

VEB1072 Traffic Engineering



UNIVERSITI TEKNOLOGI PETRONAS

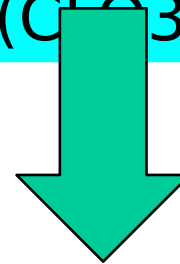
Lecture 6 Traffic Impact Assessment (TIA)



Traffic Impact Assessment (TIA)

Propose an effective mitigation measures to address complex traffic issues and challenges.

(CLO3)



Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

(PLO3)



Traffic Impact Assessment (TIA)

LEARNING OUTCOMES

- Able to perform urban transportation demand or forecasting process. (C5)
- Able to utilize all 4 processes involve in transportation demand forecasting. (C3)



Urban Transportation demand Forecasting Process

This task is a technical effort to analyze the performance of various alternatives. We must define the study area first. Then further subdivide the area into traffic analysis zone, TAZ, for data tabulation and analysis.



Urban Transportation demand Forecasting Process

- Homogenous socioeconomic characteristics : e.g., high-income residential
- Minimum intrazonal trips
- Use of physical, political, and historical boundaries, where possible
- Zones, once created, should not be subdivided into smaller zones during analysis
- Zones generating and attracting approximately equal trips, households, population, or area.
- Use of census tract boundaries, where possible (easier to collect data from the Census Bureau's publication)

