

# SI-2241 Pengantar Sistem Transportasi

KULIAH KE - 12  
PERENCANAAN dan PEMODELAAN  
TRANSPORTASI

Harun al-Rasyid Lubis, PhD.

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## AGENDA PEMBAHASAN



### Pengertian dan Kegunaan Perencanaan Transportasi

- Prinsip-Prinsip Perencanaan Transportasi
- Lingkup Studi Perencanaan Transportasi
- Prosedur Pelaksanaan Studi Perencanaan Transportasi
- **Pemodelan Transportasi**

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## Pengertian & KEGUNAAN STUDI PERENCANAAN TRANSPORTASI

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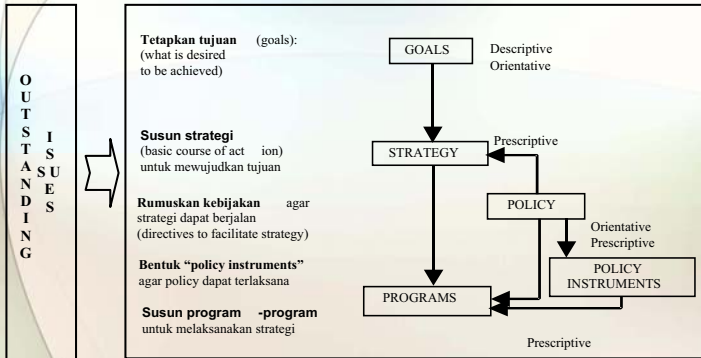
## DEFINISI

- perencanaan (Lubis et al, 2001):  
proses kontinu yang melibatkan keputusan tentang bagaimana memanfaatkan atau mengalokasi sumber daya yang ada untuk mencapai tujuan tertentu.
- perencanaan transportasi (Marangon, F., 2004):  
This sector involves engineering activities aimed at the evaluation of transportation scenarios (a railway network, an intermodal system, an urban area, etc.), with the goal of obtaining system configurations and plans that satisfy the service requirements, are consistent with the existing constraints, and optimize given targets.
- Horizon waktu (Morlok, E. K, 1978):  
"perencanaan transportasi" secara tradisional digunakan untuk mendeskripsikan suatu "perencanaan jangka panjang" (*long range planning*)

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## Perumusan kebijakan transportasi

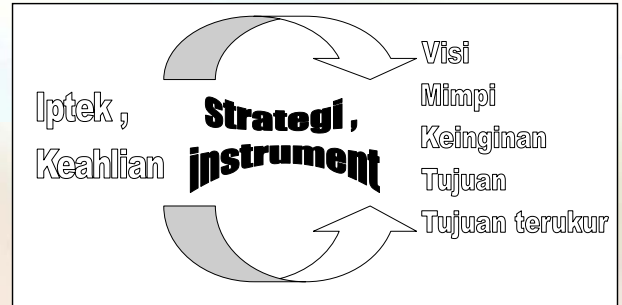


Sumber: Lubis et al, 2001

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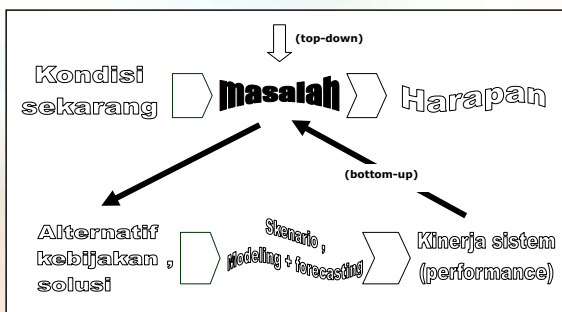
## Pengertian Perencanaan



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## Identifikasi Masalah Transport



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## Pembuatan Keputusan Vs. Pemecahan Masalah

Urut Langkah	Fokus	Pertanyaan
Identify the problem (1)	Masalah	Apa yang menjadi masalah dan apa yang harus dicapai ?
Fix the objective (2)	- ditto -	
Note the evidence (3)	Evidence (bukti)	Apa buktinya dan apa yang ia jelaskan/tunjukkan ?
Organise the information (4)	- ditto -	
Test the data (5)	- ditto -	
Generate alternative (6)	Alternatif	Apa alternatif nya dan yang mana yang terbaik ?
Evaluate the option (7)	- ditto -	
Target the best choice (8)	- ditto -	
Make the decision (9)	Keputusan	Mana keputusan yang harus dipilih?
Explain the results (10)	- ditto -	

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## KEGUNAAN PERENCANAAN TRANSPORTASI

- mengatasi masalah yang ada (*problem solving*),
- melayani kebutuhan secara optimum (*optimization*),
- mencegah persoalan yang diduga akan timbul (*prevention*),
- mempersiapkan tindakan untuk tanggap pada keadaan di masa depan (*preparation*),
- mengoptimumkan daya dan dana yang dapat digunakan sehingga tercapai daya guna dan hasil guna yang tinggi (*effectiveness*).

