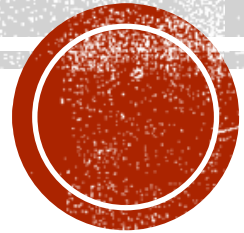
Global Initiative of Academic Networks (GIAN)

UNDERSTANDING THE INCREASING RELEVANCE OF CHOICE MODELS FOR ADVANCING TRANSPORTATION MODELLING IN SMART CITIES

MAY 22 -26, NAGPUR, INDIA



Module 5

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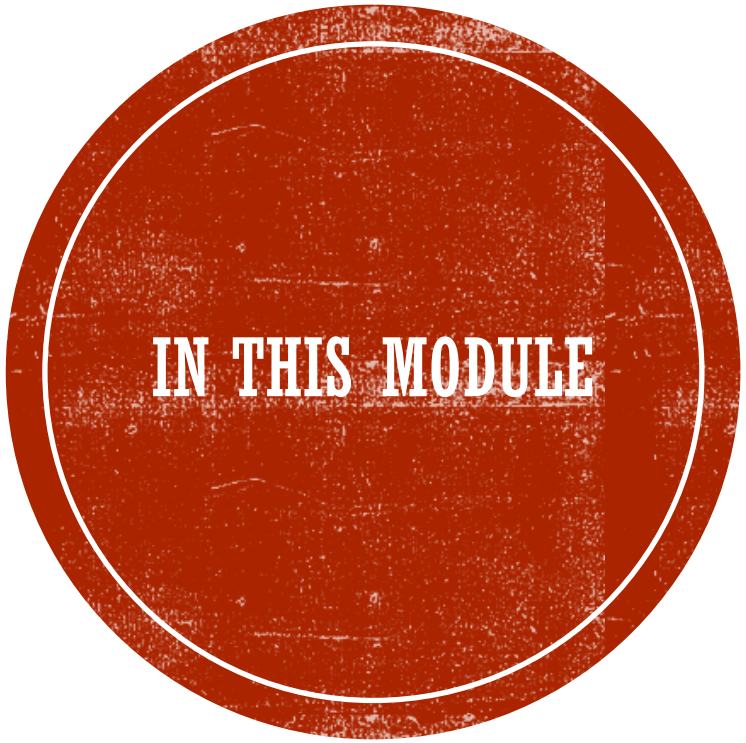
COURSE MODULES

Introduction	• Introduction to Smart City Technologies, their impact on Transportation
Stated Preference Module	• Background on Data Collection Approaches • Stated Preference Design and application
Traditional Discrete Choice Models	• Binary logit, multinomial logit, ordered logit, and count models
Advanced Discrete Choice Models	• Nested logit, mixed logit, maximum simulated likelihood estimation, regret minimization, discrete continuous models
Transportation Planning	• Current state of the art and recent advances



I will briefly highlight the current state of practice in travel demand models and highlight potential changes in planning models with smart cities

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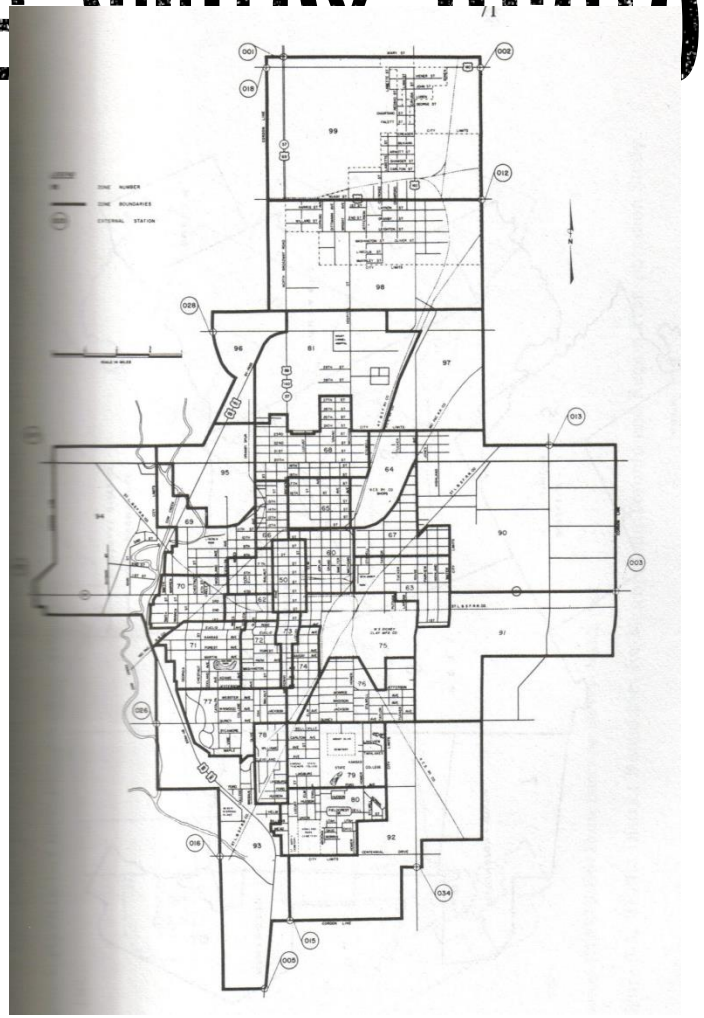
STATE OF THE PRACTICE TRANSPORTATION PLANNING

