Appendix 4 Workshop Program

TECHNICAL WORKSHOP
“TRANSPORT DEMAND FORECAST FOR DAR ES SALAAM”

1ST SESSION

Time: ***9:30 – 17:30***

Date: ***12 May 2008***

Venue: ***NIT Conference Hall***

PROGRAM

9:00 – 9:30	Registration
9:30 – 9:45	Opening Remarks by Mr. Mgonja, Director of Studies, NIT
9:45 – 10:00	Outline of Transportation Master Plan Study by Mr. Shibata, Team Leader, JICA Study Team
10:00 – 10:30	1) Role of Demand Forecast for Transport Master Plan Study by Mr. Ishiya, JICA Study Team
10:30 – 10:45	Coffee/Tea Break
10:45 – 11:30	2) Basic Concept for Transport Demand Forecast Procedure by Mr. Ishiya, JICA Study Team
11:30 – 12:15	3) Transport Surveys and Database Development by Mr. Ishiya, JICA Study Team
12:15 – 13:30	Lunch
13:30 – 14:00	4) Household Interview Survey Conducted by Dr. Bwire, BICO
14:00 – 14:30	5) Traffic Count Surveys Conducted by Mr. Wemba, NIT
14:30 – 15:00	6) Development of Current OD Matrix by Mr. Ishiya, JICA Study Team
15:00 – 15:15	Coffee/Tea Break
15:15 – 15:45	7) Traffic Demand Model Building for Dar es Salaam by Mr. Arita, JICA Study Team
15:45 – 16:15	8) Outline of JICA STRADA by Mr. Ishiya, JICA Study Team
16:15 – 16:45	9) Introduction of Microscopic Simulation by Mr. Arita, JICA Study Team

16:45 – 17:30	Discussions

Time: Class 1: 10:00 – 12:30, Class 2: 13:30 – 16:00
Date: 13 May 2008 – 16 May 2008
Venue: yet to be decided

2ND SESSION

EXERCISE OF NETWORK DEVELOPMENT

10:00 – 10:30	Basic Concept for Network Development by Mr. Ishiya, JICA Study Team
10:30 – 11:00	Exercise of Network Development on GIS Software
11:00 – 12:00	Conversion and Analysis of Network by STRADA
12:00 – 12:30	Discussions

3RD SESSION

EXERCISE IN DEVELOPMENT OF OD MATRIX FORECAST MODELS

10:00 – 10:30	Methodology of OD Matrix Forecast Model Building by Mr. Ishiya, JICA Study Team
10:30 – 11:00	Exercise of Trip Generation Model Building
11:00 – 11:30	Exercise of Trip Distribution Model Building
11:30 – 12:00	Exercise of Modal Split Model Building
12:00 – 12:30	Discussions

4TH SESSION

EXERCISE OF FUTURE OD MATRIX FORECAST

10:00 – 10:30	Guideline for OD Matrix Forecast Model Building by Mr. Ishiya, JICA Study Team
10:30 – 11:00	Exercise of Trip Generation Forecasting
11:00 – 11:30	Exercise of Trip Distribution Forecasting
11:30 – 12:00	Exercise of Modal Split Forecasting
12:00 – 12:30	Discussions

5TH SESSION

EXERCISE IN TRAFFIC ASSIGNMENT AND EVALUATION OF NETWORK

10:00 – 10:30	Basic Concept for Traffic Assignment and Evaluation by Mr. Ishiya, JICA Study Team
10:30 – 11:00	Exercise of Future Network Development
11:00 – 11:30	Exercise of Traffic Assignment and Analysis
11:30 – 12:00	Exercise of Network Evaluation
12:00 – 12:30	Discussions

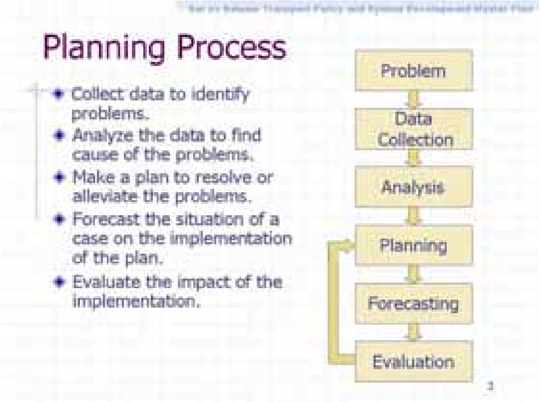
Note: Program for the afternoon is as same as the morning.

Appendix 5 Technical Workshop Handouts

1) Role of Demand Forecast for Transport Master Plan Study

Role of Demand Forecast for Transport Master Plan Study

Technical Workshop
12 May, 2008
JICA

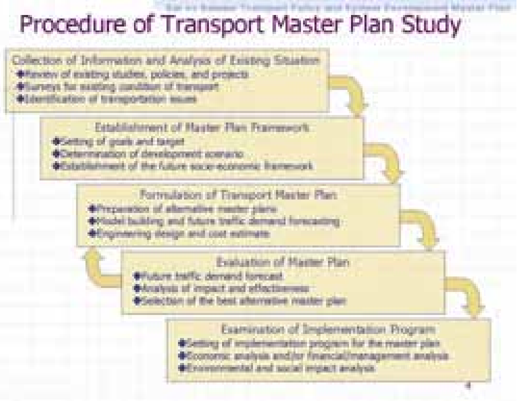


Planning Process

- Collect data to identify problems.
- Analyze the data to find cause of the problems.
- Make a plan to resolve or alleviate the problems.
- Forecast the situation of a case on the implementation of the plan.
- Evaluate the impact of the implementation.

Aspects required for Transport Master Plan Study

- Comprehensive consideration
  - Integration between long-term strategies and short-term action programs
  - Coordination between urban transport and urban development/land use
  - Coverage of all components in the transport services
  - Infrastructure development and their supporting policies
- Technical approach
  - Rational methodology should be applied
  - Re-doable evaluation
  - Anyone can get the same answer
  - Quantitative analysis on the impact of plans



Procedure of Transport Master Plan Study

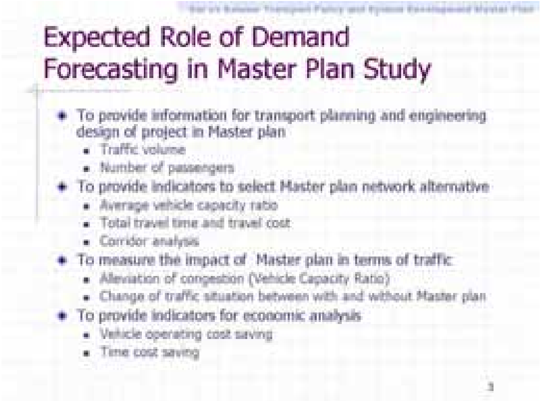
Collection of Information and Analysis of Existing Situation
- Review of existing studies, policies, and projects
- Surveys for existing condition of transport
- Identification of transportation issues

Establishment of Master Plan Framework
- Setting of goals and target
- Determination of development scenario
- Establishment of the future socio-economic framework

Formulation of Transport Master Plan
- Preparation of alternative master plans
- Model building and future traffic demand forecasting
- Engineering design and cost estimate

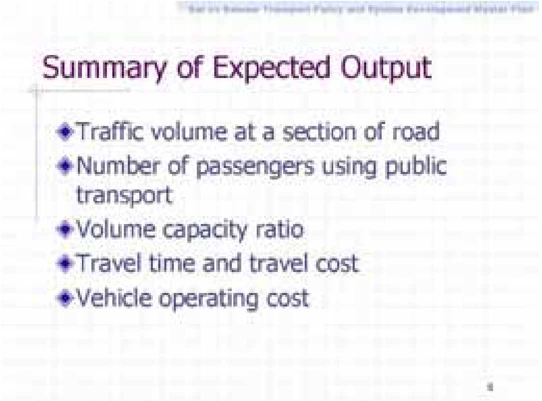
Evaluation of Master Plan
- Future traffic demand forecast
- Analysis of impact and effectiveness
- Selection of the best alternative master plan

Examination of Implementation Program
- Setting of implementation program for the master plan
- Economic analysis and/or financial/management analysis
- Environmental and social impact analysis



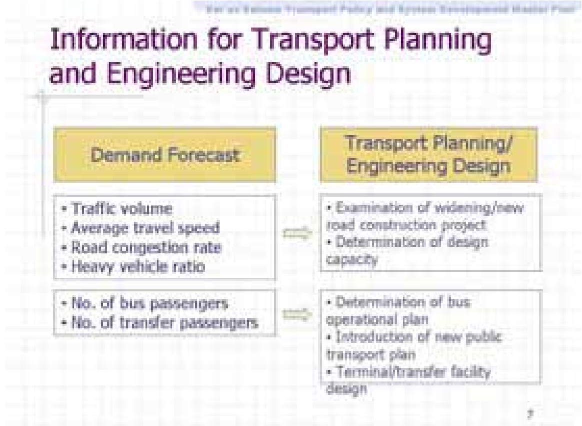
Expected Role of Demand Forecasting in Master Plan Study

- To provide information for transport planning and engineering design of project in Master plan
  - Traffic volume
  - Number of passengers
- To provide indicators to select Master plan network alternative
  - Average vehicle capacity ratio
  - Total travel time and travel cost
  - Corridor analysis
- To measure the impact of Master plan in terms of traffic
  - Alleviation of congestion (Vehicle Capacity Ratio)
  - Change of traffic situation between with and without Master plan
- To provide indicators for economic analysis
  - Vehicle operating cost saving
  - Time cost saving



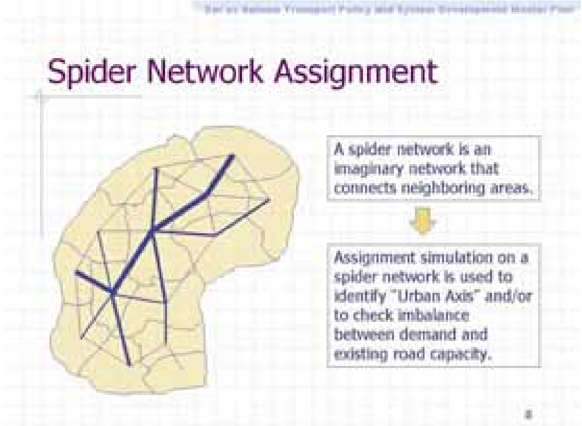
Summary of Expected Output

- Traffic volume at a section of road
- Number of passengers using public transport
- Volume capacity ratio
- Travel time and travel cost
- Vehicle operating cost



Information for Transport Planning and Engineering Design

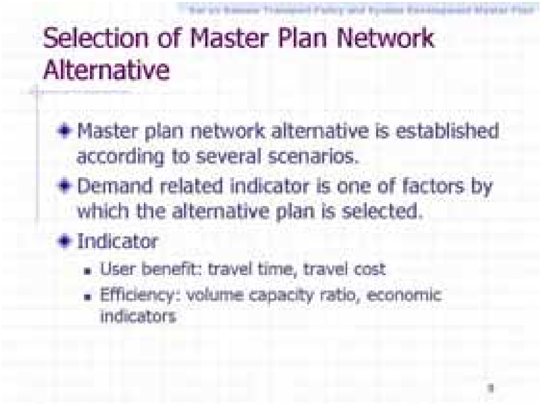
Demand Forecast		Transport Planning/ Engineering Design
• Traffic volume • Average travel speed • Road congestion rate • Heavy vehicle ratio	⇨	• Examination of widening/new road construction project • Determination of design capacity
• No. of bus passengers • No. of transfer passengers	⇨	• Determination of bus operational plan • Introduction of new public transport plan • Terminal/transfer facility design



Spider Network Assignment

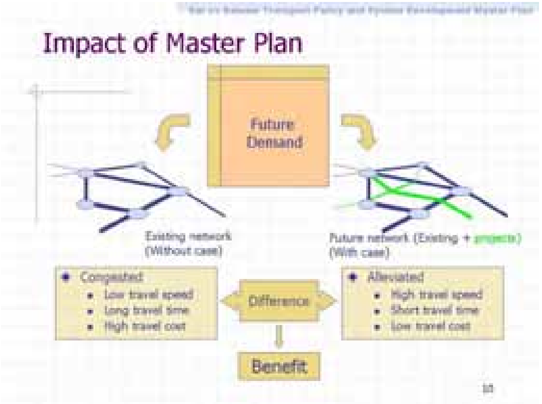
A spider network is an imaginary network that connects neighboring areas.

Assignment simulation on a spider network is used to identify "Urban Axis" and/or to check imbalance between demand and existing road capacity.

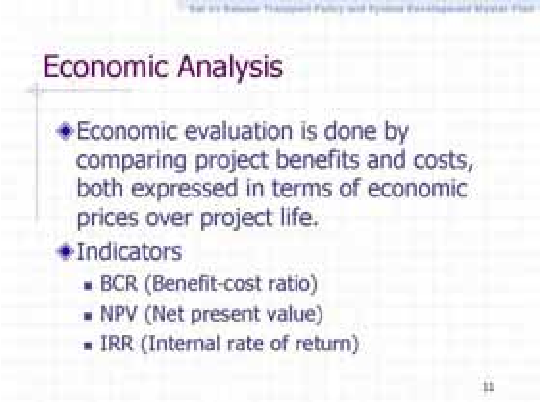


Selection of Master Plan Network Alternative

- Master plan network alternative is established according to several scenarios.
- Demand related indicator is one of factors by which the alternative plan is selected.
- Indicator
  - User benefit: travel time, travel cost
  - Efficiency: volume capacity ratio, economic indicators

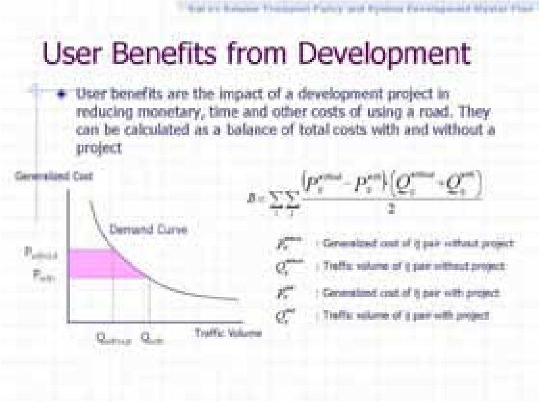


Impact of Master Plan



Economic Analysis

- Economic evaluation is done by comparing project benefits and costs, both expressed in terms of economic prices over project life.
- Indicators
  - BCR (Benefit-cost ratio)
  - NPV (Net present value)
  - IRR (Internal rate of return)

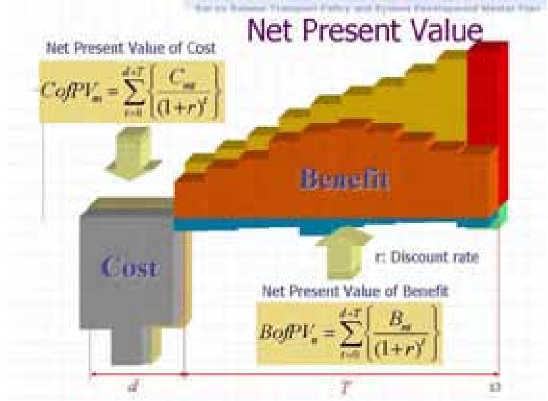


User Benefits from Development

- User benefits are the impact of a development project in reducing monetary, time and other costs of using a road. They can be calculated as a balance of total costs with and without a project

$$B=\sum_i\sum_j\frac{\left(P_{ij}^{without}-P_{ij}^{with}\right)\left(Q_{ij}^{without}+Q_{ij}^{with}\right)}{2}$$

$P_{ij}^{without}$: Generalized cost of ij pair without project
$Q_{ij}^{without}$: Traffic volume of ij pair without project
P_{ij}^{with} : Generalized cost of ij pair with project
Q_{ij}^{with} : Traffic volume of ij pair with project



Net Present Value

Net Present Value of Cost

$$CofPV_m=\sum_{t=0}^{d+T}\left\{\frac{C_{mt}}{(1+r)^t}\right\}$$

Net Present Value of Benefit

$$BofPV_n=\sum_{t=0}^{d+T}\left\{\frac{B_{nt}}{(1+r)^t}\right\}$$

r: Discount rate

2) Basic Concept for Transport Demand Forecast Procedure

Basic Concept for Transport Demand Forecast Procedure

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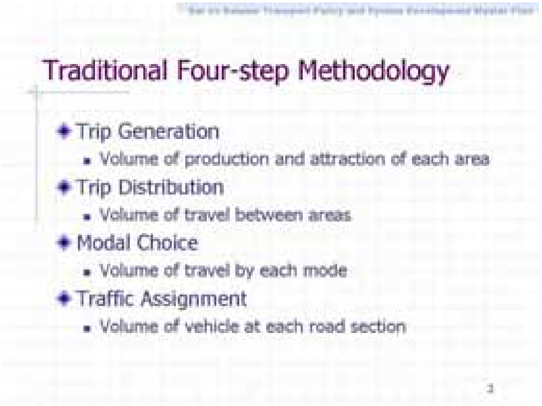
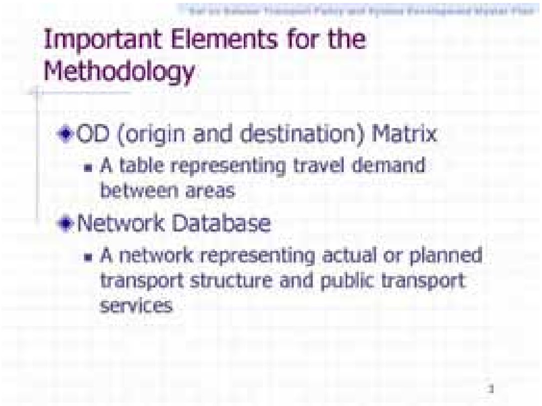