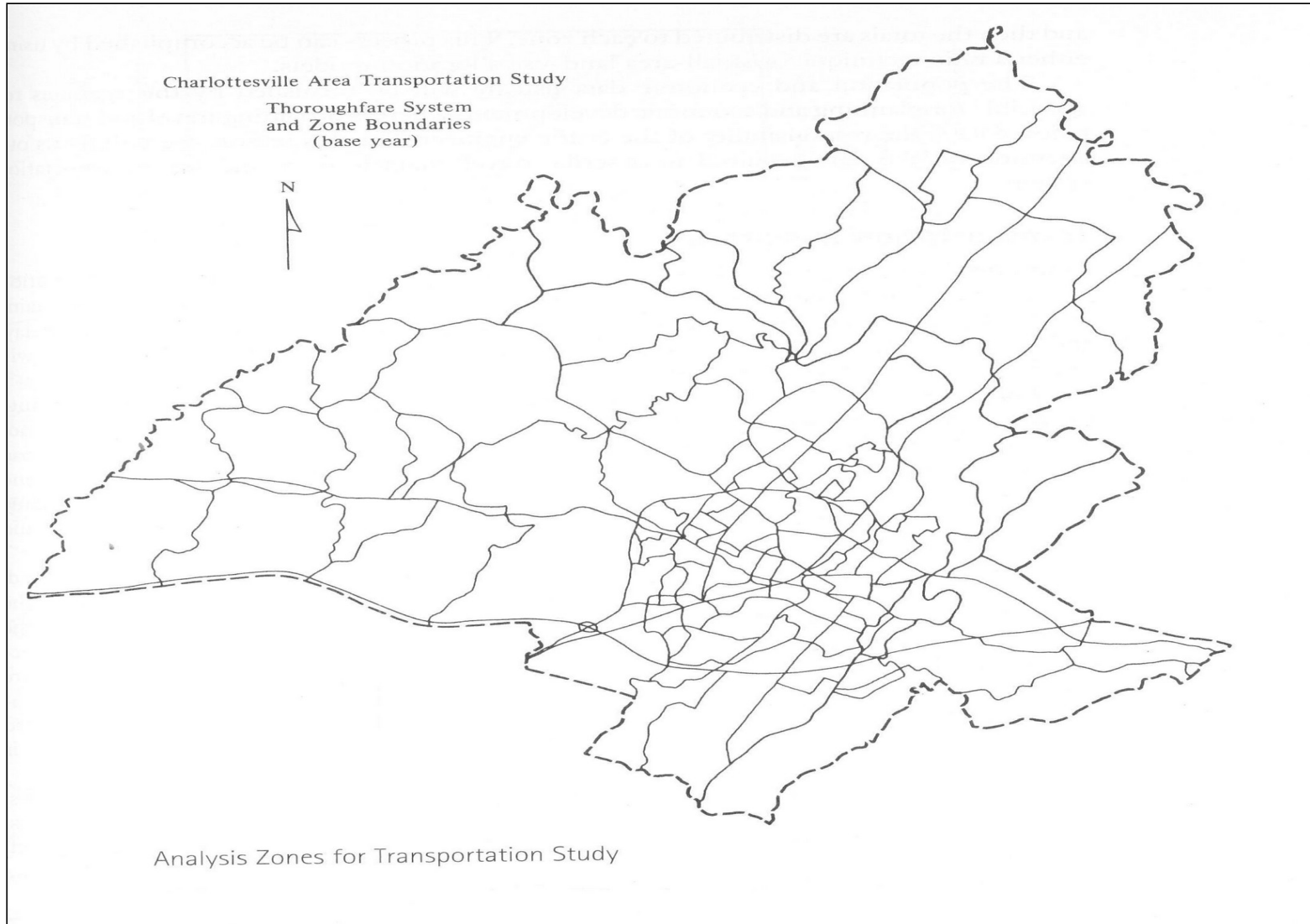


Four Basic Elements of the Urban Transportation Forecasting Process

Data collection	Economic activity (employment, sales volume, income, etc.), land use (type, intensity), travel characteristics (trip and traveler profile), and transportation facilities (capacity, travel speed, etc.), population and demography, origin-destination trip data.
Analysis of existing conditions and calibration	Analyze the data collected in the data collection stage. You may build mathematical models describe the existing conditions and then use the relationships you have found in the existing parameters to forecast future values.
Forecast of future travel demand	4-step transportation demand forecasting process
Analysis of the results	Analyze what you get from the 4-step demand forecasting process.



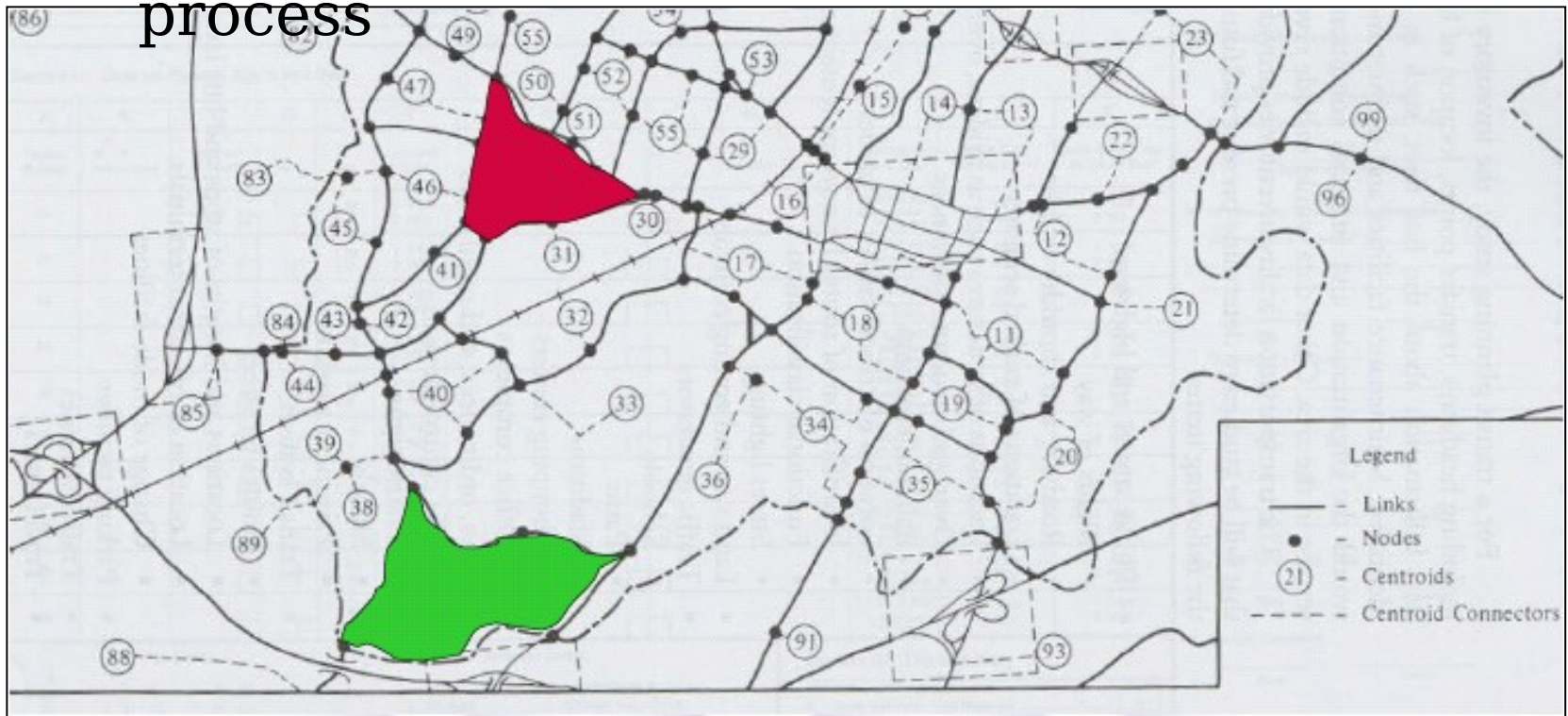
Analysis Zones for Transportation Study (TAZ)