OVERVIEW OF THE STATE-OF-THE-PRACTICE TRAVEL-FORECASTING PROCEDURE

- How do we represent the study region?
- How do we represent the transportation system?
- How do we measure travel-demand?
- What is the analytical method for forecasting travel-demand?

REPRESENTATION OF THE [illegible]

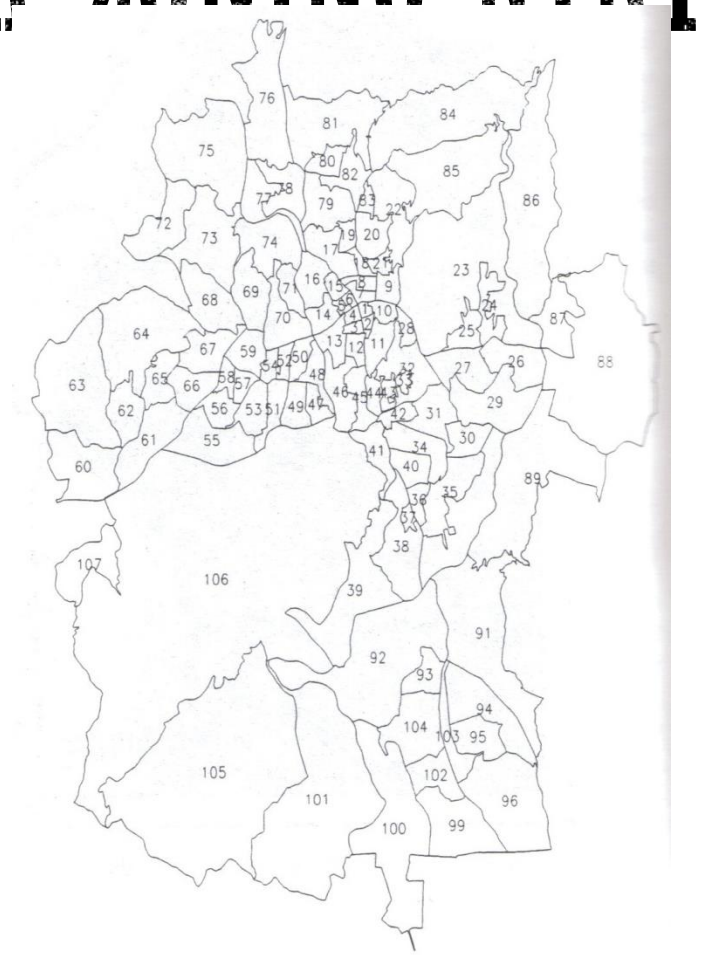
- Define the study area
- Divide the study area into "internal" zones (called Traffic Analysis Zones or TAZs)
- Divide the region outside the study area into "external" zones
- Identify the activity centriods of all the internal zones
- Assume that the activity centroid represents the zone for all further analysis



Source: Page 71, Stopher, P.R. and Meyburg, A.H. (1975)