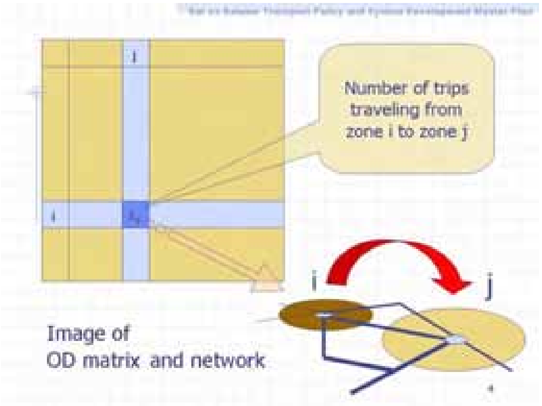
Traditional Four-step Methodology

- Trip Generation
  - Volume of production and attraction of each area
- Trip Distribution
  - Volume of travel between areas
- Modal Choice
  - Volume of travel by each mode
- Traffic Assignment
  - Volume of vehicle at each road section



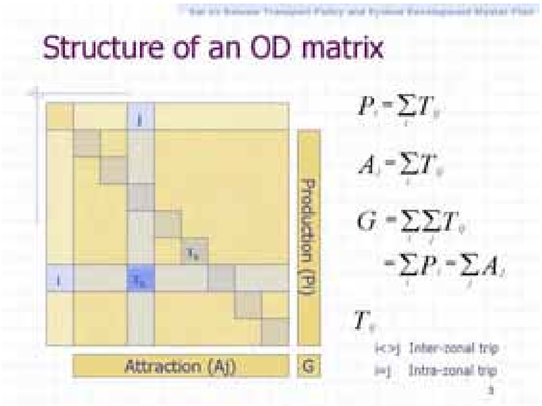
Important Elements for the Methodology

- OD (origin and destination) Matrix
  - A table representing travel demand between areas
- Network Database
  - A network representing actual or planned transport structure and public transport services



Number of trips traveling from zone i to zone j

Image of
OD matrix and network



Structure of an OD matrix

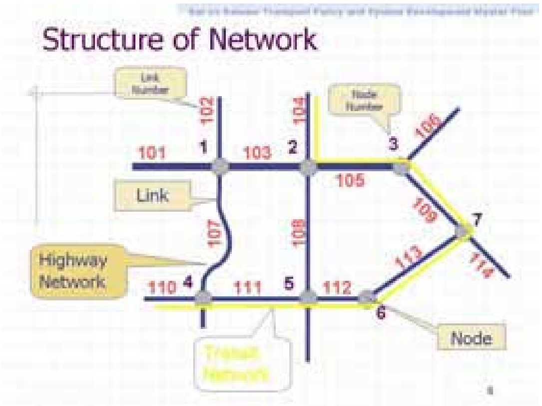
$$P_i = \sum_j T_{ij}$$

$$A_j = \sum_i T_{ij}$$

$$G = \sum_i \sum_j T_{ij} = \sum_i P_i = \sum_j A_j$$

T_{ij}

i<>j Inter-zonal trip
i=j Intra-zonal trip



Structure of Network

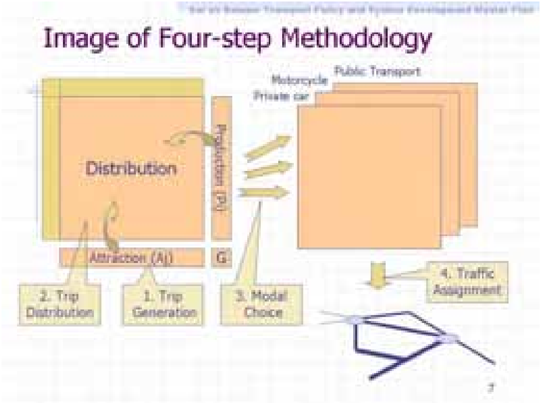
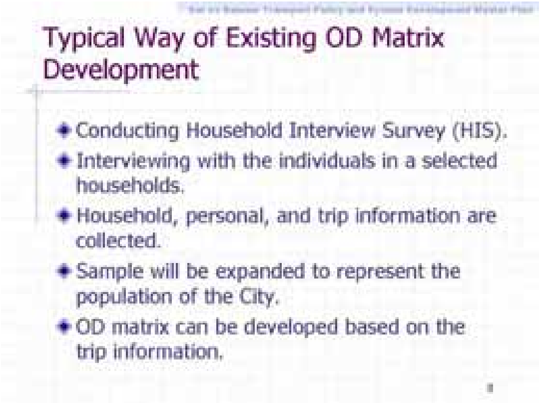
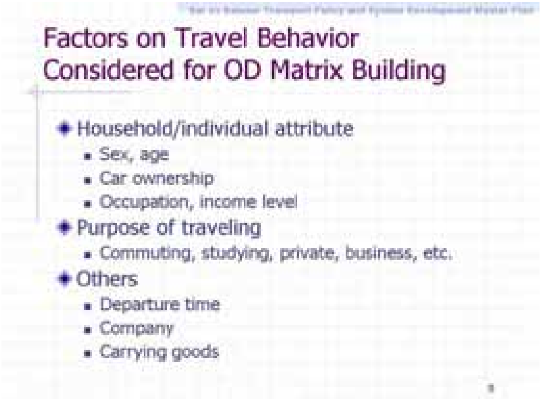


Image of Four-step Methodology



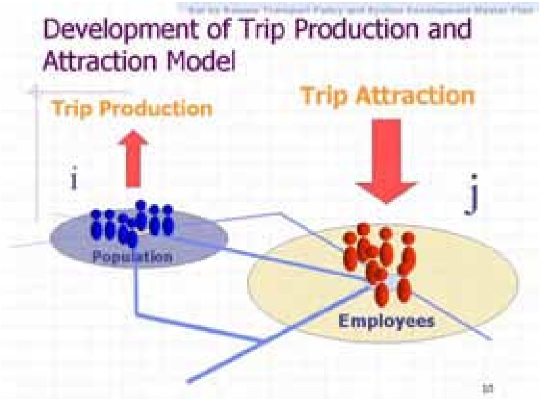
Typical Way of Existing OD Matrix Development

- Conducting Household Interview Survey (HIS).
- Interviewing with the individuals in a selected households.
- Household, personal, and trip information are collected.
- Sample will be expanded to represent the population of the City.
- OD matrix can be developed based on the trip information.

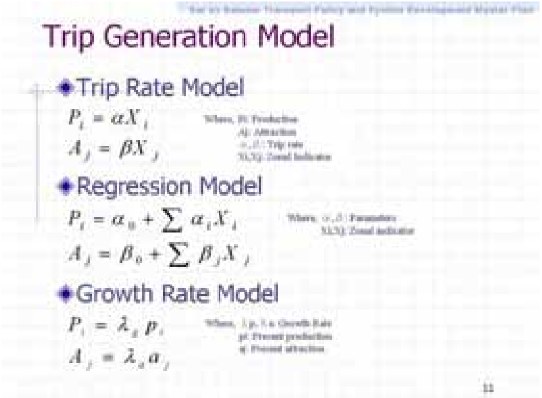


Factors on Travel Behavior Considered for OD Matrix Building

- Household/individual attribute
  - Sex, age
  - Car ownership
  - Occupation, income level
- Purpose of traveling
  - Commuting, studying, private, business, etc.
- Others
  - Departure time
  - Company
  - Carrying goods



Development of Trip Production and Attraction Model



Trip Generation Model

- Trip Rate Model

$P_i = \alpha X_i$

$A_j = \beta X_j$

Where, Pi: Production
Aj: Attraction
α, β : Trip rate
Xi,Xj: Zonal indicator

- Regression Model

$P_i = \alpha_0 + \sum \alpha_i X_i$

$A_j = \beta_0 + \sum \beta_j X_j$

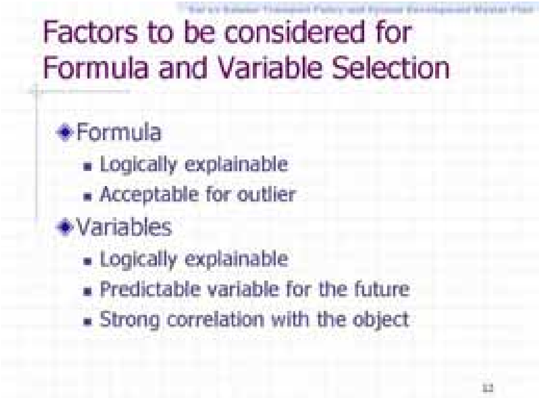
Where, α, β : Parameters
Xi,Xj: Zonal indicator

- Growth Rate Model

$P_i = \lambda_g p_i$

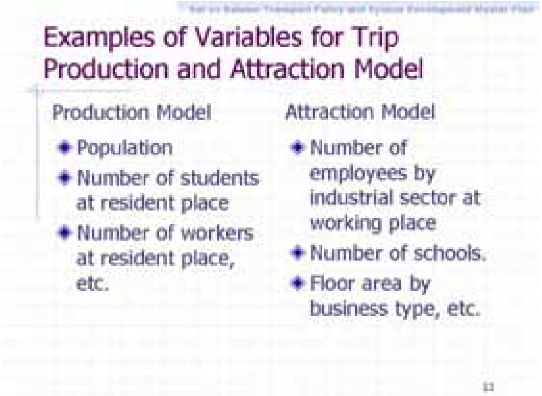
$A_j = \lambda_a a_j$

Where, λg, λa: Growth Rate
pi: Present production
aj: Present attraction



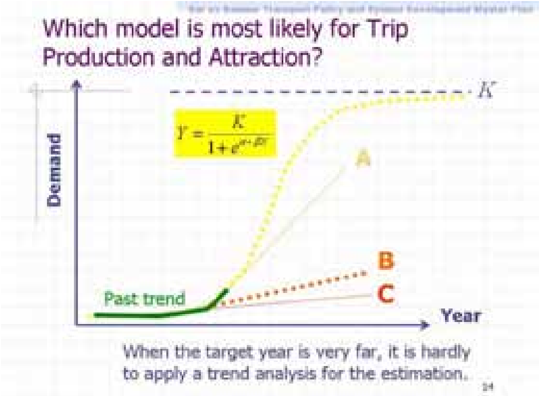
Factors to be considered for Formula and Variable Selection

- Formula
  - Logically explainable
  - Acceptable for outlier
- Variables
  - Logically explainable
  - Predictable variable for the future
  - Strong correlation with the object



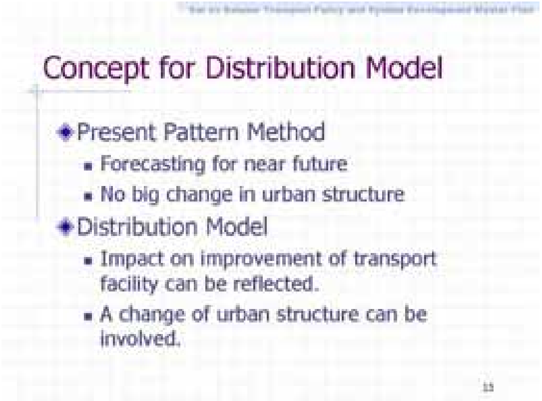
Examples of Variables for Trip Production and Attraction Model

Production Model	Attraction Model
Population Number of students at resident place Number of workers at resident place, etc.	Number of employees by industrial sector at working place Number of schools. Floor area by business type, etc.



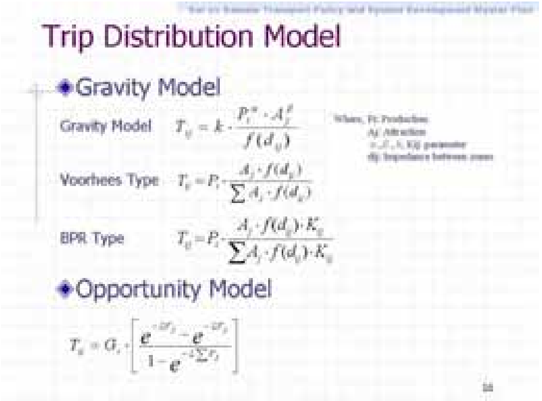
Which model is most likely for Trip Production and Attraction?

When the target year is very far, it is hardly to apply a trend analysis for the estimation.



Concept for Distribution Model

- Present Pattern Method
  - Forecasting for near future
  - No big change in urban structure
- Distribution Model
  - Impact on improvement of transport facility can be reflected.
  - A change of urban structure can be involved.



Trip Distribution Model

- Gravity Model

Gravity Model $T_{ij} = k \cdot \frac{P_i^{\alpha} \cdot A_j^{\beta}}{f(d_{ij})}$

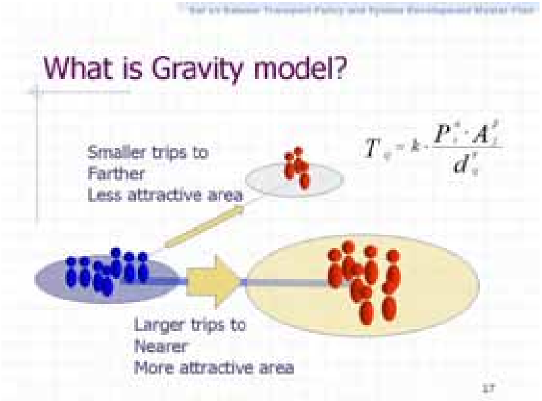
Where, Pi: Production
Aj: Attraction
α, β, λ, Kij: parameter
dij: Impedance between zones

Voorhees Type $T_{ij} = P_i \cdot \frac{A_j \cdot f(d_{ij})}{\sum A_j \cdot f(d_{ij})}$

BPR Type $T_{ij} = P_i \cdot \frac{A_j \cdot f(d_{ij}) \cdot K_{ij}}{\sum A_j \cdot f(d_{ij}) \cdot K_{ij}}$

- Opportunity Model

$T_{ij} = O_i \cdot \left[\frac{e^{-LV_j} - e^{-LV_j}}{1-e^{-L\sum V_j}}\right]$

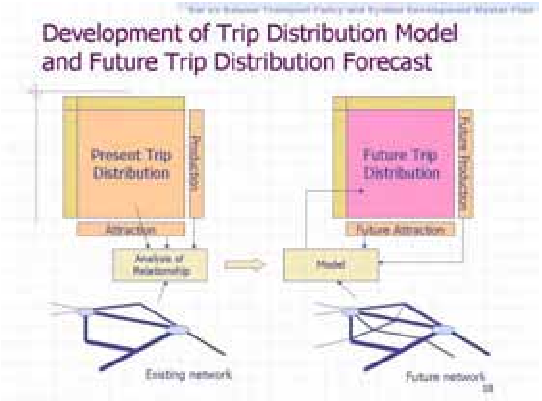


What is Gravity model?

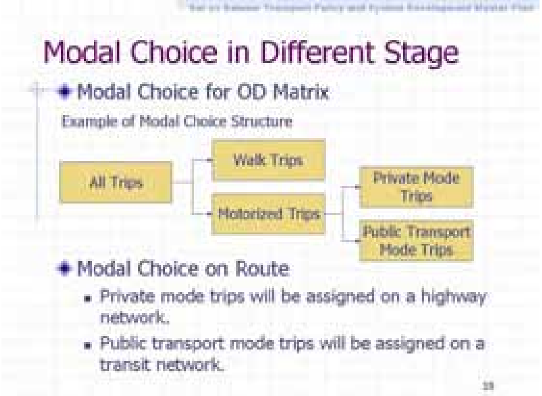
$$T_{ij} = k \cdot \frac{P_i^{\alpha} \cdot A_j^{\beta}}{d_{ij}^{\gamma}}$$

Smaller trips to
Farther
Less attractive area

Larger trips to
Nearer
More attractive area



Development of Trip Distribution Model and Future Trip Distribution Forecast



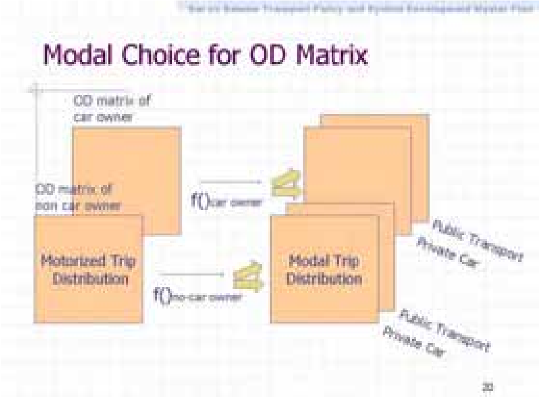
Modal Choice in Different Stage

- Modal Choice for OD Matrix

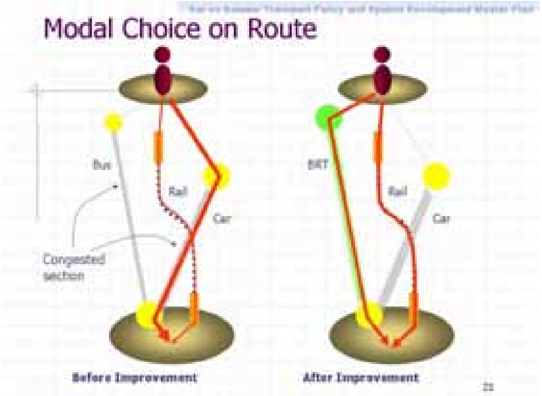
Example of Modal Choice Structure

All Trips → Walk Trips, Motorized Trips
Motorized Trips → Private Mode Trips, Public Transport Mode Trips

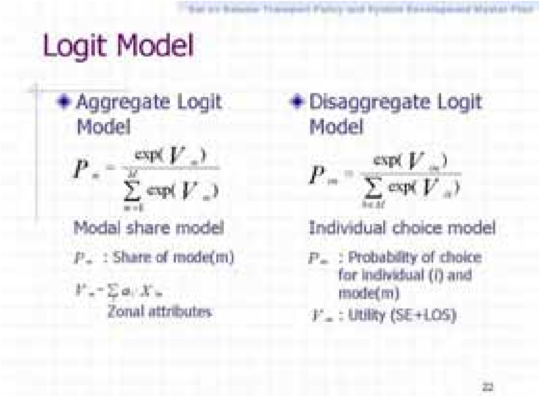
- Modal Choice on Route
  - Private mode trips will be assigned on a highway network.
  - Public transport mode trips will be assigned on a transit network.