Link-Node Map for Highway System

- Link-node maps are the starting point for the 4-step transportation demand forecasting process



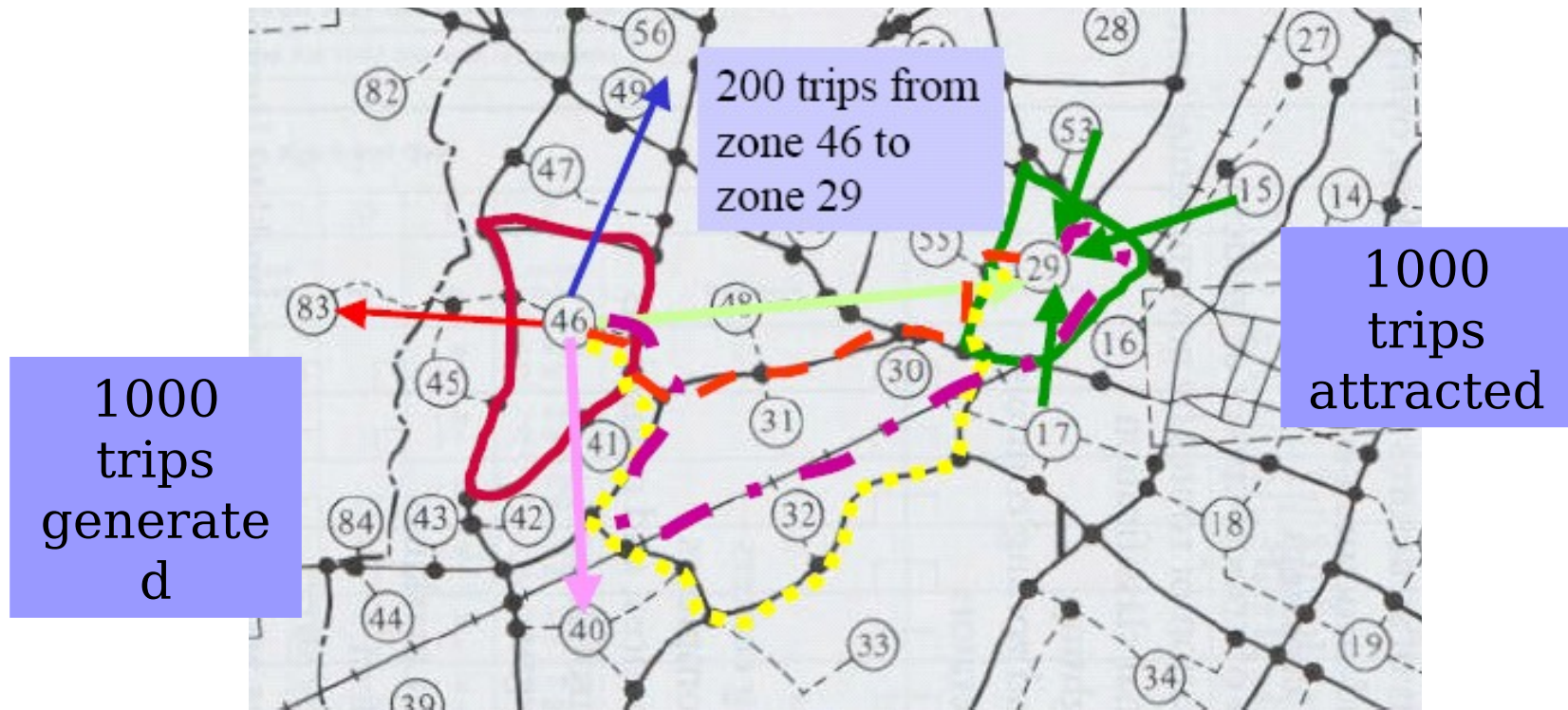


4-Step Transportation Demand Forecasting Process

Trip Generation	Determines how many trips each activity (center: residential area, commercial area, etc.) will produce or attract
Trip Distribution	Determines the origin or destination of trips that are generated at a given activity
Modal Split	Determines which mode of transportation will be used to make the trip
Trip Assignment	Determines which route on the transportation network will be used when making the trip



Graphical way of understanding the 4-step demand forecasting process



70% this route
25% this route

**Auto Total :
95%**

**Public
Transit : 5%**



(A) Trip Generation

A process of determining the number of trips that will begin or end in each traffic zone within a study area

Function of Trip Generation :

1. To develop a relationship between trip end production or attraction and land
2. To use the relationship developed to estimate the number of trips generated at some future date under a new set of land-use conditions

Trip Generation Methods

1. Cross classification
2. Rates based on activity units



(B) Trip Distribution

A process by which the trips generated in one zone are allocated to other zones in the study area