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## AGENDA PEMBAHASAN

- Pengertian dan Kegunaan Perencanaan Transportasi
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-  Lingkup Studi Perencanaan Transportasi
- Prosedur Pelaksanaan Studi Perencanaan Transportasi

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## LINGKUP PERENCANAAN TRANSPORTASI (LPM-ITB, 1996)

- Studi Perencanaan Prasarana Transportasi :
  - Persiapan masterplan pelabuhan, bandar udara ataupun terminal antar moda.
  - Penentuan trase jalan raya atau trase rel kereta.
  - Persiapan masterplan pengembangan jaringan jalan.
  - Persiapan masterplan prasarana transportasi bagi suatu daerah pemukiman.
- Studi Kebijakan Operasional :
  - Persiapan sistem sirkulasi lalu lintas jalan.
  - Strategi pengembangan tingkat pelayanan angkutan umum.
  - strategi operasional angkutan udara.
- Studi Perencanaan Transportasi Komprehensif :
  - Studi kebutuhan prasarana dan sarana transportasi dari suatu rencana pengembangan daerah baru (daerah rekreasi, daerah industri ataupun daerah komersial).
  - Studi pengembangan sistem transportasi regional.
  - Studi pengembangan sistem transportasi nasional.

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## LEVEL PERENCANAAN (LPM-ITB, 1996)

- Perencanaan Operasional**  
Perencanaan ini termasuk membuat denah untuk persimpangan-persimpangan; untuk penyebrangan untuk pejalan kaki dan daerah perparkiran, penempatan pemberhentian bis; membuat metoda pemberian karcis; langkah-langkah untuk keselamatan; dsb.
- Perencanaan Taktis**  
Tingkat perencanaan ini berhubungan dengan: pola-pola manajemen lalu lintas; pembuatan jalan-jalan lokal; pengendalian parkir; pengorganisasian transportasi umum; koordinasi dalam memberlakukan tarif; membuat daerah-daerah untuk para pejalan kaki, dsb.
- Perencanaan Strategis**  
Hal ini berkaitan erat dengan struktur dan kapasitas jaringan transportasi utama, keterkaitan antara transportasi dan tata guna tanah, keseimbangan antara permintaan dan penawaran, keterkaitan antara tujuan-tujuan transportasi dengan ekonomi, tujuan-tujuan lingkungan dan sosial.

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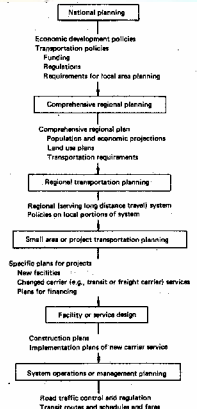
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## BEBERAPA CONTOH STUDI PERENCANAAN SISTEM TRANSPORTASI

- TATRANAS (Tatanan Transportasi Nasional),
- TATRAWIL (Tatanan Transportasi Wilayah), Provinsi,
- **Tatralok** :Lokal : Kabupaten, Kota, Kawasan,
- MASTERPLAN, misal: **Sistem Angkutan Perkotaan, Perkeretaapian, dll**
- **Perencanaan Sistem Jaringan Jalan (SISJAR) Nasional, Provinsi, Kabupaten, Kota, Koridor, dll**
- Perencanaan Operasi, misal: manajemen lalulintas, dll

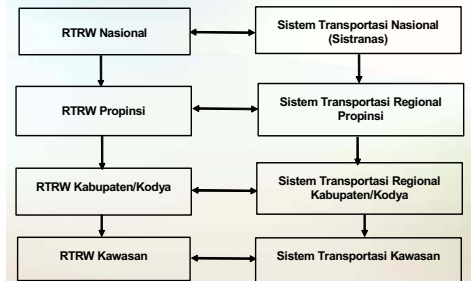
## HIRARKI PERENCANAAN TRANSPORTASI

(a) Konsep Hirarki Generik



Sumber: Morlok E.K, 1978

(b) Konsep Hirarki Perencanaan Transportasi di Indonesia

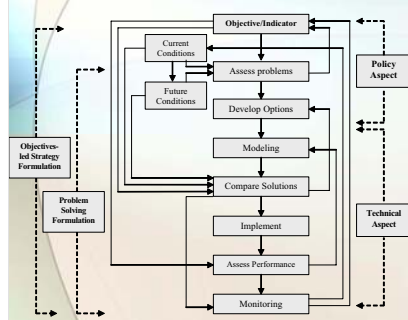


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## PROSEDUR PERENCANAAN TRANSPORTASI

A. Siklus Umum Perencanaan Transportasi

B. Pendekatan Perencanaan Transportasi



Dimodifikasi dari: May, A. D (1997)