Modal Choice for OD Matrix



Modal Choice on Route



Logit Model

- Aggregate Logit Model

$$P_m = \frac{\exp(V_m)}{\sum_{m=1}^{M} \exp(V_m)}$$

Modal share model

P_m : Share of mode(m)

$V_m = \sum a_i X_{im}$

Zonal attributes

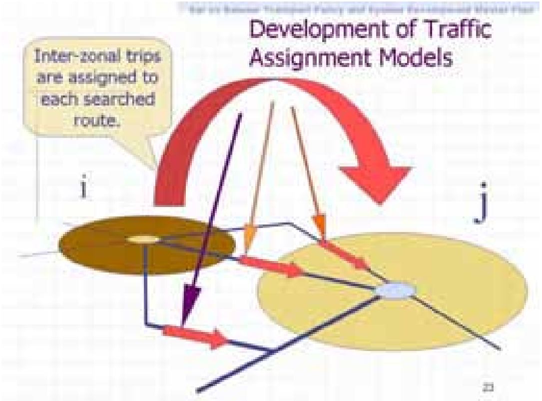
- Disaggregate Logit Model

$$P_{im} = \frac{\exp(V_{im})}{\sum_{k \in M} \exp(V_{ik})}$$

Individual choice model

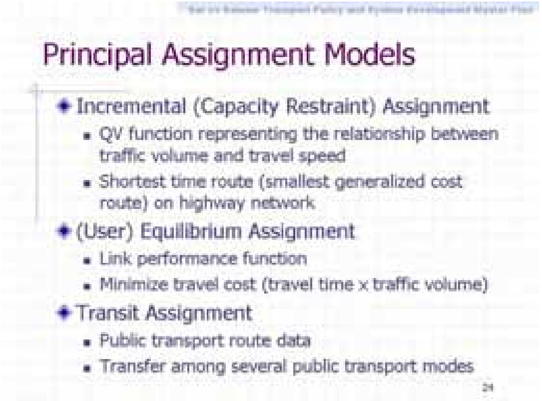
P_{im} : Probability of choice for individual (i) and mode(m)

V_{im} : Utility (SE+LOS)



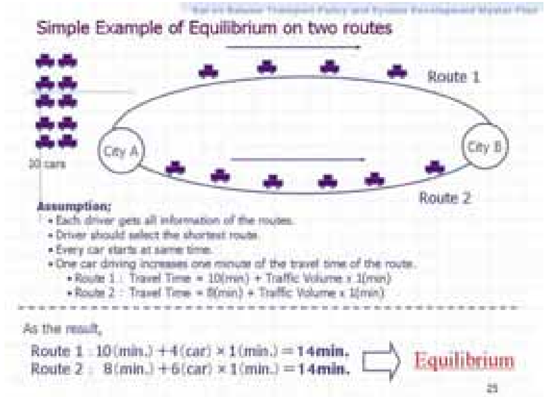
Development of Traffic Assignment Models

Inter-zonal trips are assigned to each searched route.



Principal Assignment Models

- Incremental (Capacity Restraint) Assignment
  - QV function representing the relationship between traffic volume and travel speed
  - Shortest time route (smallest generalized cost route) on highway network
- (User) Equilibrium Assignment
  - Link performance function
  - Minimize travel cost (travel time x traffic volume)
- Transit Assignment
  - Public transport route data
  - Transfer among several public transport modes



Simple Example of Equilibrium on two routes

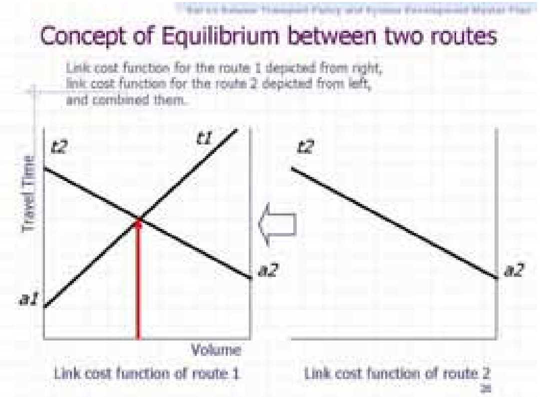
Assumption;

- Each driver gets all information of the routes.
- Driver should select the shortest route.
- Every car starts at same time.
- One car driving increases one minute of the travel time of the route.
  - Route 1 : Travel Time = 10(min) + Traffic Volume x 1(min)
  - Route 2 : Travel Time = 8(min) + Traffic Volume x 1(min)

As the result,

Route 1 : 10(min.) +4(car) × 1(min.) = **14min.**
Route 2 : 8(min.) +6(car) × 1(min.) = **14min.**

Equilibrium

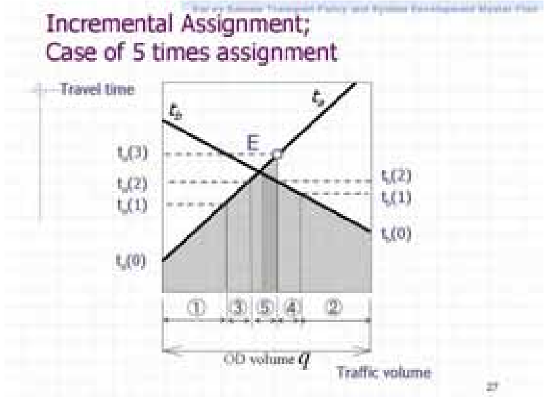


Concept of Equilibrium between two routes

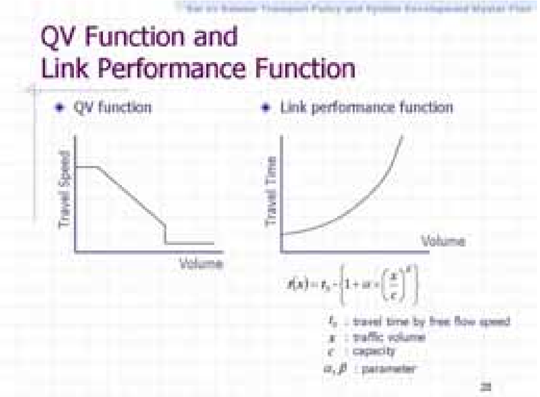
Link cost function for the route 1 depicted from right,
link cost function for the route 2 depicted from left,
and combined them.

Link cost function of route 1

Link cost function of route 2



Incremental Assignment; Case of 5 times assignment

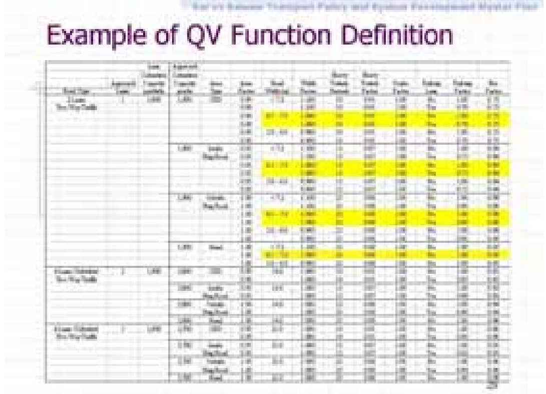


QV Function and Link Performance Function

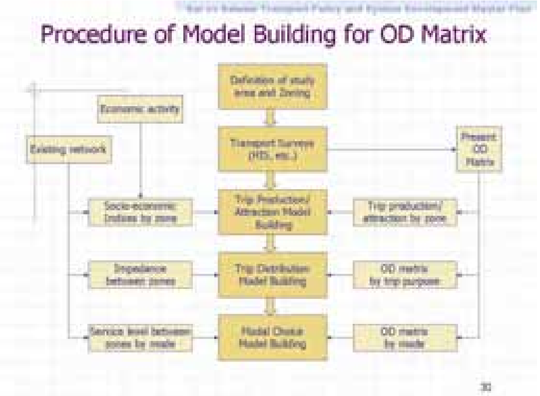
- QV function
- Link performance function

$$t(x) = t_0 \cdot \left\{1 + \alpha \cdot \left(\frac{x}{c}\right)^{\beta}\right\}$$

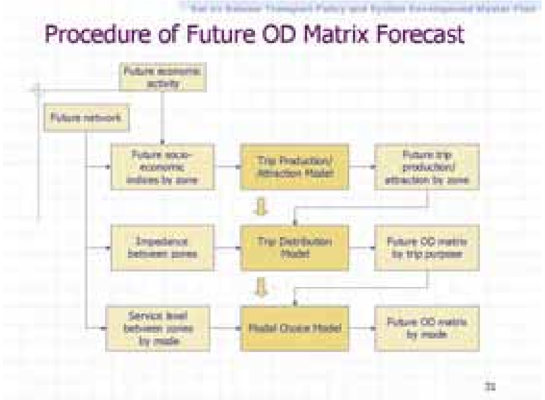
t_0 : travel time by free flow speed
x : traffic volume
c : capacity
α, β : parameter



Example of QV Function Definition

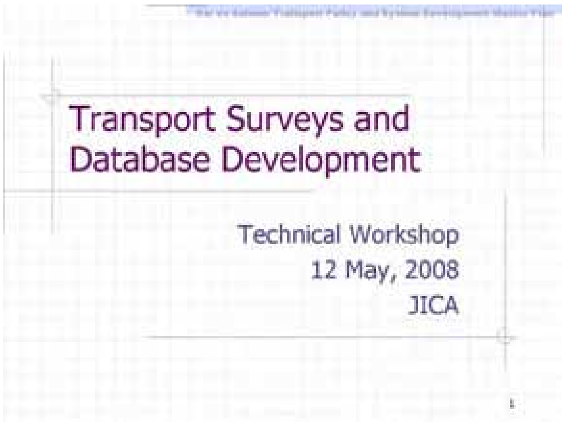


Procedure of Model Building for OD Matrix



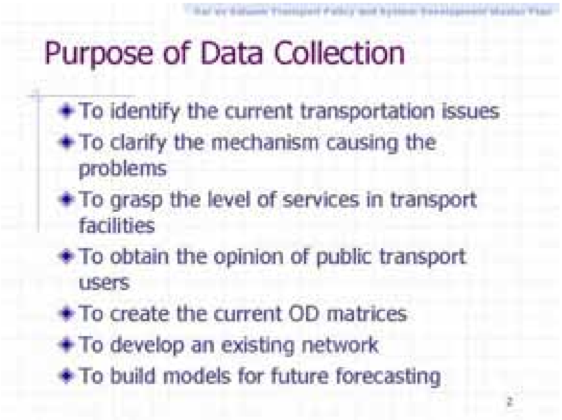
Procedure of Future OD Matrix Forecast

3) Transport Surveys and Database Development



Transport Surveys and Database Development

Technical Workshop
12 May, 2008
JICA

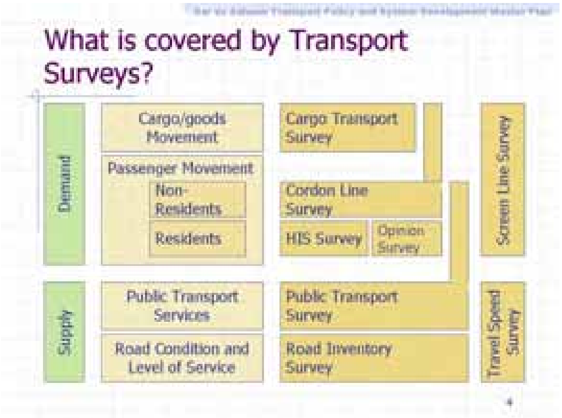


Purpose of Data Collection

- To identify the current transportation issues
- To clarify the mechanism causing the problems
- To grasp the level of services in transport facilities
- To obtain the opinion of public transport users
- To create the current OD matrices
- To develop an existing network
- To build models for future forecasting

List of Transportation Surveys

Survey	Objective	Information Collecting
Household Interview Survey (HIS)	To obtain travel pattern of residents in the Study area	- Household and individual attributes - Travel information
Opinion & Preference Survey	To obtain opinion and preferences on public transport	- Opinion and preferences on public transport
Screen Line Survey	To count traffic volume on screen lines	- Traffic volume by type of vehicle - Occupancy
Intersection Count Survey	To observe traffic flow at problem intersections	- Directional traffic volume - No. of pedestrians - Signal phase pattern
Cordon Line Survey	To obtain travel pattern of residents outside Study area	- Traffic volume by type of vehicle - Occupancy - Trip information of drivers and passengers
Public Transport Survey	To collect bus services and information of bus users	- Route and frequency of bus services - Information of bus users - Opinion and preferences on public transport
Cargo Transport Survey	To obtain cargo traffic movements	- Profile of transport related companies - Movements of cargo trucks
Travel Speed Survey	To measure travel speed on major corridors	- Travel time and travel speed
Road Inventory Survey	To collect road condition	- Road width, number of lanes, etc.
Trip Generation Survey	To obtain building attributes and their trip generation	- Building and parking inventory - Trip generation of buildings

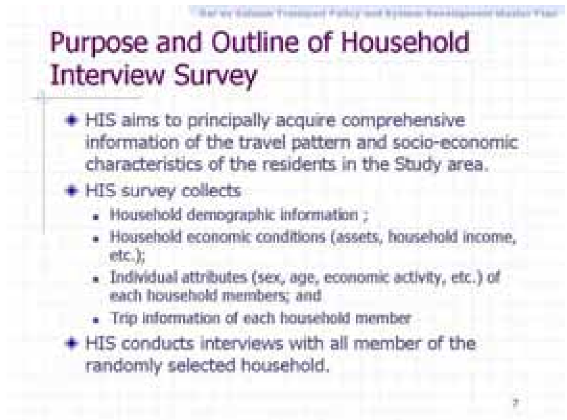


What is covered by Transport Surveys?

Principal Transport Surveys

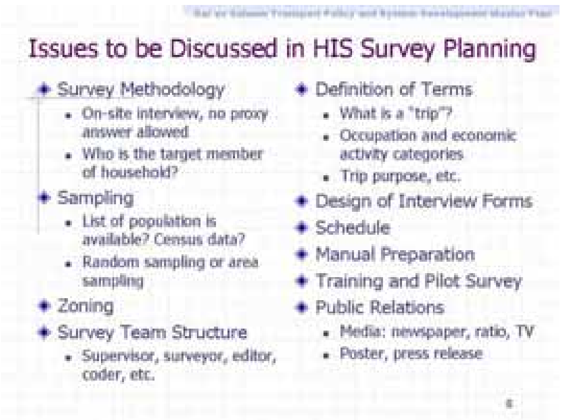
1. Household Interview Survey (HIS)
2. Screen Line Survey
3. Cordon Line Survey
4. Public Transport Survey
5. Road Inventory Survey

1. HOUSEHOLD INTERVIEW SURVEY



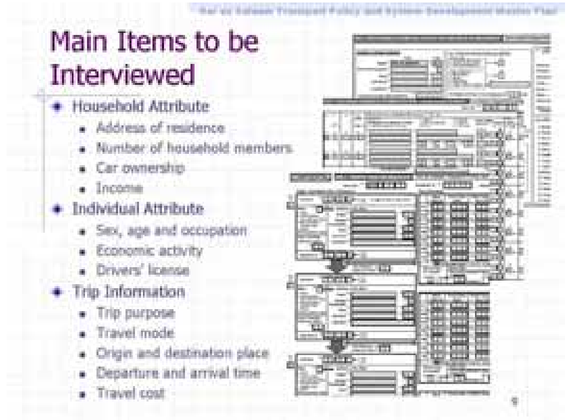
Purpose and Outline of Household Interview Survey

- HIS aims to principally acquire comprehensive information of the travel pattern and socio-economic characteristics of the residents in the Study area.
- HIS survey collects
  - Household demographic information ;
  - Household economic conditions (assets, household income, etc.);
  - Individual attributes (sex, age, economic activity, etc.) of each household members; and
  - Trip information of each household member
- HIS conducts interviews with all member of the randomly selected household.



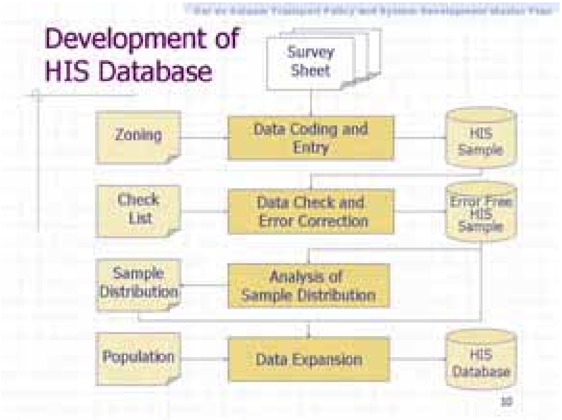
Issues to be Discussed in HIS Survey Planning

- Survey Methodology
  - On-site interview, no proxy answer allowed
  - Who is the target member of household?
- Sampling
  - List of population is available? Census data?
  - Random sampling or area sampling
- Zoning
- Survey Team Structure
  - Supervisor, surveyor, editor, coder, etc.
- Definition of Terms
  - What is a "trip"?
  - Occupation and economic activity categories
  - Trip purpose, etc.
- Design of Interview Forms
- Schedule
- Manual Preparation
- Training and Pilot Survey
- Public Relations
  - Media: newspaper, ratio, TV
  - Poster, press release



Main Items to be Interviewed

- Household Attribute
  - Address of residence
  - Number of household members
  - Car ownership
  - Income
- Individual Attribute
  - Sex, age and occupation
  - Economic activity
  - Drivers' license
- Trip Information
  - Trip purpose
  - Travel mode
  - Origin and destination place
  - Departure and arrival time
  - Travel cost