Trip Distribution Methods

1. Gravity model
2. Growth factor model (Fratar model)
3. Intervening opportunity



(1) Gravity Model

The number of trips between two zones is directly proportional to the number of trip attractions generated by the zone of destination and inversely proportional to a function of time of travel between the two zones

$$T_{ij} = P_i \left[\frac{A_j F_{ij} K_{ij}}{\sum_j A_j F_{ij} K_{ij}} \right]$$

T_{ij} = number of trips that are produced in zone i and attracted to zone j

P_i = total number of trips produced in zone i

A_j = number of trips attracted to zone j

F_{ij} = a value which is inverse function of travel time

K_{ij} = socioeconomic adjustment factor for interchange ij .



Gravity Model

Adjusted attraction factor for k iteration;

$$A_{jk} = \frac{A_j}{C_{j(k-1)}} A_{j(k-1)} \longrightarrow T_{ijk} = \left[\frac{P_i A_{jk} F_{ij} K_{ij}}{\sum_{j=1}^n A_{jk} F_{ij} K_{ij}} \right]$$

A_{jk}	=	adjusted attraction factor for attraction zone (column) j , iteration k
C_{jk}	=	actual attraction (column) total for zone j , iteration k
A_j	=	desired attraction total for attraction zone (column) j
j	=	attraction zone number, $j=1, 2, \dots, n$
k	=	iteration number, $k=1, 2, \dots, n$
m	=	number of iterations

Iteration will be continued until there is a reasonable agreement (within 5 percent) between estimated and trip generation attraction values



(2) Growth Factor Mode (Fratar Model)

Mathematical formula that proportions future trip generation estimates to each zone as a function of the product of the current trips between the two zones T_{ij} and the growth factor of the attracting zone G_j

$$T_{ij} = (t_i G_i) \left[\frac{t_{ij} G_j}{\sum_x t_{ix} G_x} \right]$$

T_{ij}	=	number of trips estimated from zone i to zone j
t_i	=	present trip generation in zone i
G_x	=	growth factor for zone x
T_i	=	$t_i G_i$ = future trip generation in zone i
t_{ix}	=	number of trips between zone i and other zones x
t_{ij}	=	present trips between zone i and zone j
G_j	=	growth factor of zone j



(C) Mode Choice or Modal Split

A process of determining the number (or percentage) of trips between zones that are made by various mode of transportation (automobile/transit)

Types of Modal Split Models

1. Direct generation of transit trips
2. Use of trip end models
3. Trip interchange modal split models



(1) Direct Generation

Transit trips are generated directly by estimating either total person trips or auto driver trips. Factors such as travel time, cost, and convenience are not considered.



(2) Trip End Models

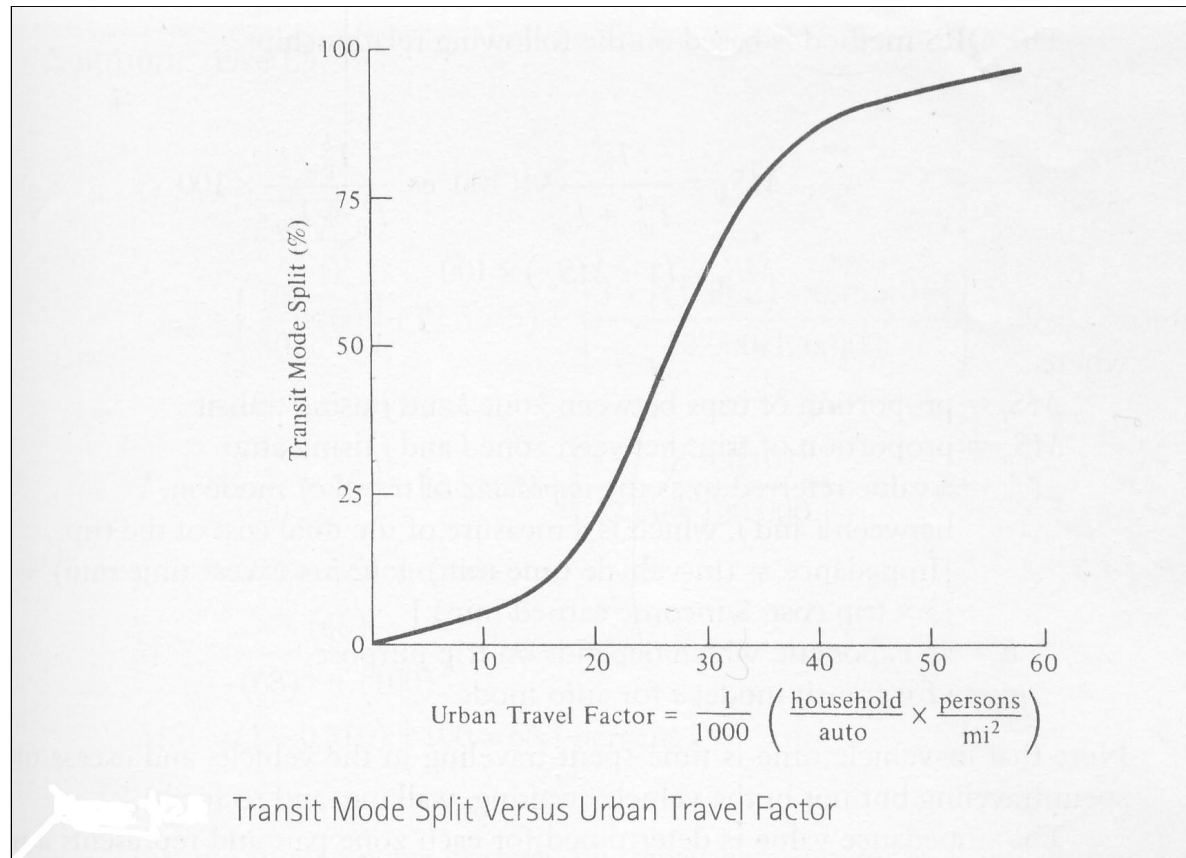
Determine the percentage of total person or auto trips that will use transit. Estimate are biased on land-use or socioeconomic characteristics of the zone

