Travel Demand Forecasting
Theory & Concepts

The Gravity Model

The gravity model is much like Newton's theory of gravity. The gravity model assumes that the trips produced at an origin and attracted to a destination are directly proportional to the total trip productions at the origin and the total attractions at the destination. The calibrating term or "friction factor" (F) represents the reluctance or impedance of persons to make trips of various duration or distances. The general friction factor indicates that as travel times increase, travelers are increasingly less likely to make trips of such lengths. Calibration of the gravity model involves adjusting the friction factor.

The socioeconomic adjustment factor is an adjustment factor for individual trip interchanges. An important consideration in developing the gravity model is "balancing" productions and attractions. Balancing means that the total productions and attractions for a study area are equal.

Standard form of gravity model

$$T_{ij} = \frac{A_j F_{ij} K_{ij}}{\sum\limits_{allzones} A_x F_{ij} K_{ix}} \times P_i$$

Where:
Tij = trips produced at I and attracted at j
Pi = total trip production at I
Aj = total trip attraction at j
F ij = a calibration term for interchange ij, (friction factor) or travel time factor (F ij $= C/t_{ij}^{n}$)
C= calibration factor for the friction factor
Kij = a socioeconomic adjustment factor for interchange ij
i = origin zone
n = number of zones

Before the gravity model can be used for prediction of future travel demand, it must be calibrated. Calibration is accomplished by adjusting the various factors within the gravity model until the model can duplicate a known base year's trip distribution. For example, if you knew the trip distribution for the current year, you would adjust the gravity model so that it resulted in the same trip distribution as was measured for the current year.

Travel Demand Forecasting
Glossary

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Centroids-- Imaginary points within zones from which all departing trips are assumed to originate and at which all arriving trips are assumed to terminate.

Cordon Line-- An imaginary line that denotes the boundary of the study area.

Friction Factor-- A mathematical factor that is used to describe the effort that is required to travel between two points.

Link-- An element of a transportation network that connects two nodes. A section of roadway or a bus route could be modeled as a link.

Modal Choice Analysis-- The process used to estimate the number of travelers who will use each of the available transportation modes (train, car, bus) to reach their destination.

Nodes-- Nodes are points at which links terminate. Links may terminate at destinations or at intersections with other links.

Routes-- Pathways through a network. Routes are composed of links and nodes.

Study Area-- The region within which estimates of travel demand are desired.

Trip-- The journey between one point and another.

Trip Assignment Analysis-- The process used to estimate the routes (for each mode) that will be used to travel from origin to destination. This process yields the total number of vehicles or passengers that a particular route can expect to service.

Trip Distribution Analysis-- The process used to determine the number of produced trips from each zone that will be attracted by each of the remaining zones.

Trip Generation Analysis-- A data collection and analysis process that is used to estimate the number of trips that each zone will produce and attract.

Urban Growth Boundary (UGB)-- An imaginary boundary that encloses all of the land that is expected to be developed at some

point in the future.

Utility Function-- A mathematical function that expresses the advantages and disadvantages of a particular transportation mode.

Zones-- Regions within the study area that contain homogenous land uses and can be described accurately by only a few variables.

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Travel Demand Forecasting can seem like a long and daunting process when viewed as a whole. It is much easier to approach when broken into small steps. The discussions below should help you develop a basic understanding of the Travel Demand Forecasting process.

Overview of the TDF Process
Description of the Study Area

Trip Generation Analysis
Cross-Classification
Multiple Regression Analysis
Experience Based Analysis

Trip Distribution Analysis
The Logit Model
The Gravity Model

Modal Choice Analysis
Trip Assignment Analysis
Results