Development of HIS Database

Survey Sheet

Zoning

Data Coding and Entry

HIS Sample

Check List

Data Check and Error Correction

Error Free HIS Sample

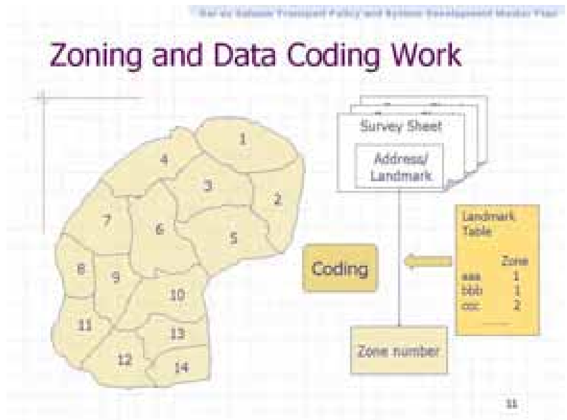
Sample Distribution

Analysis of Sample Distribution

Population

Data Expansion

HIS Database



Zoning and Data Coding Work

Survey Sheet

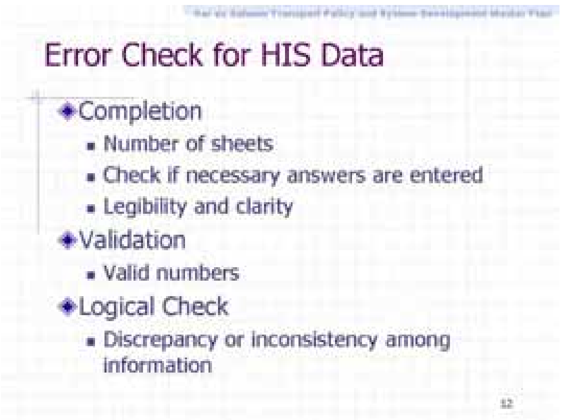
Address/ Landmark

Landmark Table

	Zone
aaa	1
bbb	1
ccc	2

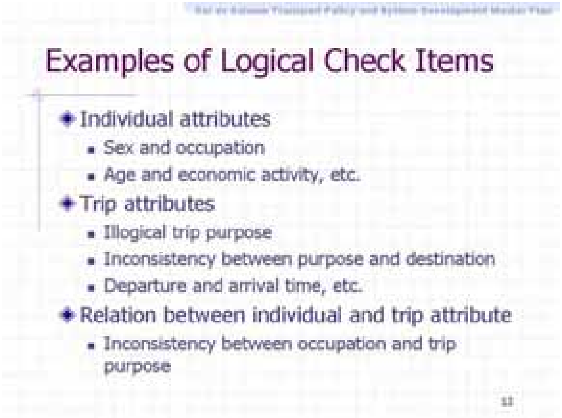
Coding

Zone number



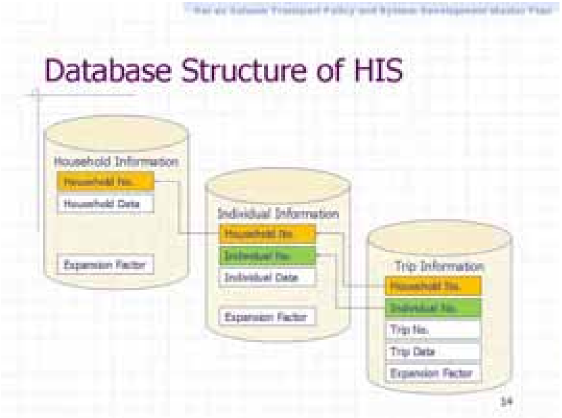
Error Check for HIS Data

- Completion
  - Number of sheets
  - Check if necessary answers are entered
  - Legibility and clarity
- Validation
  - Valid numbers
- Logical Check
  - Discrepancy or inconsistency among information

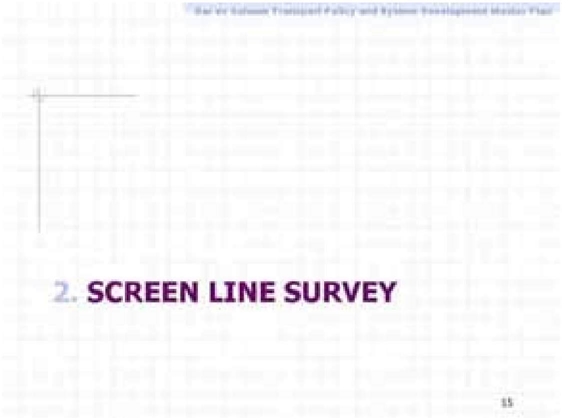


Examples of Logical Check Items

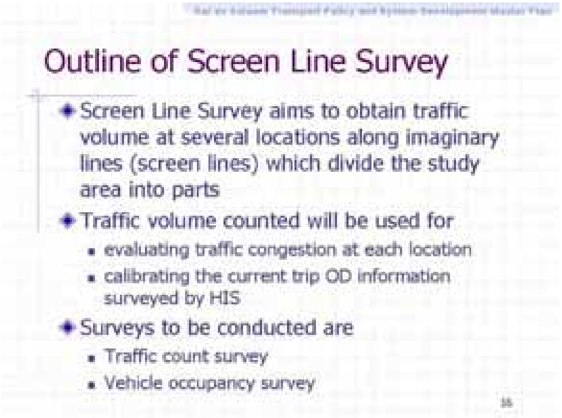
- Individual attributes
  - Sex and occupation
  - Age and economic activity, etc.
- Trip attributes
  - Illogical trip purpose
  - Inconsistency between purpose and destination
  - Departure and arrival time, etc.
- Relation between individual and trip attribute
  - Inconsistency between occupation and trip purpose



Database Structure of HIS

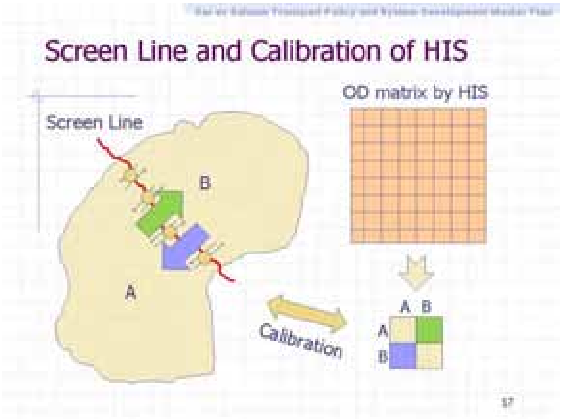


2. SCREEN LINE SURVEY

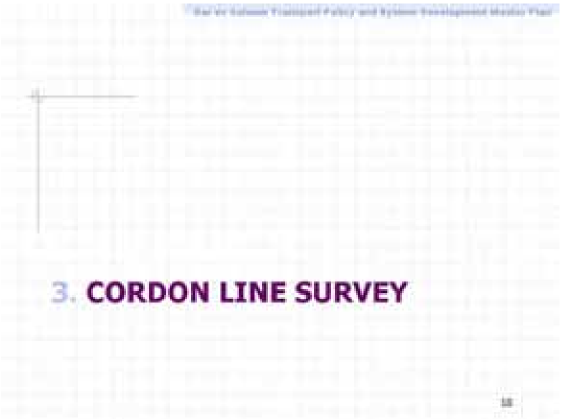


Outline of Screen Line Survey

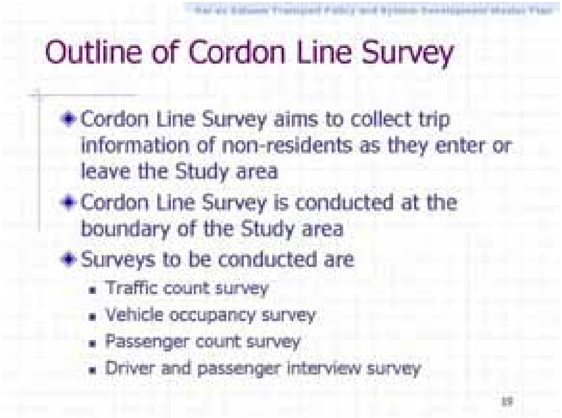
- Screen Line Survey aims to obtain traffic volume at several locations along imaginary lines (screen lines) which divide the study area into parts
- Traffic volume counted will be used for
  - evaluating traffic congestion at each location
  - calibrating the current trip OD information surveyed by HIS
- Surveys to be conducted are
  - Traffic count survey
  - Vehicle occupancy survey



Screen Line and Calibration of HIS

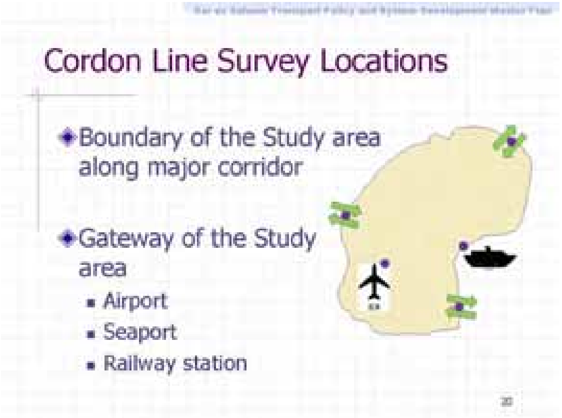


3. CORDON LINE SURVEY



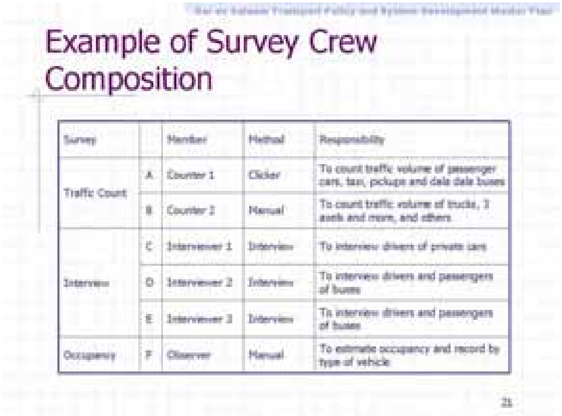
Outline of Cordon Line Survey

- Cordon Line Survey aims to collect trip information of non-residents as they enter or leave the Study area
- Cordon Line Survey is conducted at the boundary of the Study area
- Surveys to be conducted are
  - Traffic count survey
  - Vehicle occupancy survey
  - Passenger count survey
  - Driver and passenger interview survey



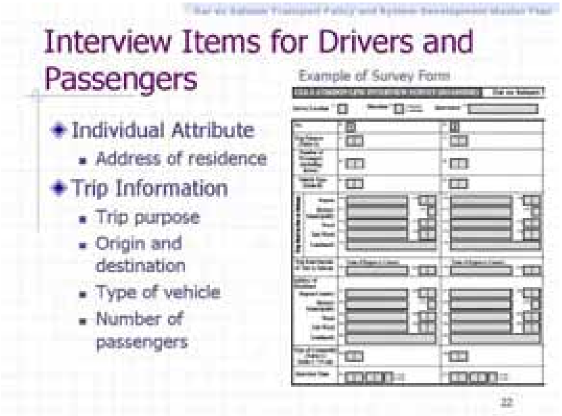
Cordon Line Survey Locations

- Boundary of the Study area along major corridor
- Gateway of the Study area
  - Airport
  - Seaport
  - Railway station



Example of Survey Crew Composition

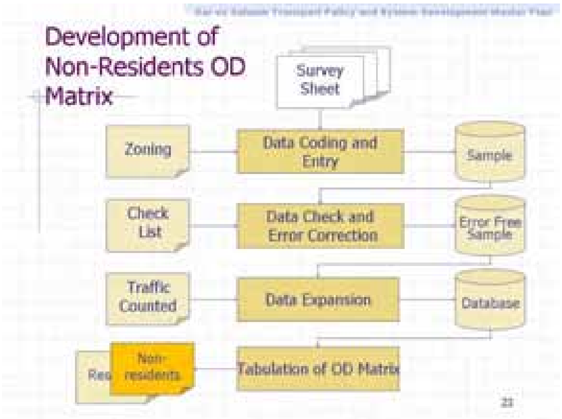
Survey		Member	Method	Responsibility
Traffic Count	A	Counter 1	Clicker	To count traffic volume of passenger cars, taxi, pickups and dala dala buses
	B	Counter 2	Manual	To count traffic volume of trucks, 3 axels and more, and others
Interview	C	Interviewer 1	Interview	To interview drivers of private cars
	D	Interviewer 2	Interview	To interview drivers and passengers of buses
	E	Interviewer 3	Interview	To interview drivers and passengers of buses
Occupancy	F	Observer	Manual	To estimate occupancy and record by type of vehicle



Interview Items for Drivers and Passengers

- Individual Attribute
  - Address of residence
- Trip Information
  - Trip purpose
  - Origin and destination
  - Type of vehicle
  - Number of passengers

Example of Survey Form



Development of Non-Residents OD Matrix

4. PUBLIC TRANSPORT SURVEY

Purpose of Public Transport Survey

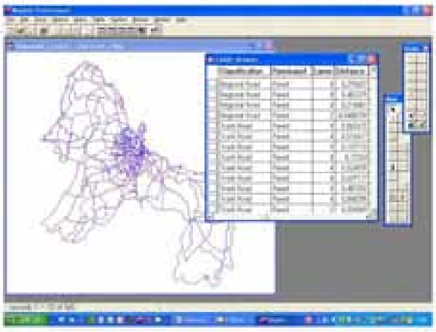
- Public transport survey aims to collect the information of existing public transport services and their demand.
- Information to be collected
  - Route
  - Number of buses and their capacity
  - Frequency/headway, travel time
  - Fare system
  - Opinion on public transport services
- Collected information is stored in an existing transit network database

5. ROAD INVENTORY SURVEY

Necessary Information to be Collected by Road Inventory Survey

- Functional Classification
  - Arterial, local, etc.
- Administrative Classification
  - National road, regional road, city road, etc.
- Road Specification
  - Road width, number of lanes
  - Median
  - Side clearance and side friction
- Traffic Operation
  - One way/two way
  - Signal

Development of Network Database



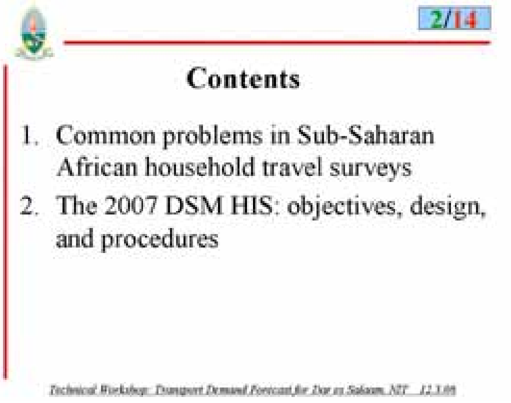
4) Transport Surveys and Database Development

1/14

Household Interview Survey

by
H. Bwire, BICO

Technical Workshop: Transport Demand Forecast for Dar es Salaam, NIT 12.3.08



2/14

Contents

1. Common problems in Sub-Saharan African household travel surveys
2. The 2007 DSM HIS: objectives, design, and procedures

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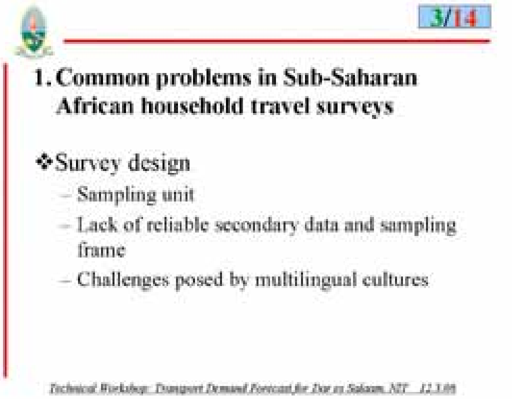

3/14

1. Common problems in Sub-Saharan African household travel surveys

❖Survey design
- Sampling unit
- Lack of reliable secondary data and sampling frame
- Challenges posed by multilingual cultures

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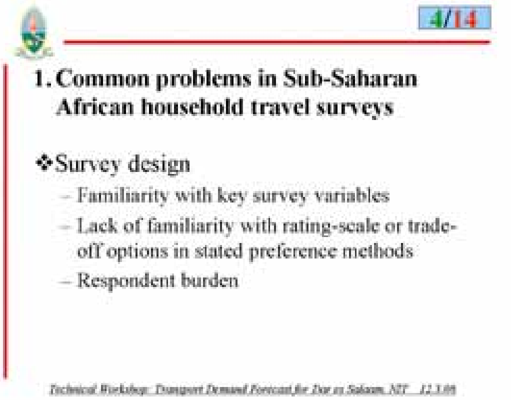

4/14

1. Common problems in Sub-Saharan African household travel surveys

❖Survey design
- Familiarity with key survey variables
- Lack of familiarity with rating-scale or trade-off options in stated preference methods
- Respondent burden

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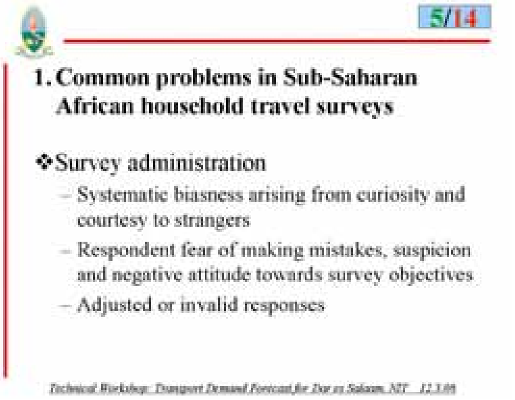

5/14

1. Common problems in Sub-Saharan African household travel surveys

❖Survey administration
- Systematic biasness arising from curiosity and courtesy to strangers
- Respondent fear of making mistakes, suspicion and negative attitude towards survey objectives
- Adjusted or invalid responses

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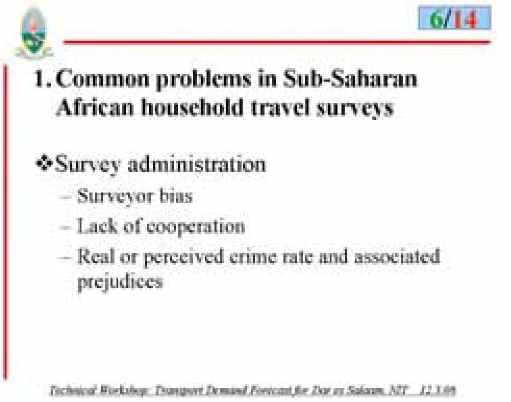

6/14

1. Common problems in Sub-Saharan African household travel surveys

❖Survey administration
- Surveyor bias
- Lack of cooperation
- Real or perceived crime rate and associated prejudices

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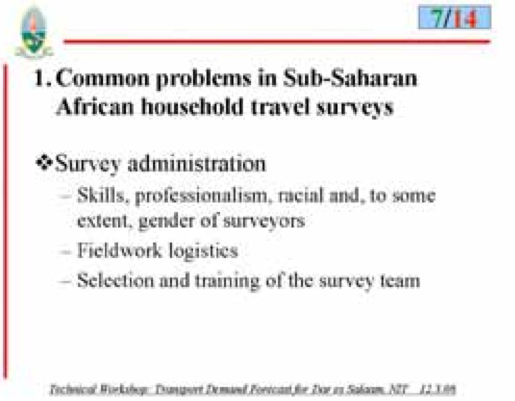