Procedure

1. Generate total person trips productions and attraction by trip purpose
2. Compute the urban travel factor (UTP)
3. Determine the percentage of these trips by transit using a mode choice curve
4. Apply auto occupancy factor
5. Distribute transit and auto trips separately



Trip End Models





(3) Trip Interchange Models

Incorporate system level of service variables such as relative travel time, relative travel cost, economic status of the trip maker, and relative travel service. (QRS method)

QRS method required

1. Distance between zones by auto and transit
2. Transit fare
3. Out-of-pocket auto cost
4. Parking cost
5. Highway and transit speed
6. Exponent value, b
7. Median income
8. Excess time

*** assume that the time worked per year is 120,000 minutes



QRS Method

$$MS_a = \frac{I_{ijt}^{-b}}{I_{ijt}^{-b} + I_{ija}^{-b}} \times 100 \text{ or } \frac{I_{ija}^b}{I_{ijt}^b + I_{ija}^b} \times 100$$

$$MS_t = (1 - MS_a) \times 100$$

MS_t = proportion of trips between zone i and j using transit

MS_a = proportion of trips between zone i and j using auto

I_{ijm} = a value referred to as the impedance of travel of mode m , between i and j , which is measure of the total cost of the trip

[Impedance = (in-vehicle time, min) + (2.5 x excess time, min) + (3 x trip costs, \$/income earned/min).]

b = an exponent, which depends on trip purpose



Logit Models

To consider the relative utility of each mode as a summation of each modal attribute. The choice of mode is expressed as a probability distribution

$$U_x = \sum_{i=1}^n a_i X_i$$

U_x = utility of mode x

n = number of attributes

X_i = attribute value (time, cost, etc.)

a_i = coefficient value for attribute i (negative, since the values are disutilities)



Logit Models

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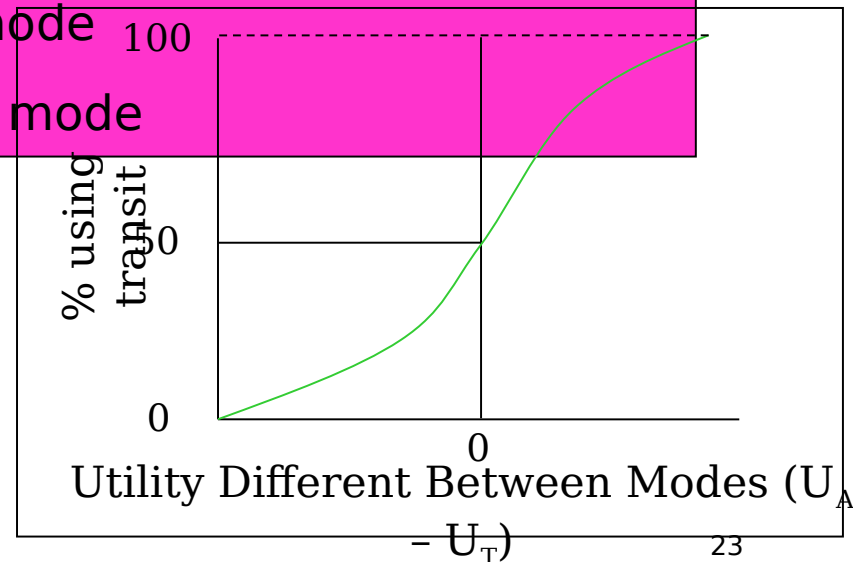
$$P(A) = \frac{e^{U_A}}{e^{U_A} + e^{U_T}} \quad \text{and} \quad P(T) = \frac{e^{U_T}}{e^{U_A} + e^{U_T}}$$