	Top Down Approach (objective led)	Bottom Up Approach (problem solving)
Orientasi formulasi strategi	Pemecahan tujuan (objective led)	pemecahan masalah (problem solving)
Proses	Tujuan - Identifikasi masalah - Alternatif solusi - Model - Implementasi-Evaluasi	Identifikasi masalah - Alternative solusi - Model - Implementasi-Evaluasi
Identifikasi masalah	Identifikasi masalah diperoleh dari pengamatan manajemen tingkat atas, perencana, pakar atau pengamat lainnya	masukan permasalahan diidentifikasi langsung dari tingkat bawah (operasional) maupun masyarakat
Kualifikasi & kuantifikasi masalah	Kesenjangan antara kondisi yang menjadi harapan/tujuan dengan kondisi yang terjadi	Eksperimentasi dengan model untuk mengidentifikasi masalah
Keterlibatan stakeholders	Dilibatkan dalam proses penetapan tujuan	
Aplikasi		Sering digunakan dalam berbagai studi di Indonesia
Resiko	Masalah dalam kuantifikasi tujuan (quantified objective), berupa indikator-indikator kinerja sistem	Kualitas model yang digunakan

Sumber: Lubis et al (2001)

## PEMODELAN TRANSPORTASI

Harun al-Rasyid Lubis, PhD.

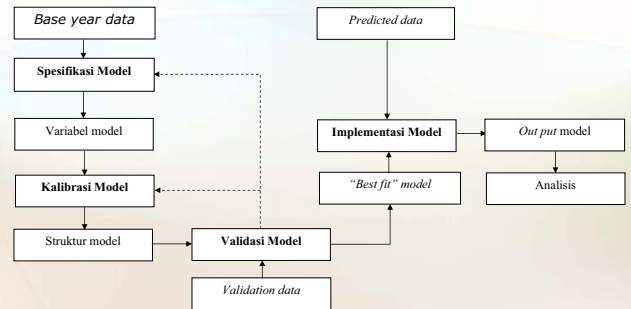
## AGENDA PEMBAHASAN

- Proses pemodelan transportasi
- Modeling & asumsi dasar
- Lingkup Studi Perencanaan Transportasi
- Prosedur Pelaksanaan Studi Perencanaan Transportasi
- Model outputs
- Validation and model errors
- Future of traffic modeling

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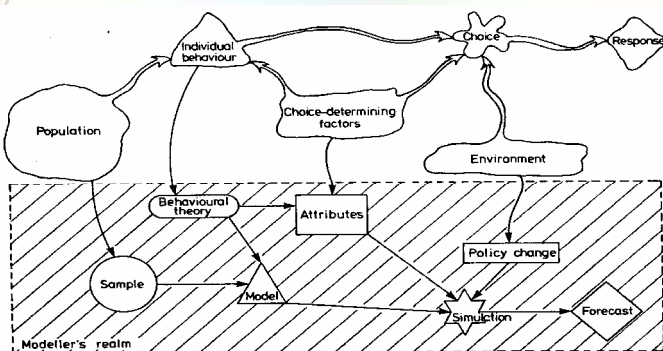
## Proses Pemodelan Transport



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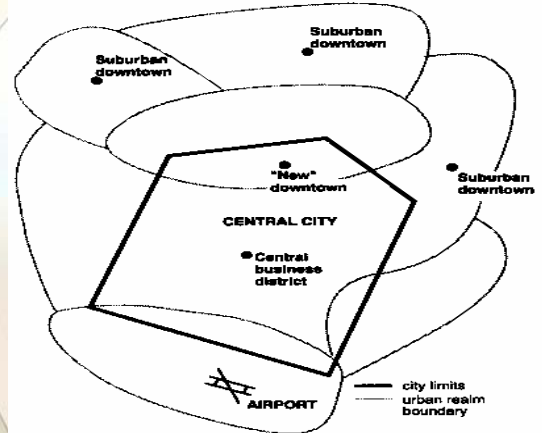
## MODELING & SAMPLING



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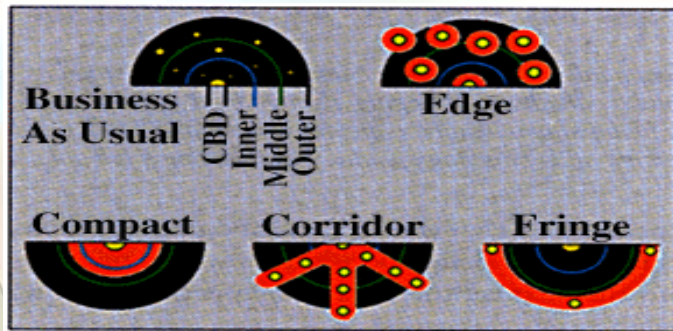
## Urban Realms Model



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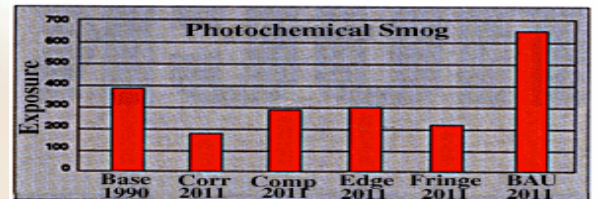
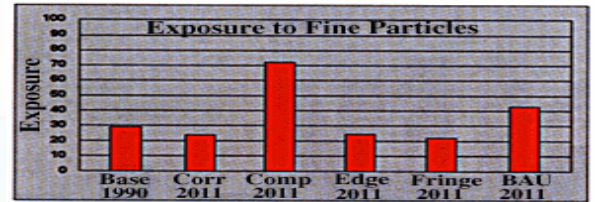
## Tata Ruang: Alternatif Penyebaran / formasi kota