7/14

1. Common problems in Sub-Saharan African household travel surveys

❖Survey administration
- Skills, professionalism, racial and, to some extent, gender of surveyors
- Fieldwork logistics
- Selection and training of the survey team

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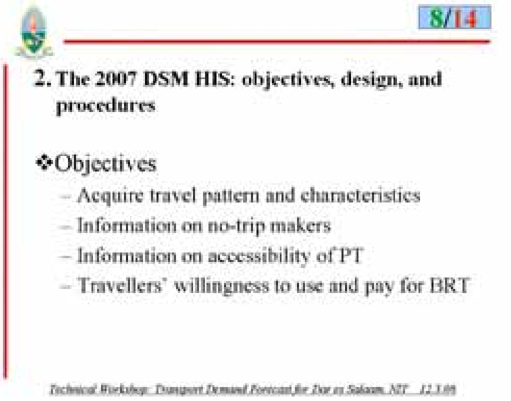

8/14

2. The 2007 DSM HIS: objectives, design, and procedures

❖Objectives
- Acquire travel pattern and characteristics
- Information on no-trip makers
- Information on accessibility of PT
- Travellers' willingness to use and pay for BRT

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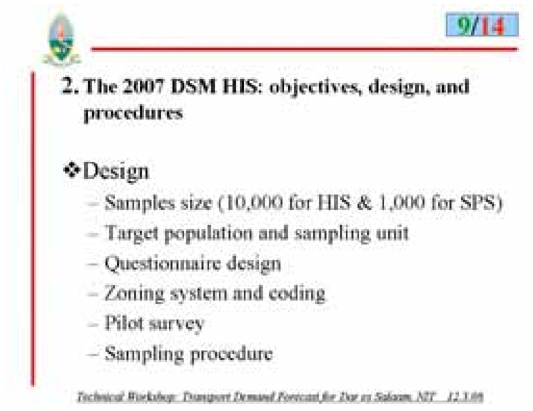
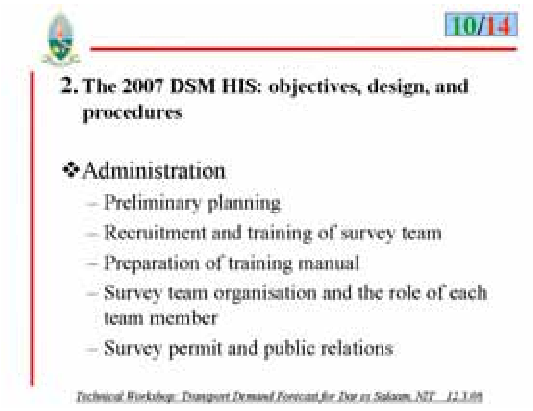


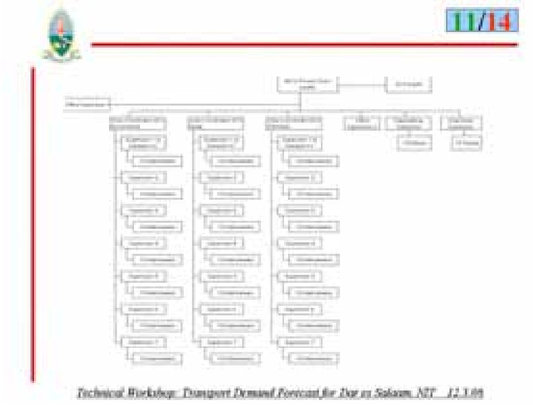
2. The 2007 DSM HIS: objectives, design, and procedures

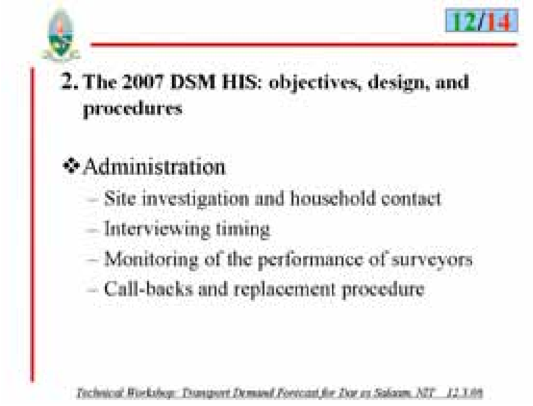
❖Design
- Samples size (10,000 for HIS & 1,000 for SPS)
- Target population and sampling unit
- Questionnaire design
- Zoning system and coding
- Pilot survey
- Sampling procedure



2. The 2007 DSM HIS: objectives, design, and procedures

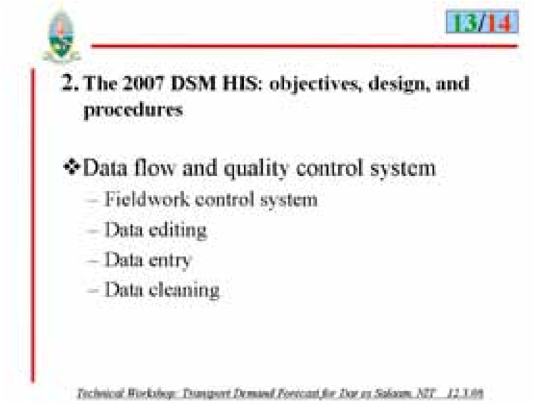
❖Administration
- Preliminary planning
- Recruitment and training of survey team
- Preparation of training manual
- Survey team organisation and the role of each team member
- Survey permit and public relations





2. The 2007 DSM HIS: objectives, design, and procedures

❖Administration
- Site investigation and household contact
- Interviewing timing
- Monitoring of the performance of surveyors
- Call-backs and replacement procedure



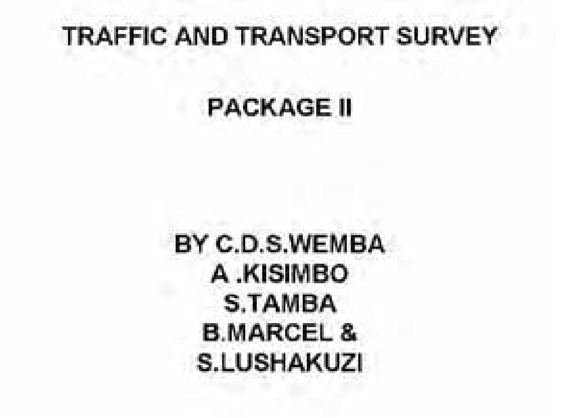
2. The 2007 DSM HIS: objectives, design, and procedures

❖Data flow and quality control system
- Fieldwork control system
- Data editing
- Data entry
- Data cleaning

THANK YOU FOR YOUR ATTENTION!

H. Bwire [MIET, REng, Ph.D.]

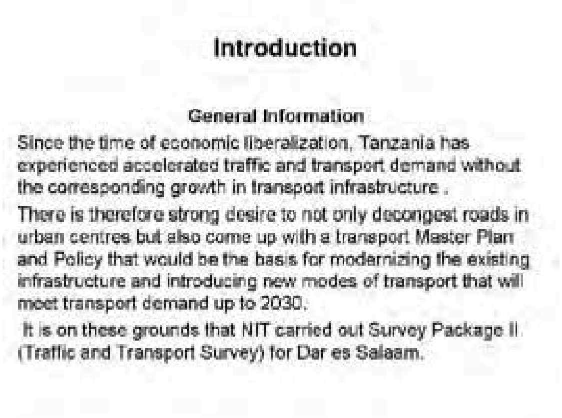
5) Traffic Count Surveys Conducted



TRAFFIC AND TRANSPORT SURVEY

PACKAGE II

BY C.D.S.WEMBA
A .KISIMBO
S.TAMBA
B.MARCEL &
S.LUSHAKUZI



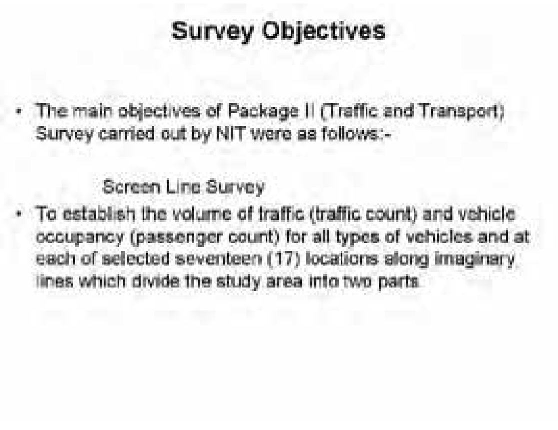
Introduction

General Information

Since the time of economic liberalization, Tanzania has experienced accelerated traffic and transport demand without the corresponding growth in transport infrastructure .

There is therefore strong desire to not only decongest roads in urban centres but also come up with a transport Master Plan and Policy that would be the basis for modernizing the existing infrastructure and introducing new modes of transport that will meet transport demand up to 2030.

It is on these grounds that NIT carried out Survey Package II (Traffic and Transport Survey) for Dar es Salaam.

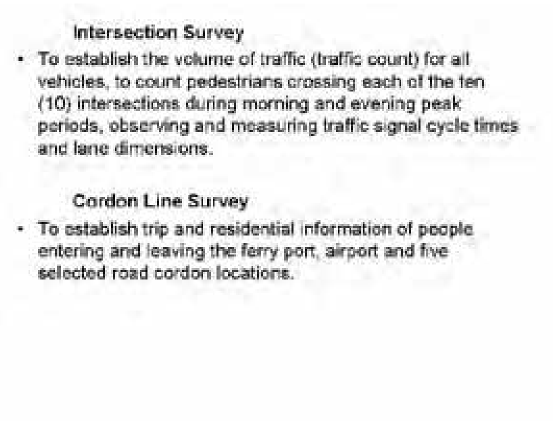


Survey Objectives

- The main objectives of Package II (Traffic and Transport) Survey carried out by NIT were as follows:-

Screen Line Survey

- To establish the volume of traffic (traffic count) and vehicle occupancy (passenger count) for all types of vehicles and at each of selected seventeen (17) locations along imaginary lines which divide the study area into two parts

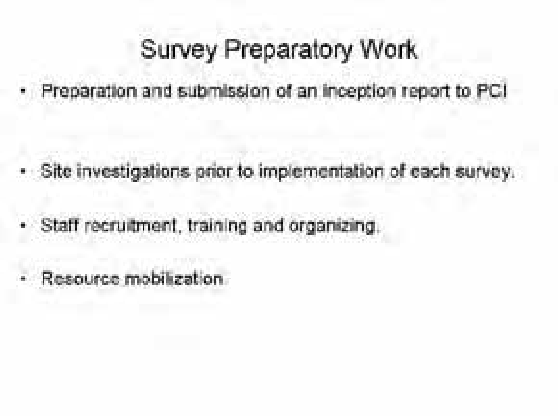


Intersection Survey

- To establish the volume of traffic (traffic count) for all vehicles, to count pedestrians crossing each of the ten (10) intersections during morning and evening peak periods, observing and measuring traffic signal cycle times and lane dimensions.

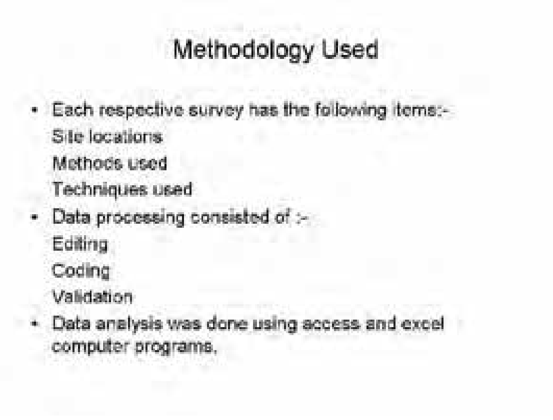
Cordon Line Survey

- To establish trip and residential information of people entering and leaving the ferry port, airport and five selected road cordon locations.



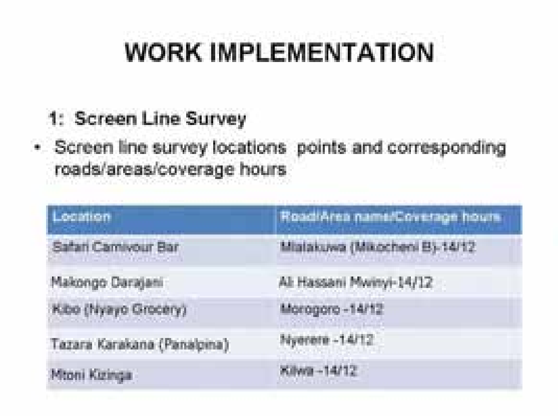
Survey Preparatory Work

- Preparation and submission of an inception report to PCI
- Site investigations prior to implementation of each survey.
- Staff recruitment, training and organizing.
- Resource mobilization



Methodology Used

- Each respective survey has the following items:-
  Site locations
  Methods used
  Techniques used
- Data processing consisted of :-
  Editing
  Coding
  Validation
- Data analysis was done using access and excel computer programs.



WORK IMPLEMENTATION

1: Screen Line Survey

- Screen line survey locations points and corresponding roads/areas/coverage hours

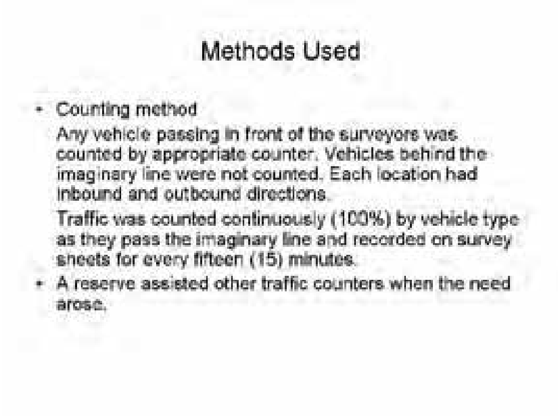
Location	Road/Area name/Coverage hours
Safari Carnivour Bar	Mlalakuwa (Mikocheni B)-14/12
Makongo Darajani	Ali Hassani Mwinyi-14/12
Kibo (Nyayo Grocery)	Morogoro -14/12
Tazara Karakana (Panalpina)	Nyerere -14/12
Mtoni Kizinga	Kilwa -14/12

- Cont

Location Point	Road/Area/Coverage
Salender Bridge	Ali Hassan Mwinyi-24/12
Konoike Jangwani	Morogoro-24/12
Kigogo Sambusa	Kawawa-14/12
Sukita	Mandela-14/12
TBL	Uhuru-14/12
Shoprite-Ilala	Nyerere-24/12
Bridge –BP depot	Bandari-14/12
Ferry Terminal	Kigamboni-14/12
MNIA Terminal I	Old airport-24/12

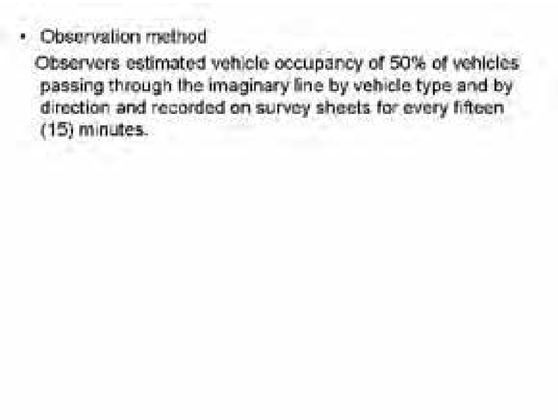
- Cont

Location	Road/Area/coverage hours
MNIA Terminal II	New airport-24/12
Seaport-gate no. 3	Bandari-24/12
Seaport-gate no. 5	Bandari-24/12

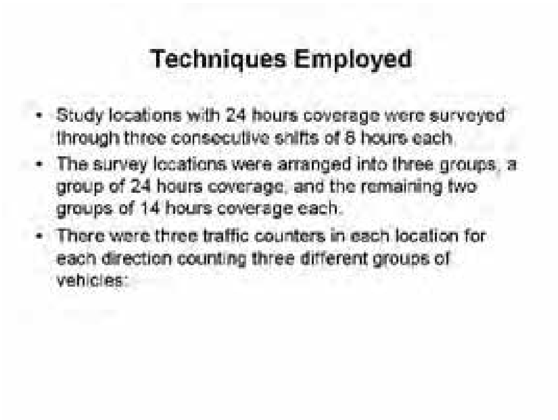


Methods Used

- Counting method
  Any vehicle passing in front of the surveyors was counted by appropriate counter. Vehicles behind the imaginary line were not counted. Each location had inbound and outbound directions.
  Traffic was counted continuously (100%) by vehicle type as they pass the imaginary line and recorded on survey sheets for every fifteen (15) minutes.
- A reserve assisted other traffic counters when the need arose.

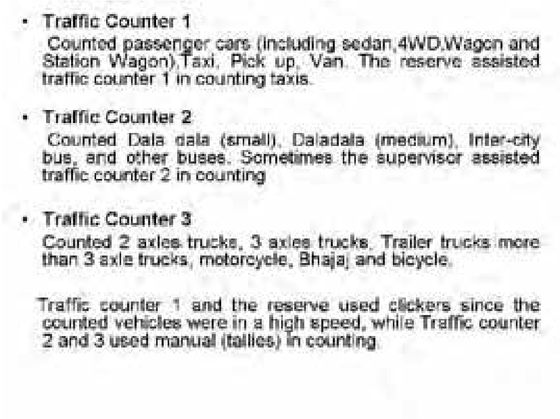


- Observation method
  Observers estimated vehicle occupancy of 50% of vehicles passing through the imaginary line by vehicle type and by direction and recorded on survey sheets for every fifteen (15) minutes.