$P(A)$ = proportion of travel in the zone by auto

$P(T)$ = proportion of travel in the zone by transit

U_A = utility of auto mode

U_T = utility of transit mode





(D) Traffic Assignment

A process of determining which route on the transportation network will be used when making the trip

Data Required

- i. Number of trips made from one zone to another (from trip distribution phase)
- ii. Available highway or transit routes between zones and how long it travel time
- iii. Criteria by which motorists or transit users will select a route

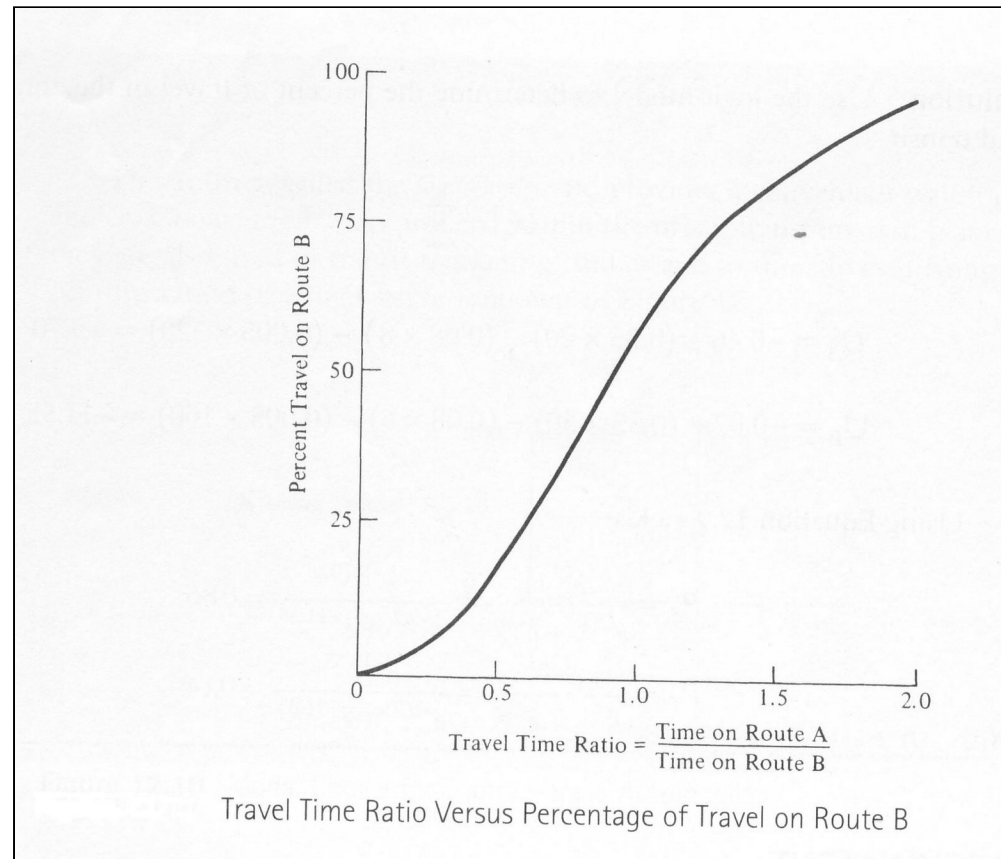
Basic Approaches

- i. Diversion curve
- ii. Minimum time path (all-or-nothing) assignment
- iii. Minimum time path with capacity restraint



(1) Diversion Curve

The traffic between two routes is determined as a function of relative travel time or cost





(2) Minimum Time Path (all-or-nothing)

All-or-nothing method assigns all trips to those links that comprise the shortest time path between the two zones



(3) Minimum Time Path (capacity restraint)

Capacity restraint refined the minimum path method in that, after all traffic has been assigned to a link, the travel times on each link are adjusted, based on the capacity of the link and the number of trips on each link