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## Emission Indicators



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## BIAYA SOSIAL KEMACETAN

- Kemacetan lalu lintas jalan:
  - Menyebar ke semua waktu
  - Menyebar hampir ke semua ruas jalan
- Biaya kemacetan:
  - Pemborosan waktu ;
  - Pemborosan bok



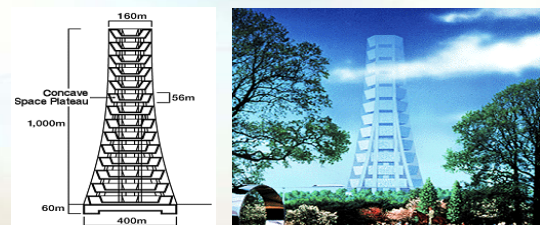
Bandung (2002) : Rp 1,2 triliun / th ; Rp 1,8 milyar / hr  
 Jakarta (2003) : Rp 17,2 triliun / th ; Rp 47 milyar / hr  
 Jabodetabek (SITRAMP, 2003) : Rp 5,4 triliun / th ; 14,8 milyar / hr

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## Penataan vertikal : *The sky city 1000*

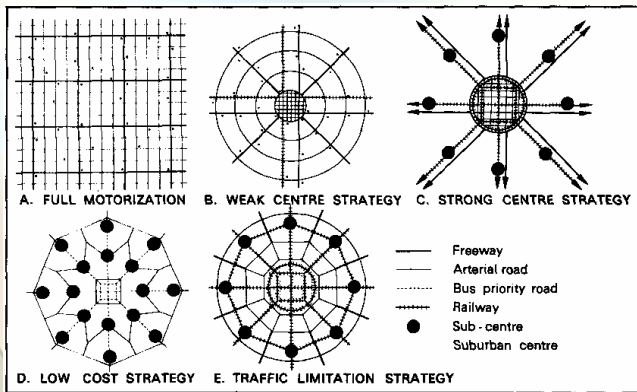
(Takonaka with Shizuo Harada of ESCO Co., Ltd)



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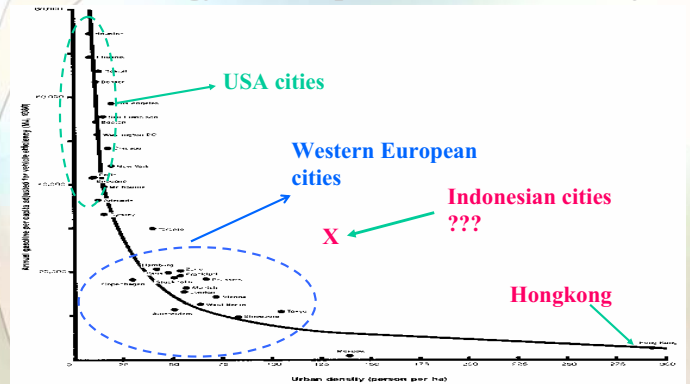
## Mike Thompson (1974)



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## Energy Consumption Vs. Urban density



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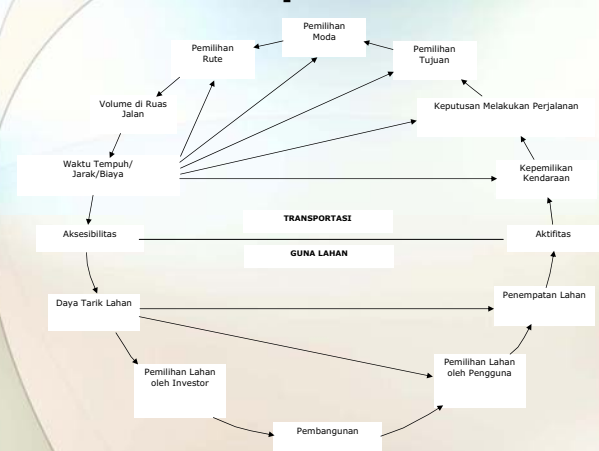
## Asumsi Dasar Model Transport

- Pola interaksi dan perilaku
- Memaksimalkan utilitas
- Kesetimbangan (equilibrium)
- Agregasi

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## Interaksi Transport – Tata Guna Lahan