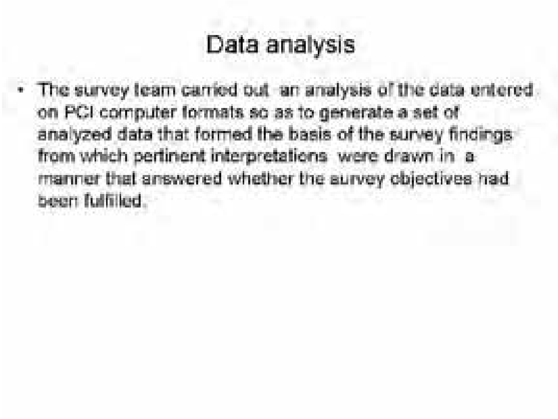
Techniques Employed

- Study locations with 24 hours coverage were surveyed through three consecutive shifts of 8 hours each.
- The survey locations were arranged into three groups, a group of 24 hours coverage, and the remaining two groups of 14 hours coverage each.
- There were three traffic counters in each location for each direction counting three different groups of vehicles:



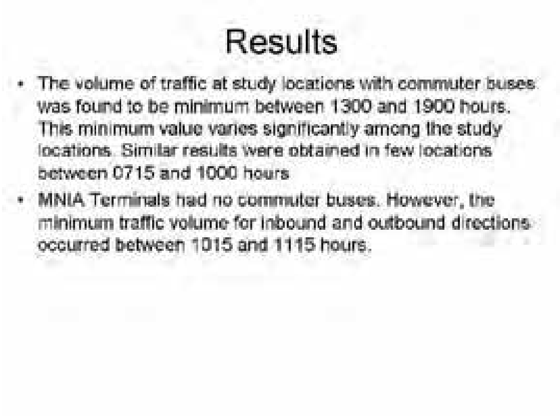
- **Traffic Counter 1**
  Counted passenger cars (including sedan,4WD,Wagon and Station Wagon),Taxi, Pick up, Van. The reserve assisted traffic counter 1 in counting taxis.
- **Traffic Counter 2**
  Counted Dala dala (small), Daladala (medium), Inter-city bus, and other buses. Sometimes the supervisor assisted traffic counter 2 in counting
- **Traffic Counter 3**
  Counted 2 axles trucks, 3 axles trucks, Trailer trucks more than 3 axle trucks, motorcycle, Bhajaj and bicycle.

Traffic counter 1 and the reserve used clickers since the counted vehicles were in a high speed, while Traffic counter 2 and 3 used manual (tallies) in counting.



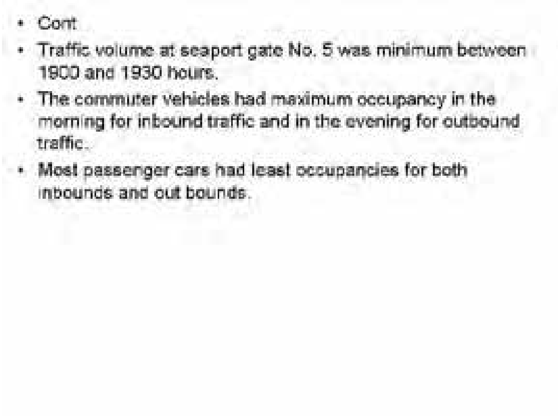
Data analysis

- The survey team carried out an analysis of the data entered on PCI computer formats so as to generate a set of analyzed data that formed the basis of the survey findings from which pertinent interpretations were drawn in a manner that answered whether the survey objectives had been fulfilled.

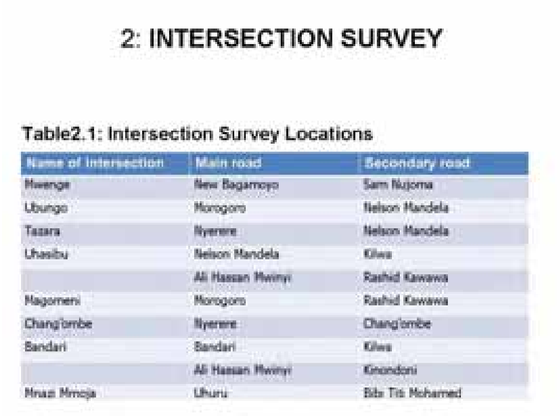


Results

- The volume of traffic at study locations with commuter buses was found to be minimum between 1300 and 1900 hours. This minimum value varies significantly among the study locations. Similar results were obtained in few locations between 0715 and 1000 hours
- MNIA Terminals had no commuter buses. However, the minimum traffic volume for inbound and outbound directions occurred between 1015 and 1115 hours.



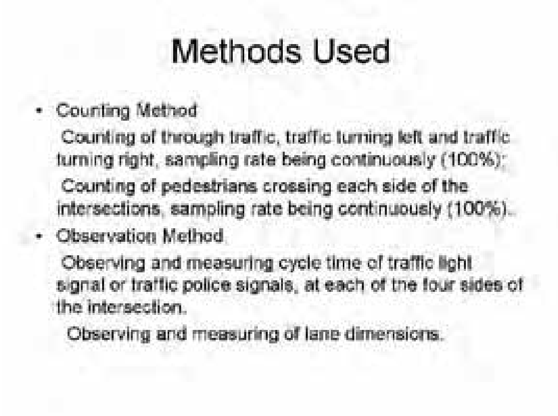
- Cont
- Traffic volume at seaport gate No. 5 was minimum between 1900 and 1930 hours.
- The commuter vehicles had maximum occupancy in the morning for inbound traffic and in the evening for outbound traffic.
- Most passenger cars had least occupancies for both inbounds and out bounds.



2: INTERSECTION SURVEY

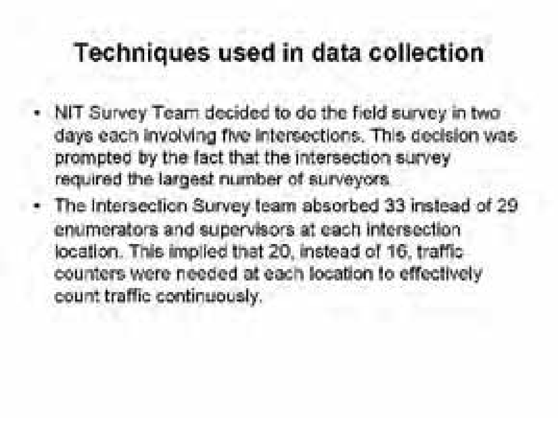
Table2.1: Intersection Survey Locations

Name of Intersection	Main road	Secondary road
Mwenge	New Bagamoyo	Sam Nujoma
Ubungo	Morogoro	Nelson Mandela
Tazara	Nyerere	Nelson Mandela
Uhasibu	Nelson Mandela	Kilwa
	Ali Hassan Mwinyi	Rashid Kawawa
Magomeni	Morogoro	Rashid Kawawa
Chang'ombe	Nyerere	Chang'ombe
Bandari	Bandari	Kilwa
	Ali Hassan Mwinyi	Kinondoni
Mnazi Mmoja	Uhuru	Bibi Titi Mohamed



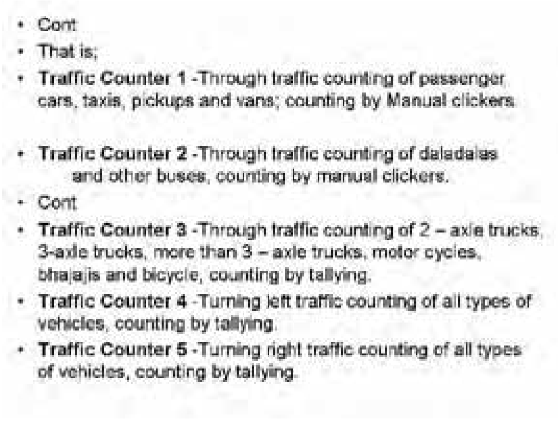
Methods Used

- Counting Method
  Counting of through traffic, traffic turning left and traffic turning right, sampling rate being continuously (100%);
  Counting of pedestrians crossing each side of the intersections, sampling rate being continuously (100%).
- Observation Method
  Observing and measuring cycle time of traffic light signal or traffic police signals, at each of the four sides of the intersection.
  Observing and measuring of lane dimensions.

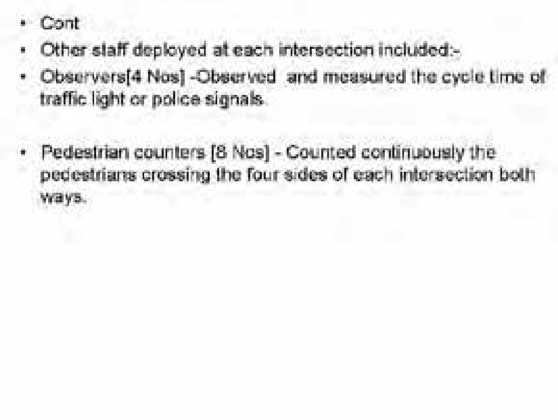


Techniques used in data collection

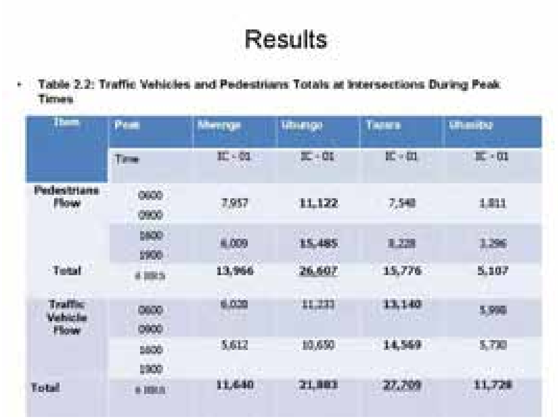
- NIT Survey Team decided to do the field survey in two days each involving five intersections. This decision was prompted by the fact that the intersection survey required the largest number of surveyors.
- The Intersection Survey team absorbed 33 instead of 29 enumerators and supervisors at each intersection location. This implied that 20, instead of 16, traffic counters were needed at each location to effectively count traffic continuously.



- Cont
- That is;
- **Traffic Counter 1** -Through traffic counting of passenger cars, taxis, pickups and vans; counting by Manual clickers.
- **Traffic Counter 2** -Through traffic counting of daladalas and other buses, counting by manual clickers.
- Cont
- **Traffic Counter 3** -Through traffic counting of 2 – axle trucks, 3-axle trucks, more than 3 – axle trucks, motor cycles, bhajajis and bicycle, counting by tallying.
- **Traffic Counter 4** -Turning left traffic counting of all types of vehicles, counting by tallying.
- **Traffic Counter 5** -Turning right traffic counting of all types of vehicles, counting by tallying.



- Cont
- Other staff deployed at each intersection included:-
- Observers[4 Nos] -Observed and measured the cycle time of traffic light or police signals.
- Pedestrian counters [8 Nos] - Counted continuously the pedestrians crossing the four sides of each intersection both ways.



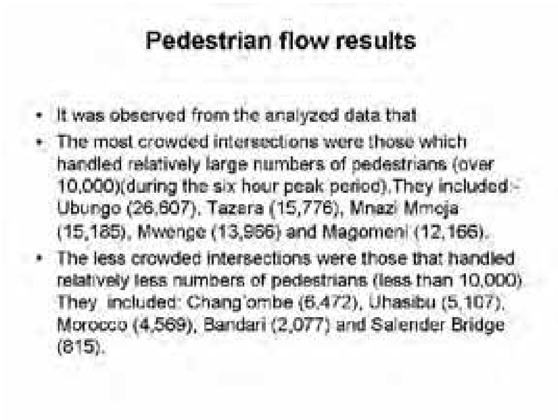
Results

- **Table 2.2: Traffic Vehicles and Pedestrians Totals at Intersections During Peak Times**

Item	Peak	Mwenge	Ubungo	Tazara	Uhasibu
	Time	IC - 01	IC - 01	IC - 01	IC - 01
Pedestrians Flow	0600 0900	7,957	11,122	7,548	1,811
	1600 1900	6,009	15,485	8,228	3,296
Total	6 HRS	**13,966**	**26,607**	**15,776**	**5,107**
Traffic Vehicle Flow	0600 0900	6,028	11,233	13,140	5,998
	1600 1900	5,612	10,650	14,569	5,730
Total	6 HRS	**11,640**	**21,883**	**27,709**	**11,728**

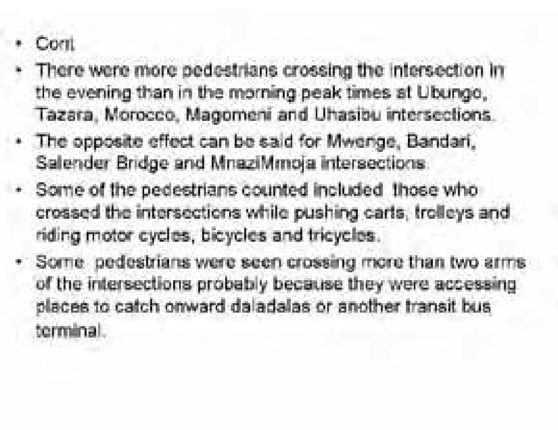
Results Cont

Item	Peak	Morocco	Magomeni	Chang'ombe	Bandari	Salender	Mnazi Mmoja
	Time	IC - 01	IC - 01	IC - 01	IC - 01	IC - 01	IC - 01
Pedestrians Flow	0600 0900	2,171	4,083	2,827	1,085	**461**	7,768
	1600 1900	2,398	8,083	3,645	992	**354**	7,417
Total	6HRS	**4,569**	**12,166**	**6,472**	**2,077**	**815**	**15,185**
Traffic Vehicle Flow	0600 0900	8,364	10,976	10,682	**4,150**	10,475	6,956
	1600 1900	8,994	10,320	13,854	**4,682**	13,260	7,376
Total	6HRS	**17,358**	**21,296**	**24,536**	**8,832**	**23,735**	**14,332**

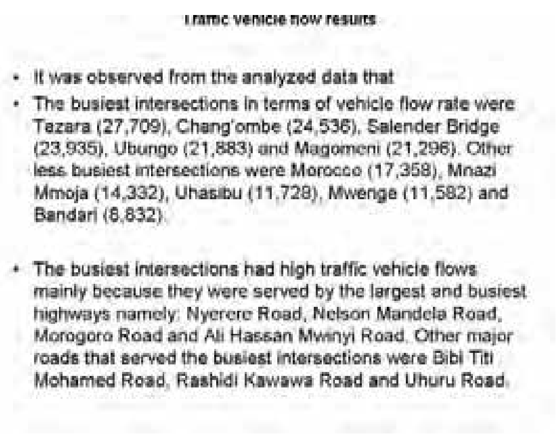


Pedestrian flow results

- It was observed from the analyzed data that
- The most crowded intersections were those which handled relatively large numbers of pedestrians (over 10,000)(during the six hour peak period).They included:- Ubungo (26,607), Tazara (15,776), Mnazi Mmoja (15,185), Mwenge (13,966) and Magomeni (12,166).
- The less crowded intersections were those that handled relatively less numbers of pedestrians (less than 10,000) They included: Chang'ombe (6,472), Uhasibu (5,107), Morocco (4,569), Bandari (2,077) and Salender Bridge (815).

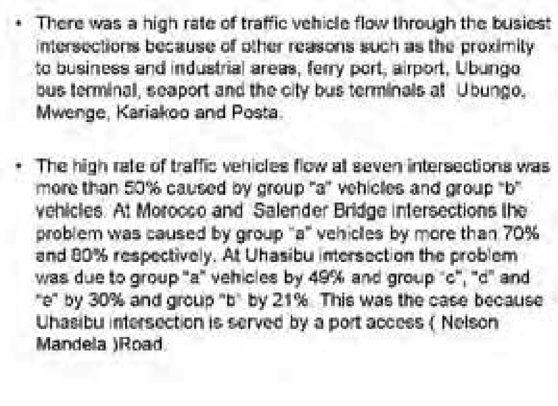


- Cont
- There were more pedestrians crossing the intersection in the evening than in the morning peak times at Ubungo, Tazara, Morocco, Magomeni and Uhasibu intersections.
- The opposite effect can be said for Mwenge, Bandari, Salender Bridge and MnaziMmoja intersections.
- Some of the pedestrians counted included those who crossed the intersections while pushing carts, trolleys and riding motor cycles, bicycles and tricycles.
- Some pedestrians were seen crossing more than two arms of the intersections probably because they were accessing places to catch onward daladalas or another transit bus terminal.

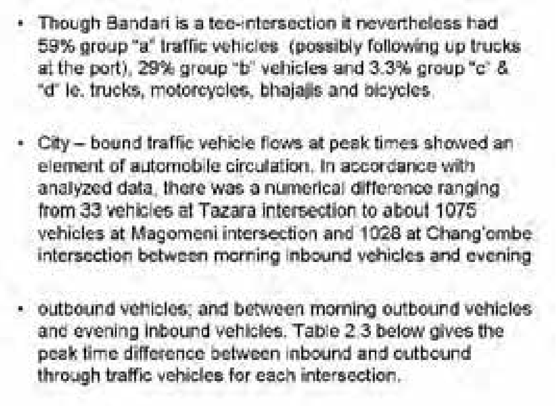


Traffic vehicle flow results

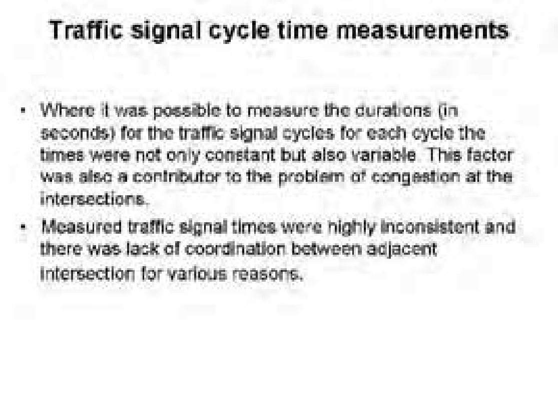
- It was observed from the analyzed data that
- The busiest intersections in terms of vehicle flow rate were Tazara (27,709), Chang'ombe (24,536), Salender Bridge (23,935), Ubungo (21,883) and Magomeni (21,296). Other less busiest intersections were Morocco (17,358), Mnazi Mmoja (14,332), Uhasibu (11,728), Mwenge (11,582) and Bandari (8,832).
- The busiest intersections had high traffic vehicle flows mainly because they were served by the largest and busiest highways namely: Nyerere Road, Nelson Mandela Road, Morogoro Road and Ali Hassan Mwinyi Road. Other major roads that served the busiest intersections were Bibi Titi Mohamed Road, Rashidi Kawawa Road and Uhuru Road.