Speed-volume relationship used;

$$t = t_o \left[1 + 0.15 \left(\frac{V}{C} \right)^4 \right]$$

t = travel time on the link

t_o = free-flow travel time

V = volume on the link

C = capacity of the link



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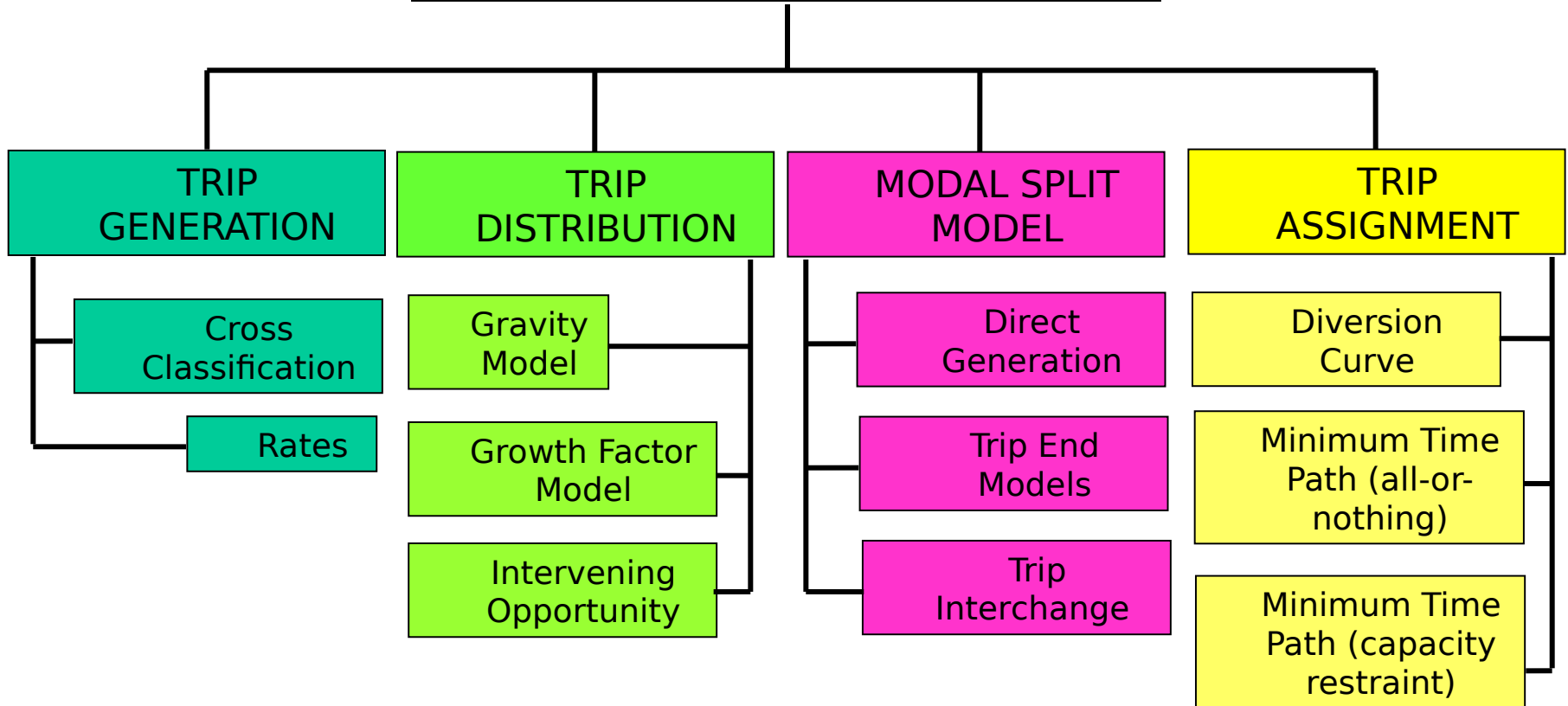


4-Step Transportation Demand Forecasting Process

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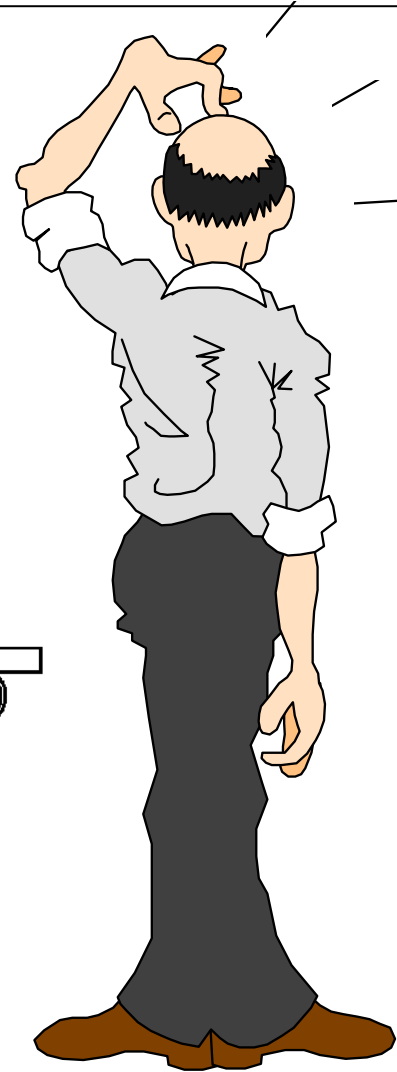
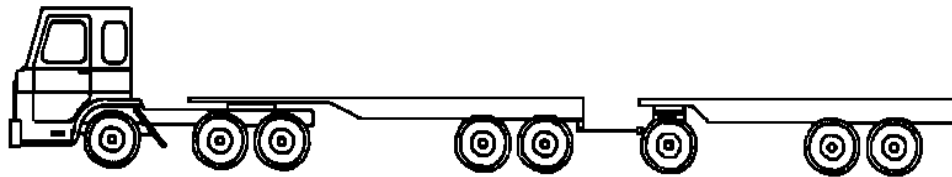