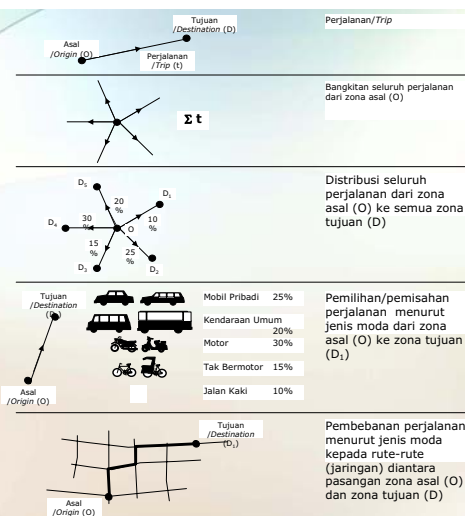
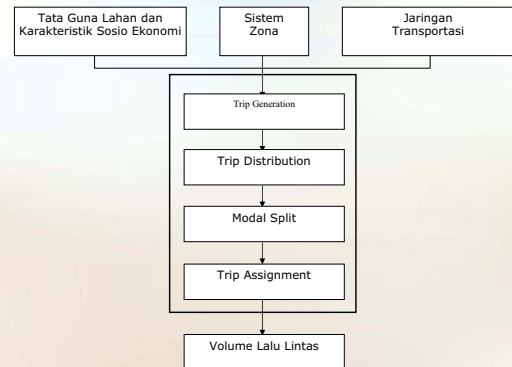
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## Travel Demand Estimation

- ❑ Divide study area into study zones
- ❑ 4 steps
  1. Trip Generation ( $T_p$  &  $T_a$ )
    - decision to travel for a specific purpose (eat lunch)
  2. Trip Distribution ( $T_{pa}$ )
    - choice of destination (Sindang Reret)
  3. Mode Choice ( $T_{pam}$ )
    - choice of travel mode (by motorcycle)
  4. Network Assignment ( $T_{pami}$ )
    - choice of route or path (Ganesha, Hasanudin, DPU)

## Model Transport 4 Tahap



## Study Area

- Clearly define the area under consideration
- Where does one entity end?
- May be defined by county boundaries, jurisdiction, town centers

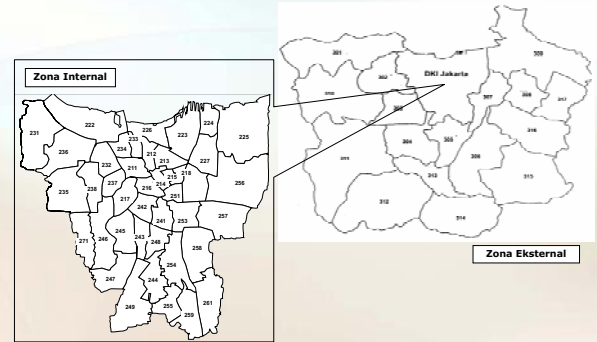
## Basis for Travel Analysis : Zoning System

- Homogenous urban activities (generate same types of trips)
  - Residential
  - Commercial
  - Industrial
- May be as small as one city block or as large as 10 sq. miles
- Natural boundaries --- major roads, rivers, airport boundaries
- Sized so only 10-15% of trips are intrazonal

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## Sistem Zona (kecamatan) Jakarta Mass Rapid Transit System Study



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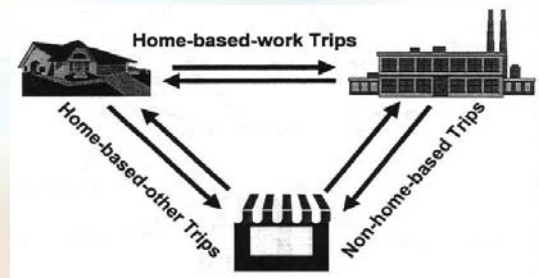
## Sebaiknya , ...

- Batas zona diusahakan bertepatan dengan batas daerah/wilayah kajian
- Besar zona konsisten dengan kerapatan jaringan tinjauan
- Luas zona tidak terlalu kecil agar pergerakan dapat dibebankan ke jaringan secara efektif
- Batas masing-masing zona sesuai dengan jenis perkembangan tata ruang

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## Trip Generation / **Bangkitan Perjalanan**



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## Trip generation

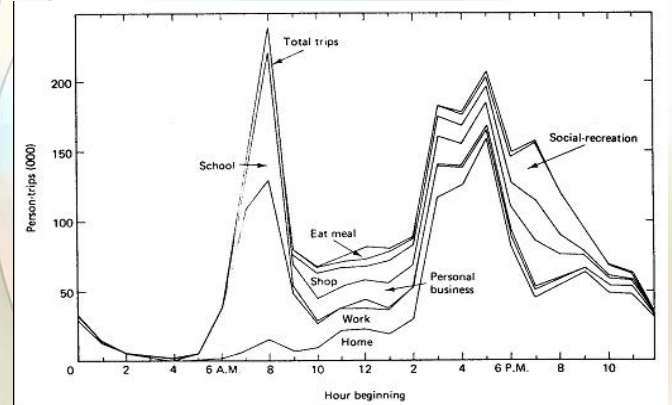
Faktor-faktor yang mempengaruhi :

- Pola dan intensitas tata guna lahan dan perkembangannya di daerah studi
- Karakteristik sosio-ekonomi populasi pelaku perjalanan di daerah studi
- Kondisi dan kapabilitas sistem transportasi yang tersedia di daerah studi dan skema pengembangannya