ISSUES IN DEVELOPING A ZONING SYSTEM

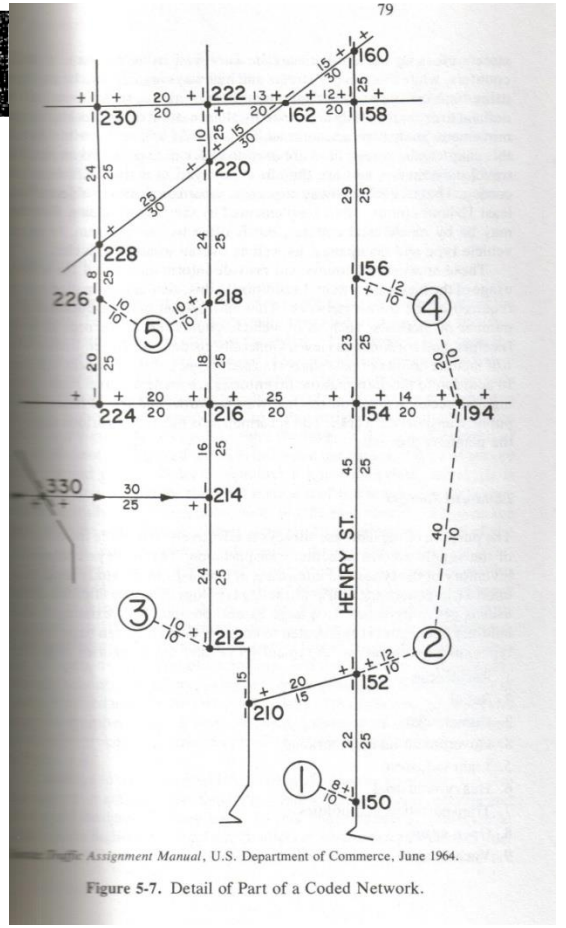
- Size
  - Modeling needs
  - Homogenous composition
- Boundaries
  - Physical geography
  - Census geography
- Hierarchical / Nested structure



Source: Page 18, NHCRP-365 (1998)

REPRESENTATION OF THE TRANSPORTATION SYSTEM

- Highway Network
  - System of links and nodes
  - Link is a homogenous stretch of roadway between two nodes characterized by length, capacity, free-flow speed, …
  - Node is junction between two or more links
  - Often local roads are not represented
  - Centroids are treated as special types of nodes: "loading" nodes
  - Centroids are connected to the roadway network through one/more links called centroid connectors



Assignment Manual, U.S. Department of Commerce, June 1964.

Figure 5-7. Detail of Part of a Coded Network.

Source: Page 79, Stopher, P.R. and Meyburg, A.H. (1975)

REFERENCES

- Inside the black box making transportation models work for livable communities http://www4.uwm.edu/cuts/blackbox/blackbox.pdf

- The four step model http://www.its.uci.edu/its/publications/papers/CASA/UCI-ITS-AS-WP-07-2.pdf

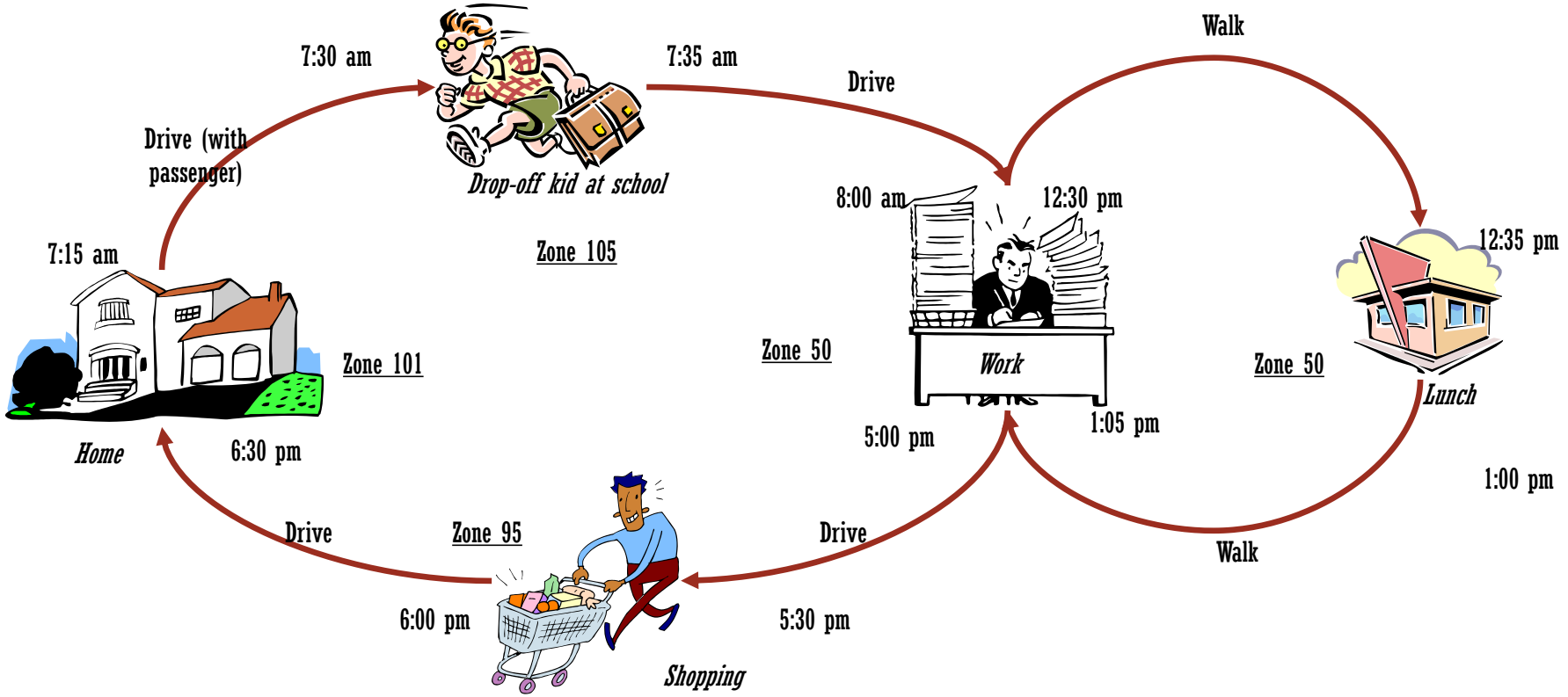
- Travel Demand Forecasting: Parameters and Techniques http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_716.pdf