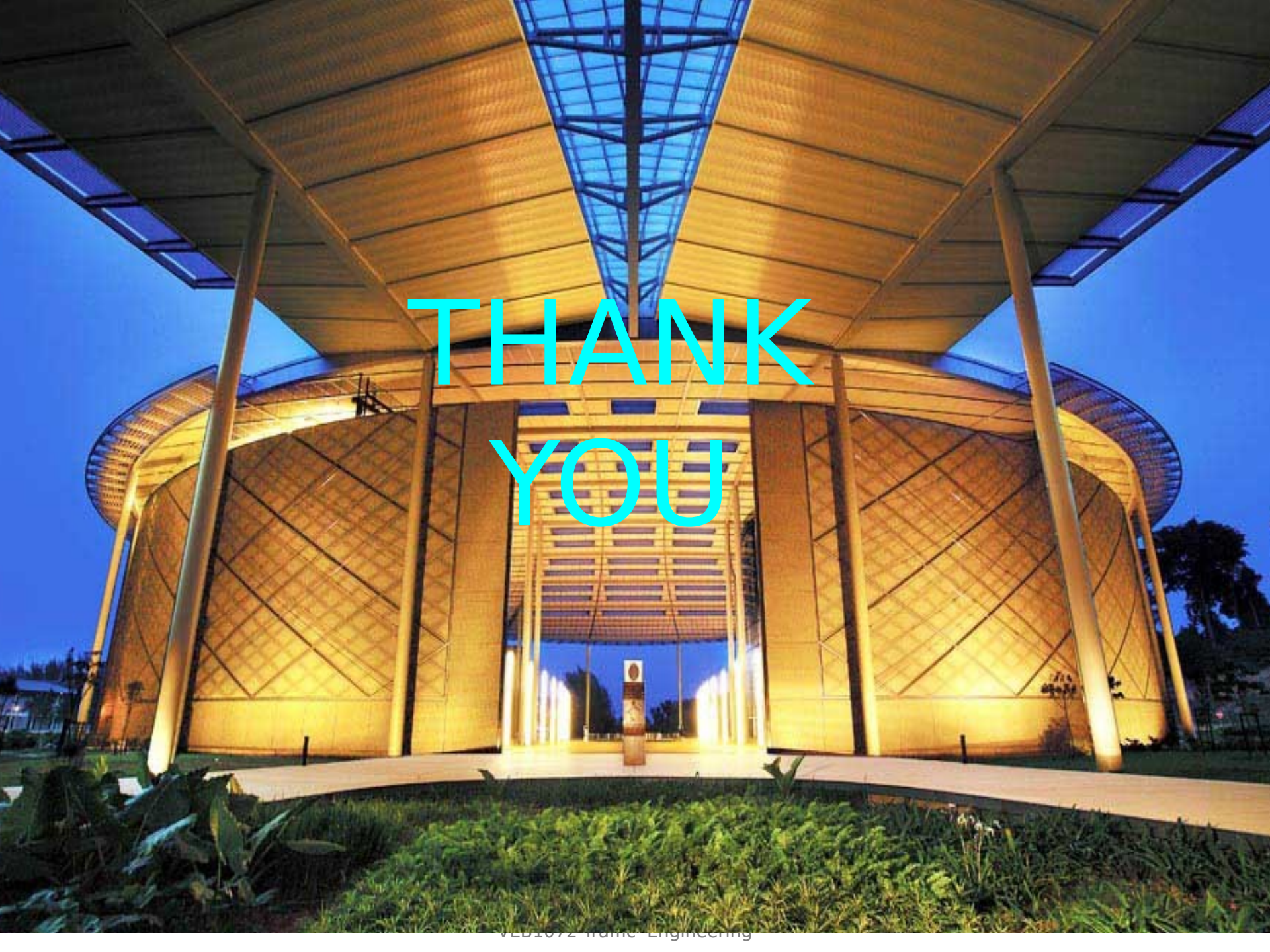
4-STEP TRANSPORTATION DEMAND FORECASTING PROCESS





Questions?





THANK
YOU