- There was a high rate of traffic vehicle flow through the busiest intersections because of other reasons such as the proximity to business and industrial areas, ferry port, airport, Ubungo bus terminal, seaport and the city bus terminals at Ubungo, Mwenge, Kariakoo and Posta.
- The high rate of traffic vehicles flow at seven intersections was more than 50% caused by group "a" vehicles and group "b" vehicles. At Morocco and Salender Bridge intersections the problem was caused by group "a" vehicles by more than 70% and 80% respectively. At Uhasibu intersection the problem was due to group "a" vehicles by 49% and group "c", "d" and "e" by 30% and group "b" by 21%. This was the case because Uhasibu intersection is served by a port access (Nelson Mandela)Road.

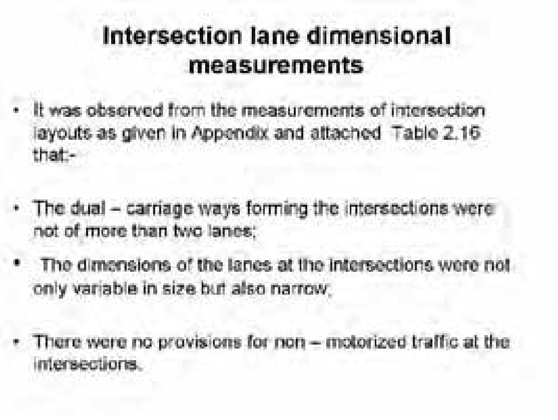


- Though Bandari is a tee-intersection it nevertheless had 59% group "a" traffic vehicles (possibly following up trucks at the port), 29% group "b" vehicles and 3.3% group "c" & "d" ie. trucks, motorcycles, bhajajis and bicycles.
- City – bound traffic vehicle flows at peak times showed an element of automobile circulation. In accordance with analyzed data, there was a numerical difference ranging from 33 vehicles at Tazara intersection to about 1075 vehicles at Magomeni intersection and 1028 at Chang'ombe intersection between morning inbound vehicles and evening
- outbound vehicles; and between morning outbound vehicles and evening inbound vehicles. Table 2.3 below gives the peak time difference between inbound and outbound through traffic vehicles for each intersection.



Traffic signal cycle time measurements

- Where it was possible to measure the durations (in seconds) for the traffic signal cycles for each cycle the times were not only constant but also variable. This factor was also a contributor to the problem of congestion at the intersections.
- Measured traffic signal times were highly inconsistent and there was lack of coordination between adjacent intersection for various reasons.



Intersection lane dimensional measurements

- It was observed from the measurements of intersection layouts as given in Appendix and attached Table 2.16 that:-
- The dual – carriage ways forming the intersections were not of more than two lanes;
- The dimensions of the lanes at the intersections were not only variable in size but also narrow;
- There were no provisions for non – motorized traffic at the intersections.

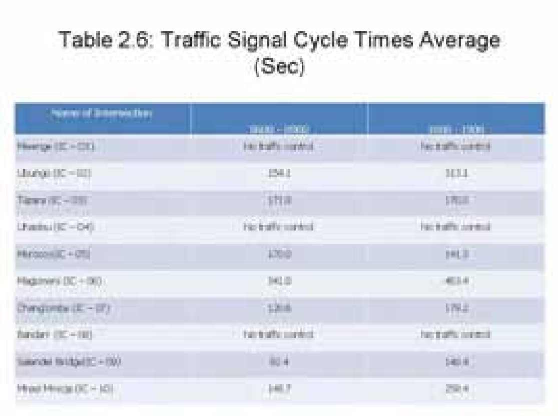
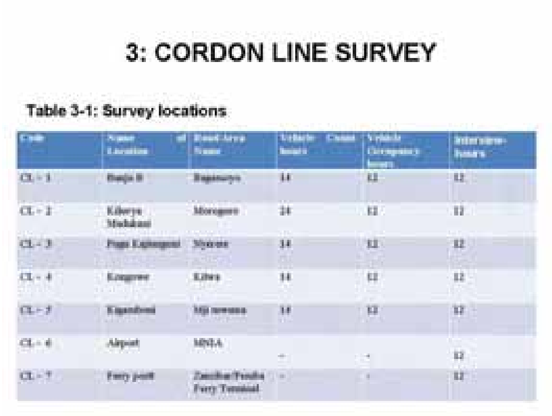


Table 2.6: Traffic Signal Cycle Times Average (Sec)

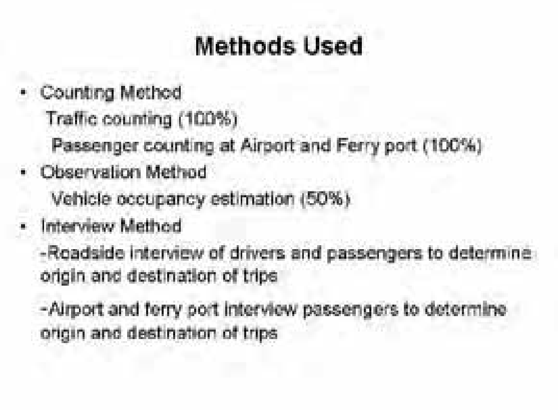
Name of Intersection	[illegible]	[illegible]
Mwenge (IC – 01)	No traffic control	No traffic control
Ubungo (IC – 02)	254.1	313.1
Tabata (IC – 03)	171.0	170.0
Uhasibu (IC – 04)	No traffic control	No traffic control
Morocco(IC – 05)	170.0	141.3
Magomeni (IC – 06)	341.0	403.4
Changombe (IC – 07)	126.6	179.2
Bandari (IC – 08)	No traffic control	No traffic control
Selander Bridge(IC – 09)	92.4	140.6
Mnazi Mmoja (IC – 10)	146.7	259.4



3: CORDON LINE SURVEY

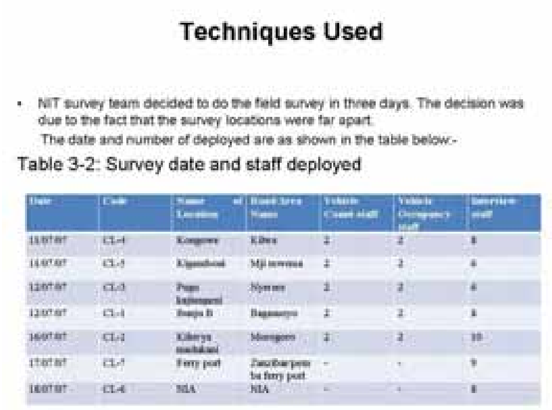
Table 3-1: Survey locations

Code	Name of Location	Road/Area Name	Vehicle Count hours	Vehicle Occupancy hours	Interview hours
CL – 1	Bunju B	Bagamoyo	14	12	12
CL – 2	Kiluvya Madukani	Morogoro	24	12	12
CL – 3	Pugu Kajiungeni	Nyerere	14	12	12
CL – 4	Kongowe	Kilwa	14	12	12
CL – 5	Kigamboni	Mji mwema	14	12	12
CL – 6	Airport	MNIA	-	-	12
CL – 7	Ferry port	Zanzibar/Pemba Ferry Terminal	-	-	12



Methods Used

- Counting Method
  Traffic counting (100%)
  Passenger counting at Airport and Ferry port (100%)
- Observation Method
  Vehicle occupancy estimation (50%)
- Interview Method
  -Roadside interview of drivers and passengers to determine origin and destination of trips
  -Airport and ferry port interview passengers to determine origin and destination of trips



Techniques Used

- NIT survey team decided to do the field survey in three days. The decision was due to the fact that the survey locations were far apart.
  The date and number of deployed are as shown in the table below:-

Table 3-2: Survey date and staff deployed

Date	Code	Name of Location	Road/Area Name	Vehicle Count staff	Vehicle Occupancy staff	Interview staff
13/07/07	CL-4	Kongowe	Kilwa	2	2	8
14/07/07	CL-5	Kigamboni	Mji mwema	2	2	6
12/07/07	CL-3	Pugu kajiungeni	Nyerere	2	2	6
12/07/07	CL-1	Bunju B	Bagamoyo	2	2	8
16/07/07	CL-2	Kiluvya madukani	Morogoro	2	2	10
17/07/07	CL-7	Ferry port	Zanzibar/pemba ferry port	-	-	9
18/07/07	CL-6	NIA	NIA	-	-	8

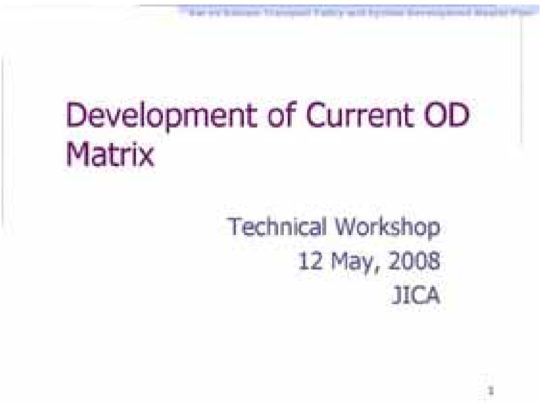
Results

1: Traffic count by location

Location	Inbound	Outboun	Maximum	Minimum
Bunju	1007	1004	469-cars 658-bicycles 334-intercity bus 257-pick up	0-trucks 0-daladalas,bhajaj
Kiluvya	3311	3710	1984-cars 1754-intercity bus	4-bhajaj 15-daladalas
Pugu	476	1502	831-bicycles 329-motorcycles	0-daladalas
Kongowe	1910	1895	1460-bicycles 789-intercity bus 494-passenger cars	6-bhajaj 20-school bus
Mjimwema	890	680	1088-bicycles	0-bhajaj 0-trucks 2-intercity bus

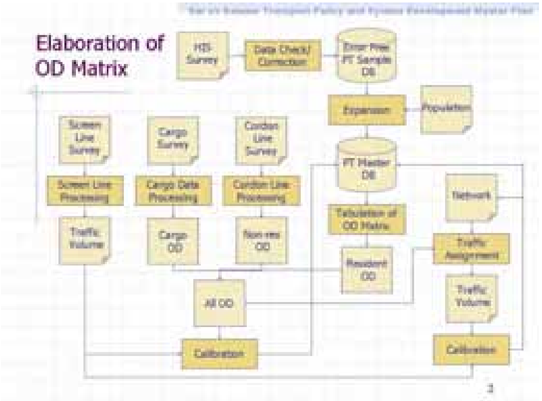
Vehicle occupancy results

6) Development of Current OD Matrix

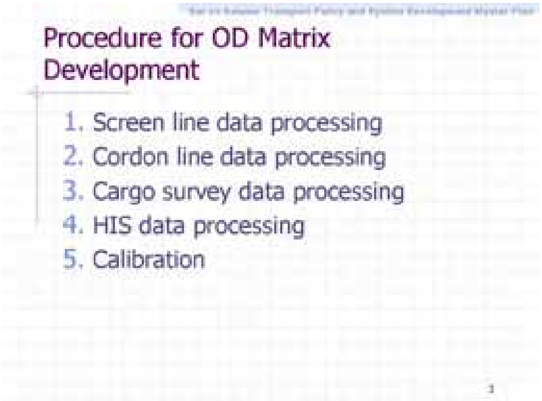


Development of Current OD Matrix

Technical Workshop
12 May, 2008
JICA

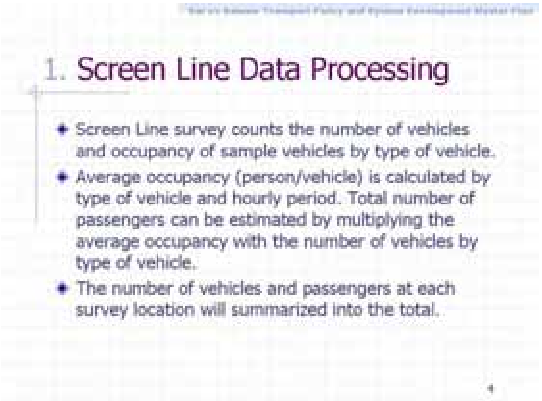


Elaboration of OD Matrix



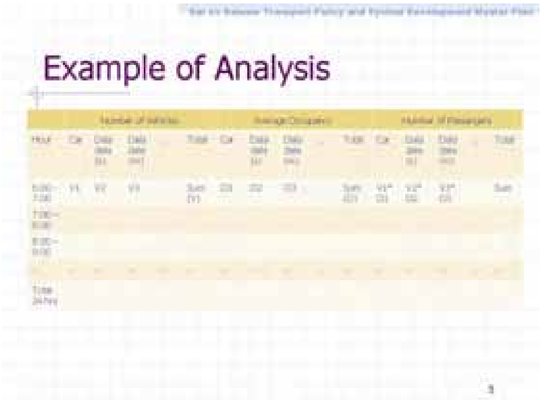
Procedure for OD Matrix Development

1. Screen line data processing
2. Cordon line data processing
3. Cargo survey data processing
4. HIS data processing
5. Calibration



1. Screen Line Data Processing

- Screen Line survey counts the number of vehicles and occupancy of sample vehicles by type of vehicle.
- Average occupancy (person/vehicle) is calculated by type of vehicle and hourly period. Total number of passengers can be estimated by multiplying the average occupancy with the number of vehicles by type of vehicle.
- The number of vehicles and passengers at each survey location will summarized into the total.

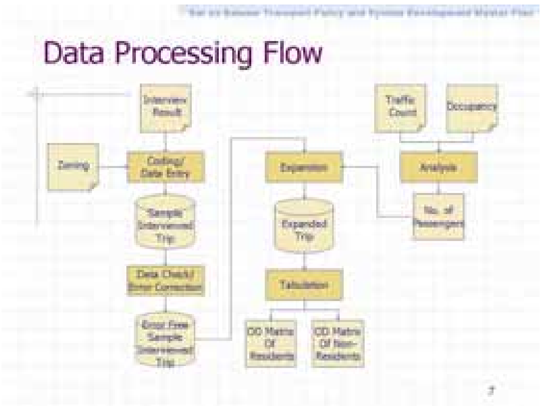


Example of Analysis

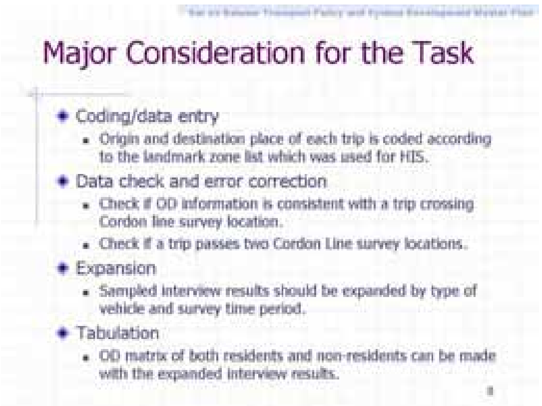
	Number of Vehicles					Average Occupancy					Number of Passengers				
Hour	Car	Dala dala (S)	Dala dala (M)	…	Total	Car	Dala dala (S)	Dala dala (M)	…	Total	Car	Dala dala (S)	Dala dala (M)	…	Total
6:00-7:00	V1	V2	V3		Sum (V)	O1	O2	O3		Sum (O)	V1*O1	V2*O2	V3*O3		Sum
7:00-8:00															
8:00-9:00															
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
Total 24 hrs															

2. Cordon Line Data Processing

- Cordon Line survey counts the number of vehicles and occupancy of sample vehicles by type of vehicle.
- Interview survey with the sampled drivers and passengers is conducted to obtain Origin and Destination of their trips.
- Average occupancy (person/vehicle) is calculated by type of vehicle. Total number of passengers can be estimated by multiplying the average occupancy with the number of vehicles by type of vehicle.
- Sampled trips are expanded into the estimated total number of passengers so that OD matrix passing the Cordon Line boundary can be obtained.



Data Processing Flow



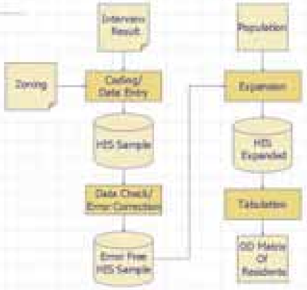
Major Consideration for the Task

- Coding/data entry
  - Origin and destination place of each trip is coded according to the landmark zone list which was used for HIS.
- Data check and error correction
  - Check if OD information is consistent with a trip crossing Cordon line survey location.
  - Check if a trip passes two Cordon Line survey locations.
- Expansion
  - Sampled interview results should be expanded by type of vehicle and survey time period.
- Tabulation
  - OD matrix of both residents and non-residents can be made with the expanded interview results.

3. Cargo Survey Data Processing

- Cargo survey investigates the characteristics of selected major companies that produce cargo vehicle trips daily.
- Interview survey with truck drivers of the companies is conducted to obtain information on trip pattern.
- Sampled trip pattern is expanded to reflect total activity of the company and the pattern will be converted into OD matrix.

4. HIS Data Processing



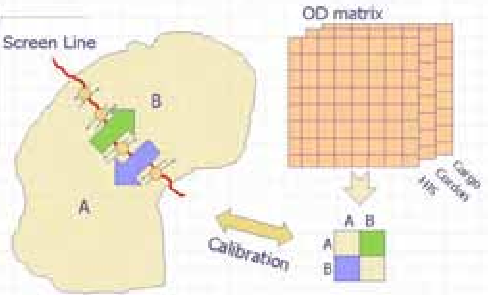
Major Considerations for the Task

- Coding/data entry
  - Origin and destination place of each trip is coded according to a landmark list.
- Data check and error correction
  - Completion
  - Validation
  - Logical check
- Expansion
  - Sampled interview results should be expanded to the population.
  - Bias in the sample distribution should be taken into account for the expansion.
- OD matrix developed with the expanded HIS data is calibrated.

5. Calibration

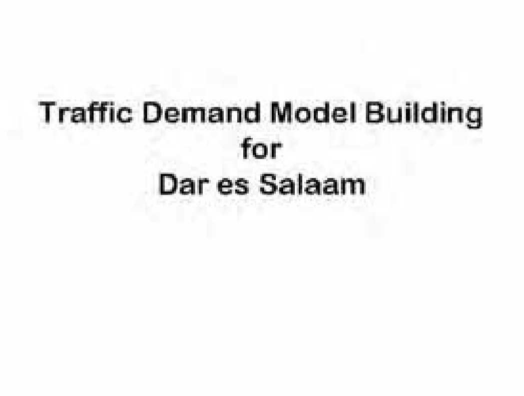
- Calibration of OD matrix
  - An OD matrix of residents, non-residents, and cargo transport are summarized into a matrix in two dimensions according to the parts divided by Screen Line.
  - The number of trips between two zones is compared with the traffic volume of Screen Line survey by type of mode.
- Calibration of traffic volume on links
  - The OD matrix is assigned onto the existing network. The result is compared with the traffic count results.

