Trip Generation

- Estimating the number of trips generated by zonal activities
- Trip generation estimate by regression analysis
- Trip generation estimates by trip rates/unit
- Trip generation estimates by category analysis
- Method to balance trip productions and attractions
What is trip generation?

- It is the process by which measures of urban activity are converted into numbers of trips.
- In trip generation, the planner attempts to quantify the relationship between urban activity and travel.

It means both trip productions and trip attractions.
A zone produces and attracts trips

Depending on the activities in the zone, it can produce and/or attract trips. Transportation planners estimate these trips first.
Three ways for estimating the number of trips produced

- Regression models
  \[ Y = A + B_1 X_1 + B_2 X_2 + \ldots \]
  \( Y \) = dependent var. (trips/household)
  \( X_1, X_2, \text{ etc.} \) = independent variables

- Trip rates, like # of trips/1000ft\(^2\)

- Category analysis (cross-classification analysis)
Trip generation rates

This is an example of trip generation rate information taken from the ITE Trip Generation Handbook. Some land use has a lot of data points like this one, but others (many of them) have only sparse data points. This handbook is evolving and every year new data are added.
Category analysis (cross-classification analysis)

(Groups individual HHs according to common socioeconomic characteristics)

- Less aggregated than trip rates and regression models
- See the list of advantages and disadvantages in the book to see why this is popular

HB Trip Production example

<table>
<thead>
<tr>
<th>Workers /HH</th>
<th>Household size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1.418</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
Trip attraction

- Trip attraction rates can be made by analyzing the urban activities that attract trips.

- Trips are attracted to various locations, depending on the character of, location, and amount of activities taking place in a zone.

- Three tools are used for this end too, but obviously types of independent variables used are different.
Trip Distribution

- Trip distribution: why is it needed?
- The Fratar Method (not covered)
- The Gravity Model

TD: Part 3 topics
What is trip distribution?

- Estimates where the attraction in zone i come from and where do the productions go.
- The decision on where the trips go is represented by comparing the relative attractiveness and accessibility of all zones in the area.
The Gravity model

Derives its base from Newton’s law of gravity, which states that the attractive force between any two bodies is directly related to their masses and inversely related to the distance between them.

Similarly, in the gravity model, the number of trips between two zones is directly related to activities in the two zones, and inversely related to the separation between the zones as a function of the travel time.
The Gravity model

\[ T_{ij} = \frac{\left( \frac{A_j}{(D_{ij})^n} \right)}{\left( \frac{A_1}{(D_{i1})^n} \right) + \left( \frac{A_2}{(D_{i2})^n} \right) + \cdots + \left( \frac{A_m}{(D_{im})^n} \right)} p_i \text{ trips} \]

Where:

- \( T_{ij} \) = trips from zone i to zone j for a specific purpose.
- \( p_i \) = total trips produced from i for a specific purpose.
- \( A_j \) = a measure of attraction of the jth zone for a specific purpose.
- \( A_i \) = distance from zone i to zone j
- \( n \) = exponent that varies with trip purpose.
The Gravity model

Example:

Given that \( P_i = 110 \) trips / day for shopping trips from zone i.

Distribute these trips to shopping centers 1, 2 and 3. Assume that the \( n = 2 \).

Given that distance from zone i to shopping centres 1, 2 and 3 are 8, 4 and 5 miles respectively. Use the value of commercial space within the destination zone as the measure of attractiveness.

<table>
<thead>
<tr>
<th>Shopping Centre</th>
<th>Floor space (1000 ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>184</td>
</tr>
<tr>
<td>2</td>
<td>215</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
</tr>
</tbody>
</table>
What is modal split?

- Split trips to different available transportation modes, by analyzing people’s decisions regarding mode of travel they use.

Trip-end models vs. Trip-interchange models

Can be done here
What affects people’s mode choice?

**Characteristics of the trip:**
- trip distance
- time of day
- trip purpose

**Characteristics of the trip maker:**
- Income
- # of autos available
- family size
- residential density
- gender

**Characteristics of the transportation system:**
- riding time
- waiting time
- transfers
- out-of-pocket cost
Logit Model

This model is used to predict the modal split ratio. It is as follows:

\[ P_{it} = \frac{e^{U_{it}}}{\sum_{All\ j} e^{U_{jt}}} \]

Where:
- \( P_{it} \) = probability of individual \( t \) choosing mode \( I \)
- \( U_{it} \) = utility of mode \( i \) to individual \( t \)
- \( U_{jt} \) = utility of mode \( j \) to individual \( t \)
- \( U_{\text{car}} \) = \( 1.0 - 0.1 \ \text{(TT}_{\text{car}}) - 0.05 \ \text{(TC}_{\text{car}}) \)
- \( U_{\text{bus}} \) = \( -0.1 \ \text{(TT}_{\text{bus}}) - 0.05 \ \text{(TC}_{\text{bus}}) \)
- \( U_{\text{walk}} \) = \( -0.05 - 0.1 \ \text{(TT}_{\text{walk}}) \)
- \( TT \) = travel time in minutes.
- \( TC \) = travel cost in $. 

\( U_{\text{car}} \) = 1.0 – 0.1 (TT_{car}) – 0.05 (TC_{car})
\( U_{\text{bus}} \) = – 0.1 (TT_{bus}) – 0.05 (TC_{bus})
\( U_{\text{walk}} \) = – 0.05 – 0.1 (TT_{walk})

TT = travel time in minutes.
TC = travel cost in $. 
Example:
1000 trips being made between zones A and B. There are 3 modes available to make this trip. The utility of the individual modes are as above. Given that:

<table>
<thead>
<tr>
<th>Mode</th>
<th>TT(min.)</th>
<th>TC ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>5</td>
<td>0.6</td>
</tr>
<tr>
<td>Bus</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>Walk</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Estimate the number of trips made by each mode of transportation.

Answers:
822 trips are made by car.
112 trips are made by bus.
66 would walk.
Trip assignment is the procedure by which the planner predicts the paths the trips will take.

The planner can get realistic estimates of the effects of policies and programs on travel demand.
Trip Assignment

It is one of the most important and complex phases of transportation planning.