school-going children, the number of school purpose trips will be large. If some of the children are grown up and are employed, the number of work purpose trips will increase. The age structure of the family also effect the trip rates. Old persons are not expected to generate as many trips as younger ones. The occupation of the family is also known to influence the travel pattern.

4] Land use Characteristics:- Different land uses produce different trip rates. For example a residential area with a high density of live can produce more trips than one with a low density of dwelling. On the other hand low density areas may represent dwellings of the rich society which may produce a large number of private car trips. The market value of the dwelling and the type of the dwelling units affect the trip generation rates. The most important assumption made in transport planning is that the amount of travel is dependent on land use.

5] Distance of the zone from the town centre:-

The distance of the zone from town centre is an important determinant of the amount of travel that people might like to make the town centre. The farther the town centre, the less the number of trips are likely to be.

6] Accessibility to public transport System and its efficiency :-

The accessibility to a public transport system and its efficiency determine ~~per~~ desire of persons to make trips. An easily accessible and efficient public transport system generates more trips.

Multiple Linear Regression Analysis:-

Multiple linear regression analysis is a well-known statistical technique for fitting mathematical relationships between dependent and independent variables. In case of trip generation equations the dependent variable is the number of trips and the independent variables are the various measurable factors that influence trip generation. These independent variables are the land use, socio-economic characteristics. The general form of the equation

$$Y_p = a_1x_1 + a_2x_2 + a_3x_3 + \dots + a_nx_n + U$$

Y_p = number of trips for specified purpose p.

$x_1, x_2, x_3, \dots, x_n$ = independent variable ~~related to~~

$a_1, a_2, a_3, \dots, a_n$ = Coefficients of respective independent Variable $x_1, x_2, x_3, \dots, x_n$.

U = ~~related~~ Disturbance term, which is a constant, and representing that position of the value of Y_p .

The equation of the above ~~fit~~ is developed from the present data related to independent variables and the dependent variables using the "least squares" fitting. This equation is used for determining the future values of trips knowing the estimated future values of independent variables.

An example of the ~~above~~ & multiple linear regression analysis equation developed from a study of Toronto is given

Total trips (generated at home on an average week day) = ~~0.00~~ $0.318 \times (\text{population } \leq \text{ years of older}) + 0.458 \times (\text{number of households}) + 0.890 \times (\text{number of cars owned})$

Another example below is from study of Modesto

$$Y = 2.18 + 3.404A + 0.516H + 0.0119X_1 - 0.343X_2$$

Y = Average trips per occupied

A = Car ownership

H = House hold size Residential unit

X_1 = Social Rank Zone }
 X_2 = Urbanization Zone } Constant

Assumptions in Multiple Linear Regression Analysis ~~&~~

- i] All the variables are independent of each other
- ii] All the variables are normally distributed
- iii] All the variables are ~~continuous~~ continuous
- iv] A linear relationship exists between the dependent variable & independent variable.
- v] Influence of independent variable is additive

The above assumption are ~~not~~ difficult to take for example because the first assumption independent variables in the equations are not truly independent of each other and some ~~co~~ correlation normally exists among them. the variables such as co-ownership, Family income, residential density etc. Secondly many of these variables are not normally distributed. Finally, some of them are not continuous variables.

Types of Multiple linear regression analysis :-

Multiple linear regression analysis is of two types

- (i) Aggregated (or) Zonal least-square regression, where each traffic zone is treated as one observation
- (ii) Disaggregated (or) Household least-square regression, where each household is treated as an observation.

Aggregated Analysis :

The Aggregated Analysis which is widely used, based on the assumption that ~~co~~ zonal households exhibit a certain amount of similarity in travel characteristics.

Some of the disadvantages of the aggregated analysis :-

- Variations in the analysis of the data
- The data is inefficiently utilised
- The Zonal sample mean not coincide with the estimate of the population mean
- The method is based on an important assumption that zones are to be a large extent homogeneous with respect to travel of socio-economic ~~activities~~ characteristics. while care is taken normally to select the zone boundary to fulfil the above assumption.

→ In the process of making the zones as small as possible to make them truly homogeneous.

Disaggregated Analysis :-

Disaggregated Analysis not so widely used, treats each household as an observation. In this process

The amount of data is used more effectively. As compared to aggregated analysis, disaggregated analysis produces better results and provide more reliable future estimates.

Criteria for Evaluation of Regression Equations :

- 1] The multiple co-relation coefficient should have a value at least 0.75 or even higher. A value close to 1.0 shows a very good co-relation.
- 2] The standard error of the estimate of the dependent variable should be sufficiently small.
- 3] The equation should have accuracy, validity, constancy.

Disadvantages of the Multiple Linear Regression Analysis Technique

- i] The equation fails to establish ~~indeed~~ meaningful relationship between the dependent & independent variables.
- ii] The Regression coefficients initially established will still remain unchanged in the future and can be used in the regression equation for predicting future travel.

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Category Analysis :-

Category Analysis (8) cross-classification technique is a method developed by Hotton and Pick and has been used in some transportation studies in U.K.

It is based on determining the average value of the dependent variable for categories of the independent variables.

Assumptions :

The technique is based on the following assumptions :-

- i] The household is the fundamental unit in the trip generation process, and most journeys begin & end in response to the requirements of the family.
- ii] The trip generated by the household depend upon the characteristics of that household and its location relative to its required facilities such as shops, school and work place.
- iii] Only three factors are of prime important in affecting the amount of travel a household produces : car-ownership, income & household structure.
- iv] Households with one set of characteristics generate different rates of trips from households with other set of characteristics.
- v] Within each of the above three factors, a limited number of ranges can be established so as to describe the trip generating capacity of a household by a limited number of categories.

Categorisation of Households:-

Households are classified on the basis of three factors, car ownerships, income and household structures. These are then classified into different ranges as indicated below:

1] Car ownership - 3 levels [0 car, 1 car and more than 1 car]

2] Disposable Income - 6 classes

- (i) < 500 Per day
- (ii) 500 - 1000 Per day
- (iii) 1000 - 1500 "
- (iv) 1500 - 2000 "
- (v) 2000 - 2500 "
- (vi) > 2500 "

3] Household Structure - 6 classes

- i] No. employed residents & One non-employed adult
- ii] No. employed residents and 2 or more non-employed adult
- iii] One employed residents & One or less non-employed adult
- iv] One employed residents & 2 or more non-employed adult
- v] Two or more employed residents & one or less non-employed adult
- vi] Two or more employed residents & two or more non-employed adult

The above system gives in all $3 \times 6 \times 6 = 108$ categories.

Critical appraisal of the category analysis

Technique :

The advantages that ~~are~~ ~~been~~ for Critical appraisal of the category analysis Technique.

- (i) The whole concept of household trip making is simplified in this technique. The technique categorises the household according to certain socio-economic characteristics.
- (ii) Unlike regression analysis technique, no mathematical relationship is derived b/w trip making & household characteristics.
- (iii) Since data from the census can be used directly, it saves considerable effort, time and money spent on home-interview survey.
- (iv) The computations are relatively simpler.

Disadvantages of Category analysis :-

- * The following are some of the disadvantages of the technique:
 - (i) It is difficult to test the independent variable.
 - (ii) The technique normally makes use of studies in the past.
 - (iii) In the analysis it is assumed that income and car ownership increase in future. The categories of higher incomes and higher car ownership also increases.
 - (iv) New variables can not be introduced at a future date.
 - (v) Large samples are needed to assign trip rates to any one category.