MEASURING TRAVEL DEMAND

- Trip-based measurement of travel demand
- A Trip is a (one-way) movement from one location (address) to another
- Trips are characterized by:
  - Origin & destination locations (TAZs)
  - Mode of travel
  - Route
  - Start and End Times
  - Purpose

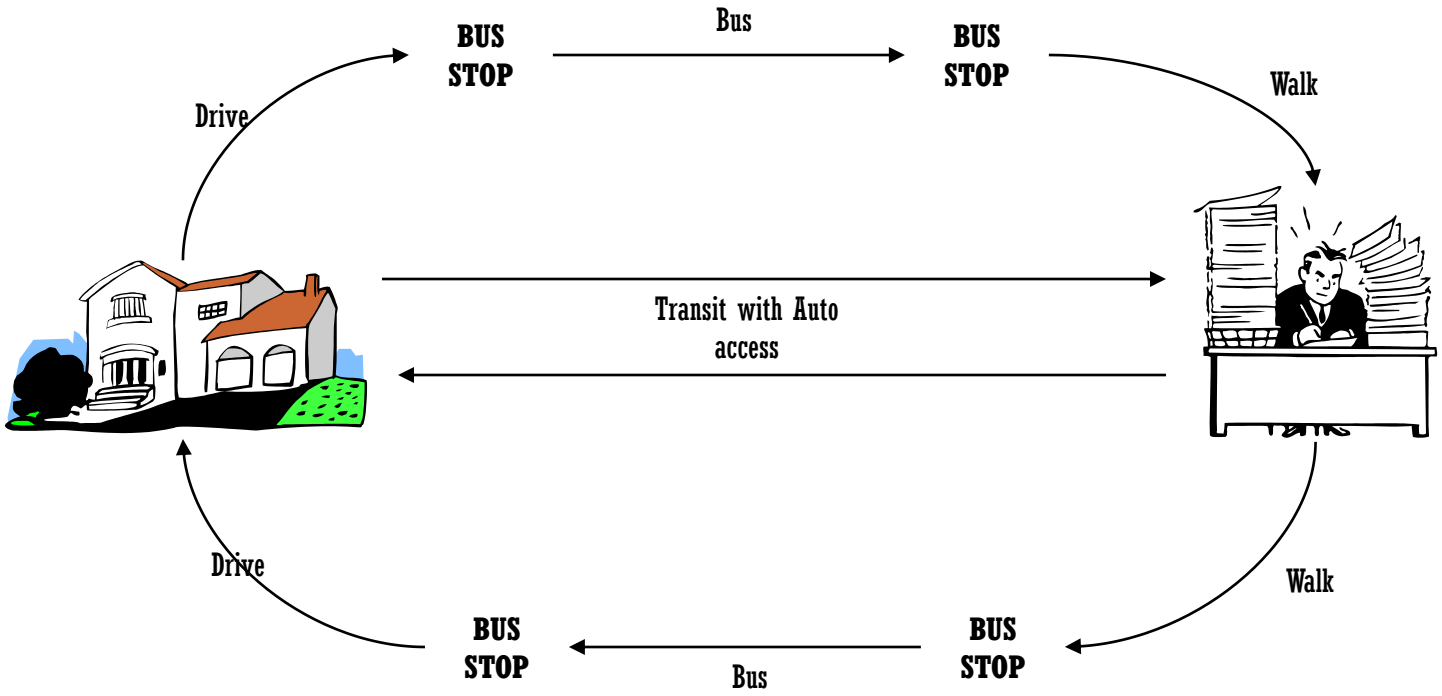
MEASURING TRAVEL DEMAND

Characterizing Trips: Example 1



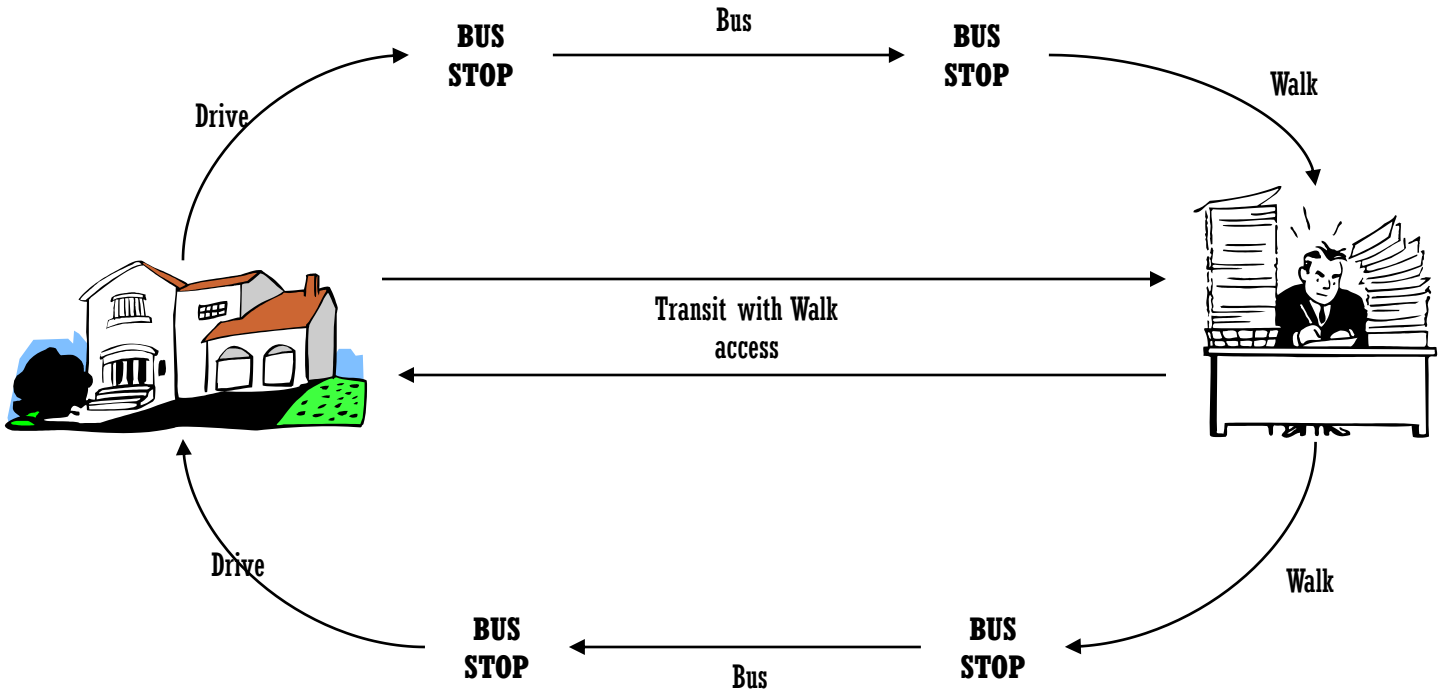
MEASURING TRAVEL DEMAND

Characterizing Trips: Example 2



MEASURING TRAVEL DEMAND

Characterizing Trips: Example 3



MEASURING TRAVEL DEMAND

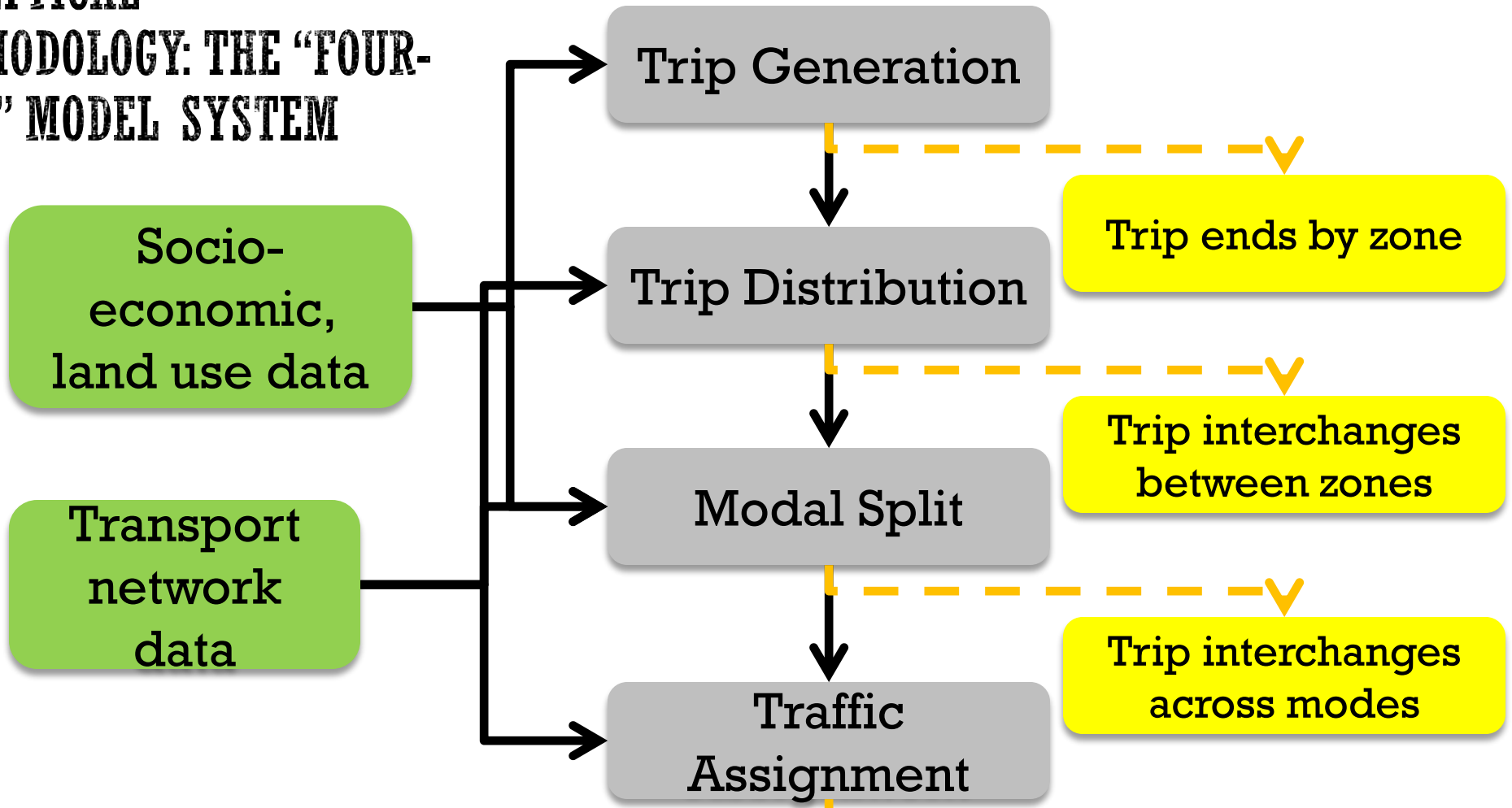
- How many trips are made for what purposes? → frequency
- What are the origin and destination locations (TAZs) of each trip?
- What is the mode for each trip?
- What is the route for each trip?
- When is each trip made (time-of-day)?

- Aggregate all the trips to get the traffic flows by each mode, for each time-of-day, between each origin-destination pair, on each route (and link) of the transportation network.
  - Recognizes that individual vehicles on the road are an aggregation of decisions (of individuals, households, firms) across the urban region

NOTE

- The measurement unit of travel demand keeps evolving
- For example, vehicle emissions were not part of the transportation planning process until recently
- Now, more subjective and/or quantitative metrics such as accessibility to opportunities, happiness and well being are being incorporated into the planning process
- While some of these measures have been considered in the planning process – some of these ideas are being studied and debated in academia

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM



Other names: Urban Transportation Modeling System (UTMS), Trip-based Model , Traditional model

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM

- Trip Generation
  - How much travel (How many trips) to and from each zone for each purpose?
  - Estimate the number of trip ends generated in each zone.
  - Or, predict the total trip flows into and out of each zone (does not predict where these flows are coming from or going to)