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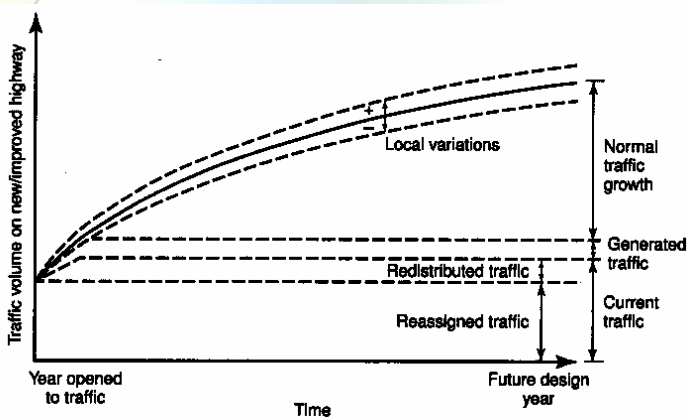
## Fluktuasi bangkitan/tarikan menurut maksud perjalanan



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## Pertumbuhan lalu lintas



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## Trip Generation Analysis

3 techniques

1. Cross-classification
2. Multiple regression analysis
  - Mathematical equation that describes trips as a function of another variable
  - Similar in theory to trip rate
3. Trip-rate analysis models
  - Average trip-production or trip-attraction rates for specific types of producers and attractors
  - More suited to trip attractions

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## Trip Generation Methods

- Cross - Classification
  - Used to determine TAZ productions in regional models
- Rates Based on Activity Units
  - Used for Traffic Impact Analysis or very detailed regional models
- Regression
  - Used to determine TAZ attractions

## Cross-Classification Method

- Households in TAZs aggregated into groups
- Rates for each group used to determine the number of trips.
- Trip rates based on household characteristics (income level, vehicle ownership, household size, ... )

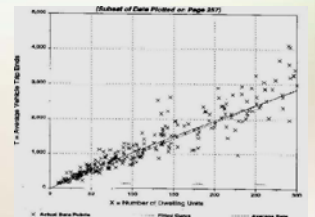
## Cross-Classification Method -

Example Cross-Classification Rates Table

Persons per Household	Autos per Household				
	0	1	2	3	4+
1	0.16	0.82	1.02	0.82	0.86
2	0.27	0.99	1.77	1.86	1.94
3	0.37	1.71	2.29	2.7	3.06
4+	1.56	1.9	2.18	2.93	3.43

## Rates Based on Activity Units Method

- Rates provided by the Institute of Transportation Engineers (ITE)
- Rates based upon demographics (average household size, business type, number of employees ...)
- ITE provides a trip generation software package

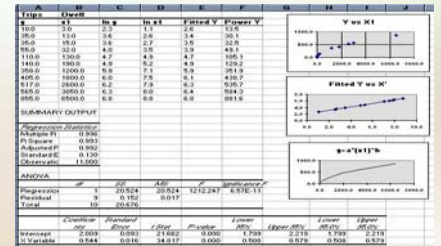


## ITE Trip Generation Software

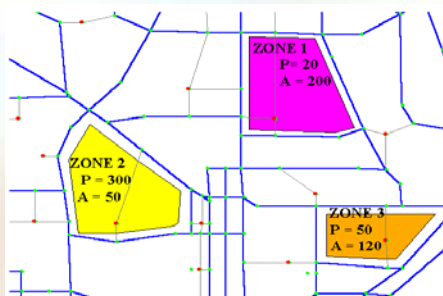


## Regression Method

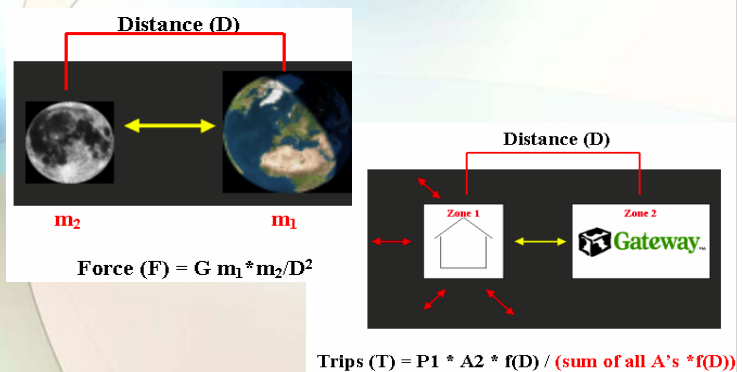
- Allows multiple variables and nonlinearity
- The number of trips = f (population, autos, number of dwelling units, ...)
- The trip predictors (population, autos, ...) need to be independent



## Trip Distribution



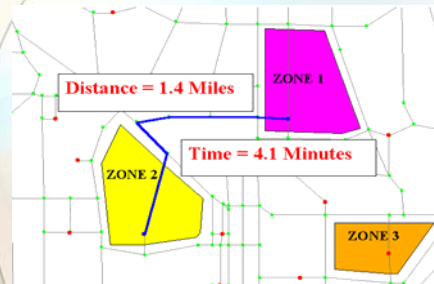
## Gravity Model



## Trip Distribution - The Gravity Model

$$T_{ij} = P_i \times \left( \frac{A_j \times F_{ij} \times K_{ij}}{\sum_{j=1}^n A_j \times F_{ij} \times K_{ij}} \right)$$

