Orf 467

Transportation Systems Analysis

Fall 2017/18

Class #7

Part 2: Planning and Analysis Tools of Transportation Demand and Investment

Modal Split Ref: Southern California Association of governments (SCAG) Regional Travel Demand Model Mode Choice Model (Ch 6) ; (other chapters describing Overview (Ch1); Socio-economic data (Ch2), Trip Generation (Ch3), Trip Distribution (Ch4), Trip Assignment (Ch9) and others are available in this pdf file); Look carefully at this reference: Logit, Nested Logit and Probit Choice Models

- Direct generation usage models
  - These models attempt to forecast mode usage as a function of land use and socio-economic characteristics of the trip production area/zone. (*I don't like these*) They focus on auto ownership (or lack thereof) and relegate relatively little mode share to transit. These are generally derived from regression analyses that 'correlates" know auto ownership rates and mass transit patronage rates to the land use and socio economic characteristics of a zone. They suggest that a change in mode share is dominated by these variables rather than the relative quality of the competing modes. In the typical urban/suburban area, mass transit has been such a poor competitor that unless there is a radical change in the quality of mass transit, these relationships have been good at forecasting changes in mode share as the land use and socio economic conditions of an area changes. I find these models intellectually unsatisfying because they don't reflect changes in service in the modes themselves.
- Trip – Interchange node usage models. (*I prefer these!*). These models focus on the attributes of each mode in the service of each trip. They basically model the decision process that a traveler makes in choosing to go by car, bus train, walk etc. Each mode is characterized in terms of its Utility and a choice process is modeled. That process could be a "winner takes all" or some softening of that choice that suggests that the "winner" only gets a higher share but that the losers also "win" some.

Logit Model: Given a set of modal alternatives, C_j (C_1 = Auto, C_2 = Bus, C_3 =PRT, …) the Probability of an individual t choosing alternative i from a set of alternatives C_j is:

$P_{it} = P(U_{it} > U_{jt})$ for every j in C_j

Where $U_{jt} = V_{jt} + \varepsilon_{jt}$ (The Utility, from the perspective of the decider, U_{jt} , of alternative C_j . It is made up of the Utility, from the perspective of the modeler, V_{jt} , plus some error term ε_{jt})

If we assume (largely for the sake of analytical convenience) that the error term is "independently and identically distributed with a Gumbel Type I distributions" whose cumulative distribution function is given by: $f(x|a,b) = abe^{-(be^{-ax}+ax)}$

for

$$-\infty < x < \infty.$$

(Simplest of versions being: $F(w) = e^{-e^{-w}}$)

Then it can be shown that

$P_{it} = e^{V_{it}} / \Sigma_{j=1,n} e^{V_{jt}}$

Where

P_{it} = probability of choosing mode i by individual t

n = number of modes being considered

V_i = is the modeled Utility function of mode i for individual t (without the error term).

The simplest form of which is a linear function of the n transportation system attributes, X_k k=1,n

$$V_{it} = a_{0t} + a_{1t} X_1 + a_{2t} X_2 + a_{3t} X_3 + \ldots + a_{nt} X_n$$

Where a_{kt} = are the calibrated (possibly individual traveler-specific (t)) coefficients of the linear utility model.

For two modes: If U* is the difference in utility between two modes, $V^* = V_A - V_B$, then

$$P_B = e^{-V^*} / (1 + e^{-V^*}) \text{ and } P_A = 1 / (1 + e^{-V^*})$$

In selecting modes, one must be careful about the Independence if Irrelevant Alternatives Property (IIA):

In the derivation of the Logit model it is assumed that the error term ε_{jt} is "independently and identically distributed". This means that un-observed attributes of alternatives that are essentially buried in the error term are not correlated across alternatives. (They only affect one alternative). Thus, the ratio of the propbablity of any two alternatives is unaffected by any un-modeled (aka un-observed) attribute. Go to Link for an example