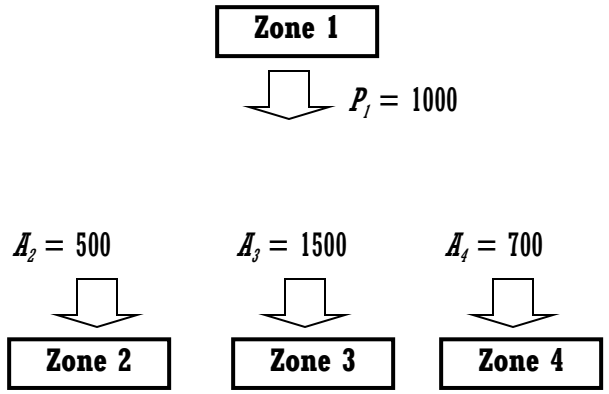
- Trip Distribution
  - How many trips between each OD pair?
  - Prediction of Origin-Destination (OD) flows between all zonal pairs
  - Link the trip ends to form trip flows or interchanges

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM

- Mode Split
  - What travel modes are used for trips between each OD pair?
  - Predict the percentage of trips by different modes

- Traffic Assignment
  - What routes are used for travel between each OD pair?
  - Load all trips on the transportation network

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM



- **Trip Generation**

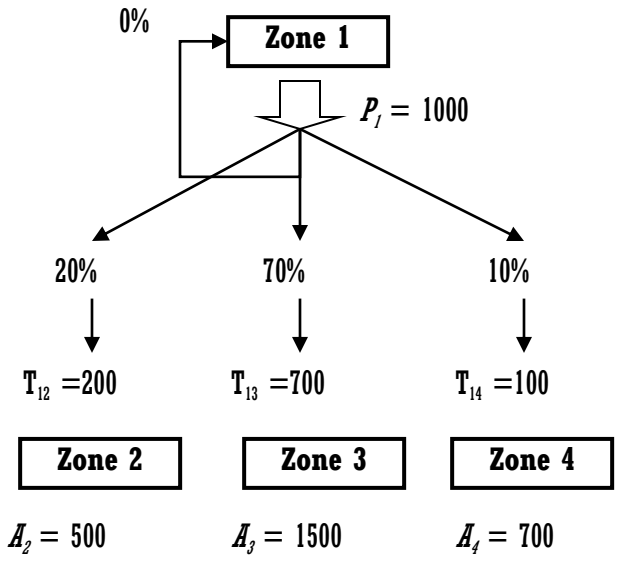
Total number of trips generated by zone *i*

= f [characteristics of people in zone *i*, land-use of zone *i*]

P_i = Number of trips "produced" in zone *i* = f [characteristics of people in zone *i*]

A_i = Number of trips "attracted" to zone *i* = f [socioeconomics and land-use in zone *i*]

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM



- **Trip Distribution**

Fraction of trips produced in zone *i* & attracted to zone *j*

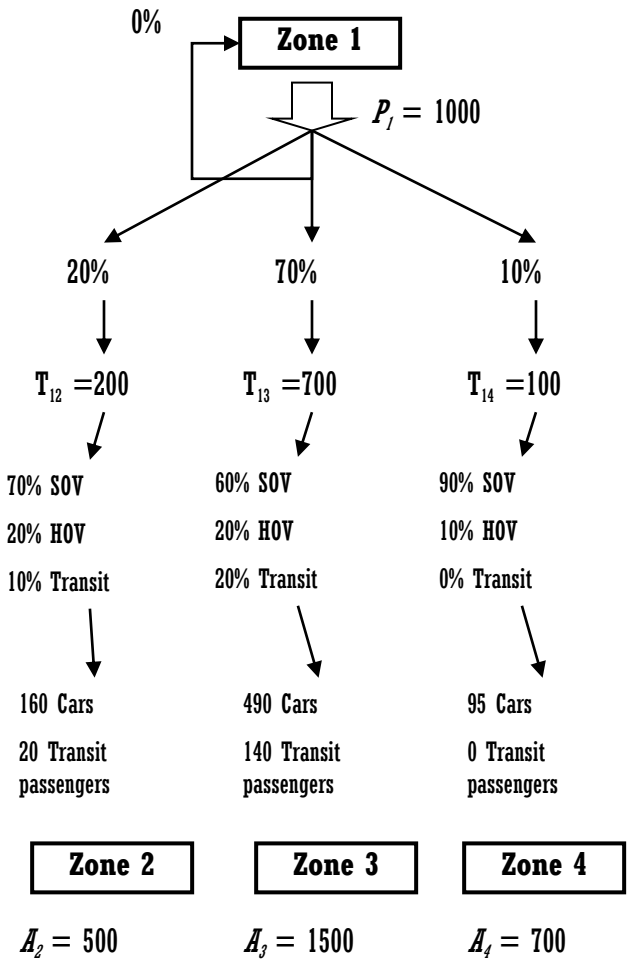
= *f* [

total number of trips attracted to zone *j*,

characteristics of the transportation system between zones *i* & *j* , &

other "special" linkages between zones *i* & *j*]