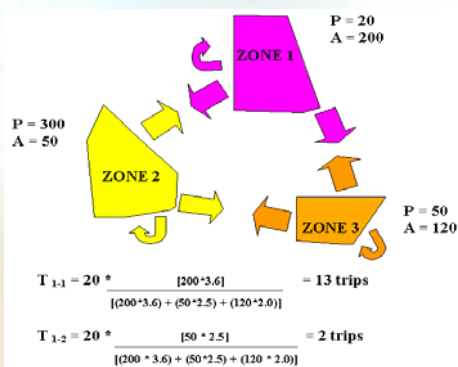
## Trip Distribution



Travel Time (Minutes)	Distance Function f(D)
2.9	3.6
3.7	3.1
4.1	2.5
5.2	2.0

- f(D) can be a function of distance, time, or user cost. Usually use time.

## Trip Distribution



## Trip Distribution



Trip Matrix	Zone 1	Zone 2	Zone 3	Total Productions
Zone 1	13	2	5	20
Zone 2	143	51	106	300
Zone 3	20	8	22	50

## The “Four-Steps”

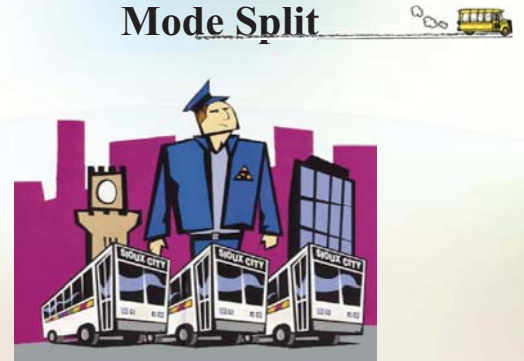
- **Network Building** - computer representation of your city (not a step!)
- **Trip Generation** - How many trips?
- **Trip Distribution** - Where are they going?
- **Mode Choice** - By what mode?
- **Trip Assignment** - What path are they taking?



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## Mode Split

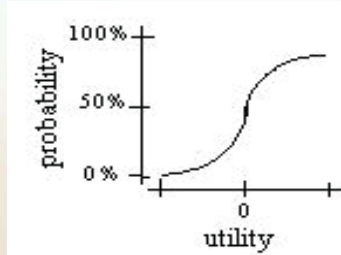


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## Mode Choice Models

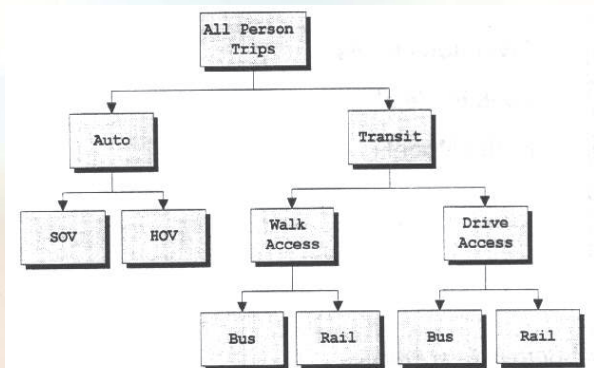
- None used in Iowa at present
  - number of trips smaller than error term
  - chicken and egg problem???
- Diversion curves
- Logit Models



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## Mode & Path Choice - Models

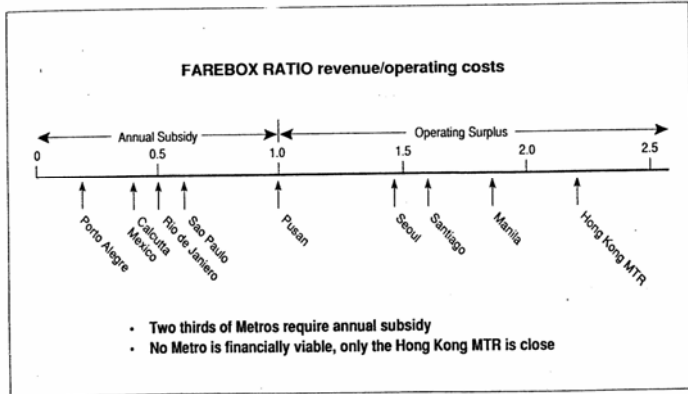


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## LRT/METRO STUDIES - FINANCIAL PERFORMANCE



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## The “Four-Steps”

- **Network Building** - computer representation of your city (not a step!)
- **Trip Generation** - How many trips?
- **Trip Distribution** - Where are they going?
- **Mode Choice** - By what mode?
- **Trip Assignment** - What path are they taking?