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM



- **Mode Split**

Fraction of trips produced in zone *i* & attracted to zone *j* made by mode *m*

= *f* [

Availability of different modes

Characteristics of alternate modes]

Note – assume HOV on average has 2 occupants

ANALYTICAL METHODOLOGY: THE "FOUR-STEP" MODEL SYSTEM

- Network Assignment

(1) Highway Assignment

Highway Demand Matrix:

	1	2	3	4
1	0	$Cars_{12}$	$Cars_{13}$	$Cars_{14}$
2	$Cars_{21}$	0	$Cars_{23}$	$Cars_{24}$
3	$Cars_{31}$	$Cars_{32}$	0	$Cars_{34}$
4	$Cars_{41}$	$Cars_{42}$	$Cars_{43}$	0

$cars_{ij}$ = number of car trips originating in zone i and destined to zone j

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Highway System Characteristics

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Link volumes, speeds, toll revenue, …

(2) Transit Assignment

Transit Demand Matrix:

	1	2	3	4
1	0	TR_{12}	TR_{13}	0
2	TR_{21}	0	TR_{23}	0
3	TR_{31}	TR_{32}	0	0
4	0	0	0	0

TR_{ij} = number of transit riders originating in zone i and destined to zone j

Zone 4 has no transit service

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Transit System Characteristics

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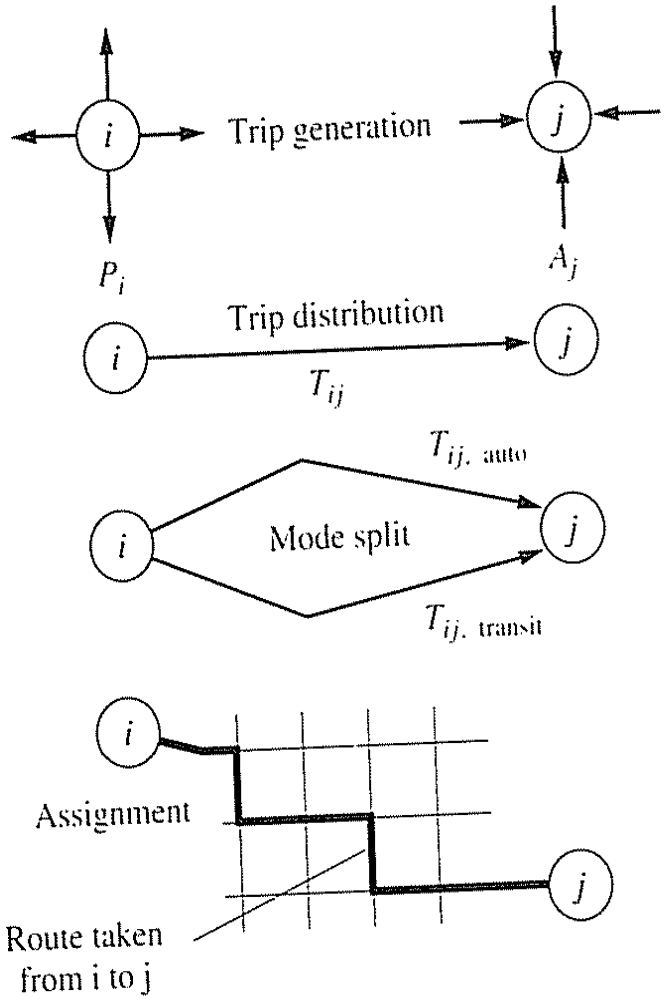
Ridership by route, revenue, ….

THE FOUR-STEP PROCESS: SUMMARY



- Trip generation step involves the estimation of the number of home-based and non-home based person-trips produced from, and attracted to, each zone in the study area.
- Trip distribution determines the trip-interchanges (*i.e.,* number of trips from each zone to each other zone).
- Mode choice, step splits the person-trips between each pair of zones by travel mode.
- Traffic assignment, step assigns the vehicle trips to the roadway network to obtain link-level vehicle volumes and travel times.

REFERENCES

- Ortuzar, J. D. and L. G. Willumsen (2011). Modelling transport, Wiley. 4th ed.