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## Trip Assignment - Path Selection Criteria

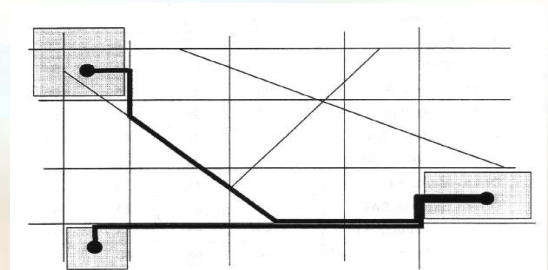
Composite index of travel impedance which would normally include:

- Travel Time
- Trip Cost
  - Out of pocket costs
  - Tolls
- Turn Penalties & Prohibitions (e.g., no left turn)

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## Trip Assignment - Path Selection



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## **Trip Assignment**

- Several methods available
  - uncongested
  - human behavior
  - congestion
- model may have to be adjusted
  - bridges
  - freeways

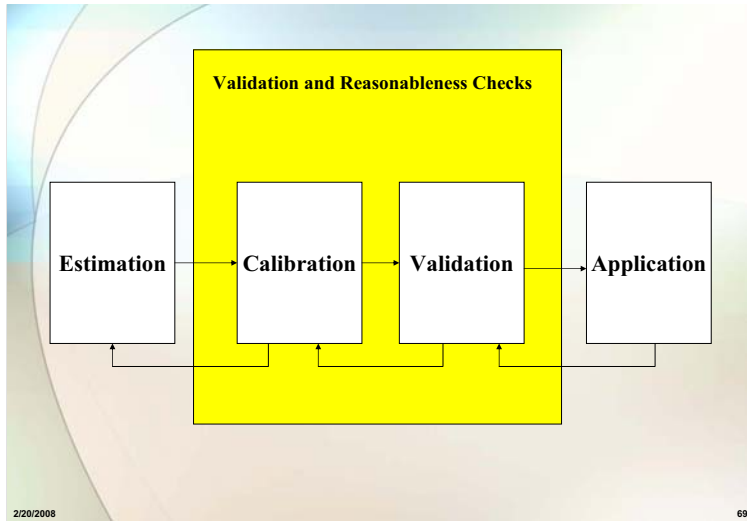
## **Model Outputs**

- Link volumes and speeds
- turning movements at intersections
- estimates of VMT (vehicle miles traveled)
- congestion measures
- all by category (jurisdiction, type of roadway, corridor, ...)

## **Contoh Equilibrium**

## **Steps to Obtain a Reliable Model**

- Model Estimation
  - Model Calibration
  - Model Validation
  - Model Application
  - Reasonableness Checks
  - Sensitivity Checks
-



## Steps to Obtain a Reliable Model

- Model Estimation
  - Statistical estimation of model parameters
    - Trip Generation Rates
    - Trip Length Frequency Distribution
- Model Calibration
  - Adjustment of model parameters until predicted travel matches observed travel

## Steps to Obtain a Reliable Model

- Model Validation
  - Checking the model results against observed data and adjusting the parameters until model results fall within an acceptable range of error.
- Model Application
  - Checking the reasonableness of future year traffic projections
  - Testing the sensitivity of the model to system or policy changes

## Reasonableness Checks

- Trip Length Frequency Distribution
- Trip Generation Rates (What land uses generate what kind and number of trips?)
- Total Regional Values (VMT, VHT)
- Sub-regional Values
- Logic Tests (Shortest Path)

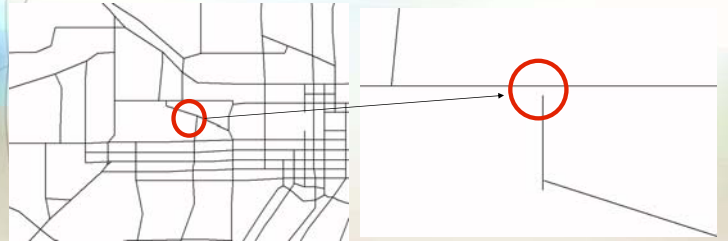
## Sensitivity Checks

- How the model responds to changes in:
  - Transportation System
  - Socioeconomic Data
  - Policy Changes (For base year and future year!)
- Expressed in the Elasticity of a variable
  - What happens to travel demand when gas prices triple? Or, parking costs decrease dramatically?

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## Connectivity Check



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## Screen Line



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## Cordon Line



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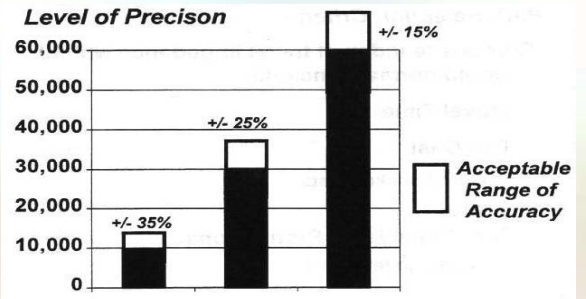
## Cut Line



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## Acceptable Ranges of Error



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## Highway Assignments - Level of Precision

- In general, assignments have been considered sufficiently accurate if to within +/- one lane of traffic.  
(More precision is being sought for air quality analysis)
- Intersection turning movements are beyond the reach of region travel models!  
(Local)

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## Travel models ... Masa depan ?

- Simultaneous models (1970s)
- dynamic models (ITS)
- activity-based models
- microsimulation models

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**..... TERIMA KASIH.....**