Calibration of OD Matrix

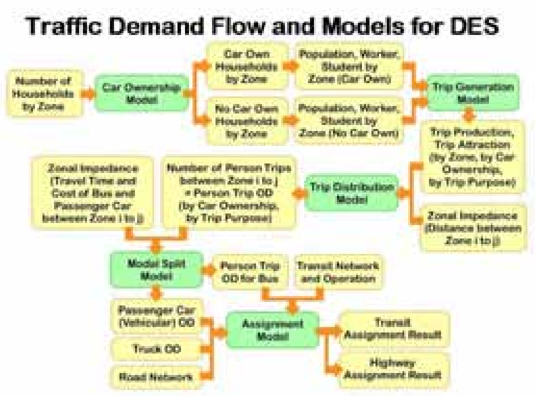


Calibration of Traffic Volume on Links

7) Traffic Demand Model Building for Dar es Salaam

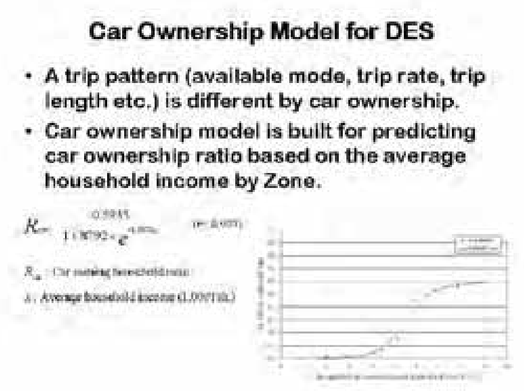


Traffic Demand Model Building
for
Dar es Salaam



Traffic Demand Flow and Models for DES

Number of Households by Zone
Car Ownership Model
Car Own Households by Zone
No Car Own Households by Zone
Population, Worker, Student by Zone (Car Own)
Population, Worker, Student by Zone (No Car Own)
Trip Generation Model
Trip Production, Trip Attraction (by Zone, by Car Ownership, by Trip Purpose)
Zonal Impedance (Distance between Zone i to j)
Trip Distribution Model
Number of Person Trips between Zone i to j = Person Trip OD (by Car Ownership, by Trip Purpose)
Zonal Impedance (Travel Time and Cost of Bus and Passenger Car between Zone i to j)
Modal Split Model
Person Trip OD for Bus
Transit Network and Operation
Passenger Car (Vehicular) OD
Truck OD
Road Network
Assignment Model
Transit Assignment Result
Highway Assignment Result

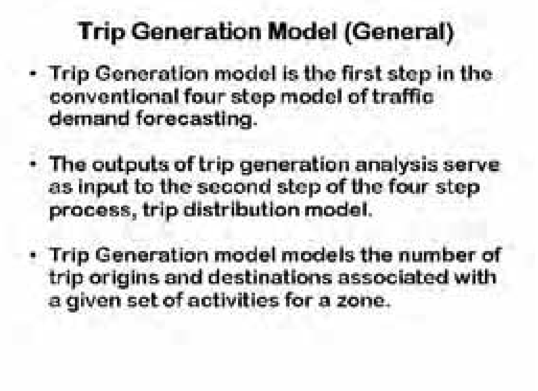


Car Ownership Model for DES

- A trip pattern (available mode, trip rate, trip length etc.) is different by car ownership.
- Car ownership model is built for predicting car ownership ratio based on the average household income by Zone.

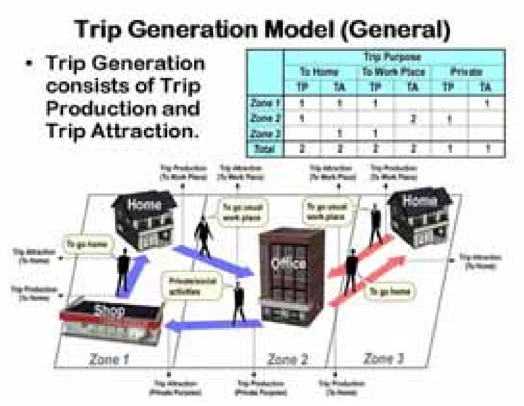
$R_{co} = \frac{0.5945}{1+9792 \cdot e^{[illegible]}}$ [illegible]

R_{co} : Car owning household ratio
x : Average household income (1,000TSh)



Trip Generation Model (General)

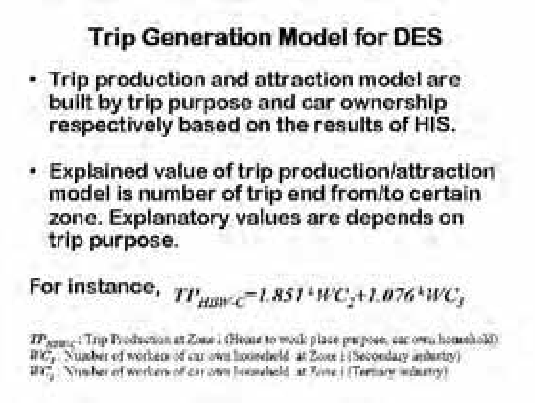
- Trip Generation model is the first step in the conventional four step model of traffic demand forecasting.
- The outputs of trip generation analysis serve as input to the second step of the four step process, trip distribution model.
- Trip Generation model models the number of trip origins and destinations associated with a given set of activities for a zone.



Trip Generation Model (General)

- Trip Generation consists of Trip Production and Trip Attraction.

	Trip Purpose					
	To Home		To Work Place		Private	
	TP	TA	TP	TA	TP	TA
Zone 1	1	1	1			1
Zone 2	1			2	1	
Zone 3		1	1			
Total	2	2	2	2	1	1

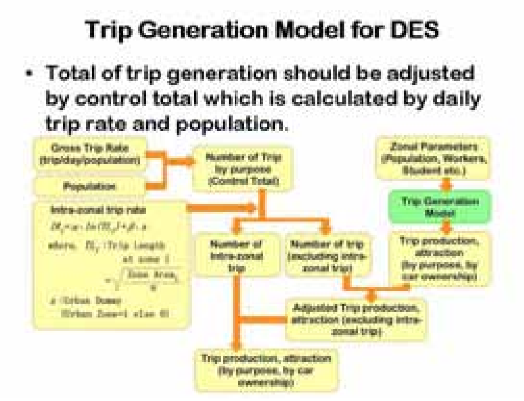


Trip Generation Model for DES

- Trip production and attraction model are built by trip purpose and car ownership respectively based on the results of HIS.
- Explained value of trip production/attraction model is number of trip end from/to certain zone. Explanatory values are depends on trip purpose.

For instance, $TP_{HBW\text{-}C} = 1.851 * WC_2 + 1.076 * WC_3$

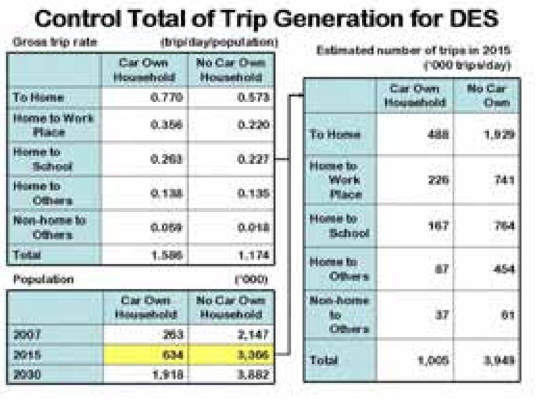
$TP_{HBW\text{-}C}$: Trip Production at Zone i (Home to work place purpose, car own household)
WC_2 : Number of workers of car own household at Zone i (Secondary industry)
WC_3 : Number of workers of car own household at Zone i (Tertiary industry)



Trip Generation Model for DES

- Total of trip generation should be adjusted by control total which is calculated by daily trip rate and population.

Gross Trip Rate (trip/day/population)
Population
Number of Trip by purpose (Control Total)
Intra-zonal trip rate
$IR_i = \alpha \cdot ln(TL_i) + \beta \cdot z$
where, TL_i : Trip Length at zone i $= \sqrt{\frac{Zone\ Area_i}{\pi}}$
z : Urban Dummy (Urban Zone=1 else 0)
Number of intra-zonal trip
Number of trip (excluding intra-zonal trip)
Zonal Parameters (Population, Workers, Student etc.)
Trip Generation Model
Trip production, attraction (by purpose, by car ownership)
Adjusted Trip production, attraction (excluding intra-zonal trip)
Trip production, attraction (by purpose, by car ownership)



Control Total of Trip Generation for DES

Gross trip rate (trip/day/population)

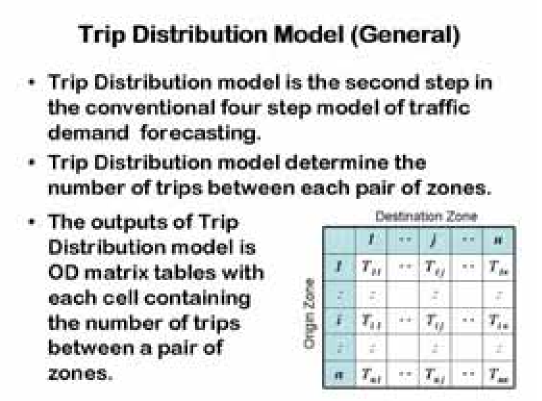
	Car Own Household	No Car Own Household
To Home	0.770	0.573
Home to Work Place	0.356	0.220
Home to School	0.263	0.227
Home to Others	0.138	0.135
Non-home to Others	0.059	0.018
Total	1.586	1.174

Population ('000)

	Car Own Household	No Car Own Household
2007	263	2,147
2015	634	3,366
2030	1,918	3,882

Estimated number of trips in 2015 ('000 trips/day)

	Car Own Household	No Car Own
To Home	488	1,929
Home to Work Place	226	741
Home to School	167	764
Home to Others	87	454
Non-home to Others	37	61
Total	1,005	3,949

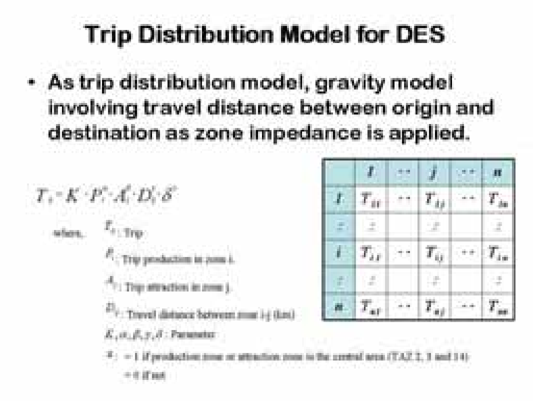


Trip Distribution Model (General)

- Trip Distribution model is the second step in the conventional four step model of traffic demand forecasting.
- Trip Distribution model determine the number of trips between each pair of zones.
- The outputs of Trip Distribution model is OD matrix tables with each cell containing the number of trips between a pair of zones.

Destination Zone

Origin Zone	1	··	j	··	n
1	T_{11}	··	T_{1j}	··	T_{1n}
⋮	⋮		⋮		⋮
i	T_{i1}	··	T_{ij}	··	T_{in}
⋮	⋮		⋮		⋮
n	T_{n1}	··	T_{nj}	··	T_{nn}



Trip Distribution Model for DES

- As trip distribution model, gravity model involving travel distance between origin and destination as zone impedance is applied.

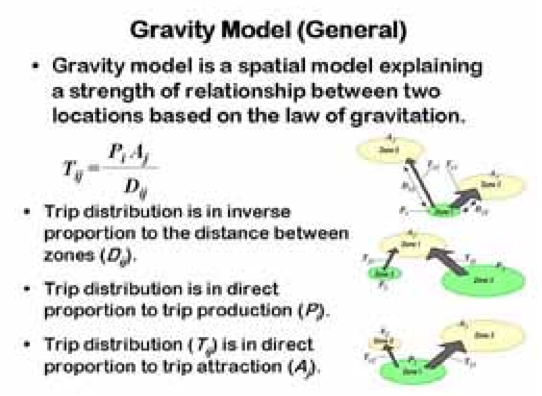
$$T_{ij} = K \cdot P_i^{\alpha} \cdot A_j^{\beta} \cdot D_{ij}^{\gamma} \cdot \delta^{\theta}$$

where, T_{ij} : Trip
P_i : Trip production in zone i.
A_j : Trip attraction in zone j.
D_{ij} : Travel distance between zone i-j (km)
$K, \alpha, \beta, \gamma, \theta$: Parameter
δ : = 1 if production zone or attraction zone is the central area (TAZ 2, 3 and 14)
= 0 if not

	1	··	j	··	n
1	T_{11}	··	T_{1j}	··	T_{1n}
⋮	⋮		⋮		⋮
i	T_{i1}	··	T_{ij}	··	T_{in}
⋮	⋮		⋮		⋮
n	T_{n1}	··	T_{nj}	··	T_{nn}

Desire Line in 2007 existing

Desire Line in 2007 existing

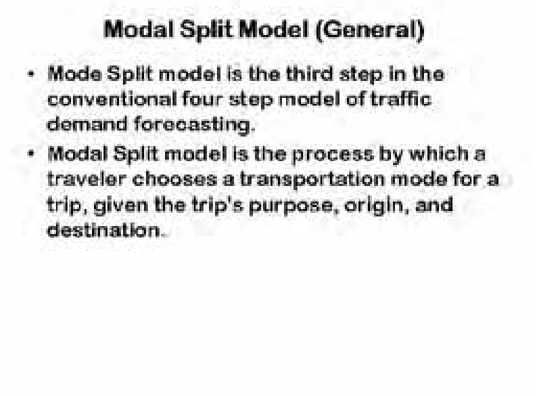


Gravity Model (General)

- Gravity model is a spatial model explaining a strength of relationship between two locations based on the law of gravitation.

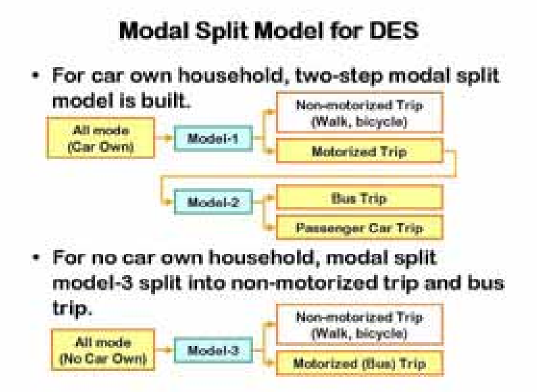
$$T_{ij} = \frac{P_i A_j}{D_{ij}}$$

- Trip distribution is in inverse proportion to the distance between zones (D_{ij}).
- Trip distribution is in direct proportion to trip production (P_i).
- Trip distribution (T_{ij}) is in direct proportion to trip attraction (A_j).



Modal Split Model (General)

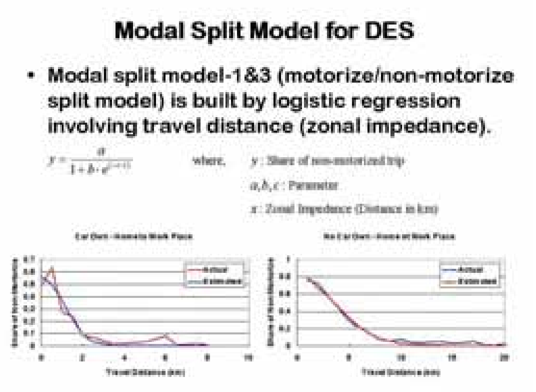
- Mode Split model is the third step in the conventional four step model of traffic demand forecasting.
- Modal Split model is the process by which a traveler chooses a transportation mode for a trip, given the trip's purpose, origin, and destination.



Modal Split Model for DES

- For car own household, two-step modal split model is built.

- For no car own household, modal split model-3 split into non-motorized trip and bus trip.



Modal Split Model for DES

- Modal split model-1&3 (motorize/non-motorize split model) is built by logistic regression involving travel distance (zonal impedance).

$$y = \frac{a}{1 + b \cdot e^{(c \cdot x)}}$$

where, y : Share of non-motorized trip
a, b, c : Parameter
x : Zonal Impedence (Distance in km)

Modal Split Model for DES

- Modal split model-2 (car-bus split model for car own household only) is also built by logistic regression.

$$y = \frac{1}{1+e^{\text{[illegible]}}}$$

where, y : Share of private car use
$\alpha, \beta, \gamma, \delta$: Parameter
$TimeC$: Entire travel time of private car
$TimeB$: Entire travel time of bus
$CostC$: Estimated travel cost of private car based on the travel distance
$CostB$: Bus fare in Tsh

Desire Line in 2007 existing

Desire Line in 2007 existing

Assignment Model (General)

- Trip Assignment model is the fourth step in the conventional four step model of traffic demand forecasting. Trip Assignment model is a process by which trips, defined by time-of-day and mode, are allocated to feasible paths between an origin and a destination in a network.
- The output of Traffic Assignment model is the number of vehicle-trips (or passenger-trips) equilibrated over a network.

Assignment Model for DES

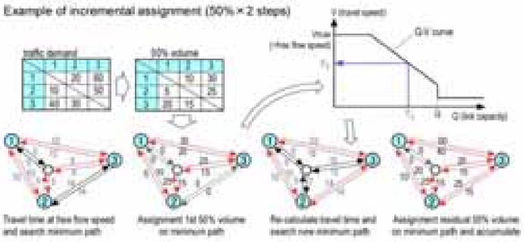
- Assignment model includes transit (bus) assignment and highway assignment.
- JICA STRADA provides two types of highway assignment model, namely, incremental [*1] and user equilibrium [*2] assignment model.

*1:A trip assignment algorithm that loads predetermined increments of a trip table onto the minimum paths, then recalculates minimum paths and assigns the next increment, accumulating increments of traffic at each step.

*2:A user equilibrium trip assignment satisfies Wardrop's 1st Principle that states, for a given origin-destination pair, that travel times are equal on all paths actually utilized, and are less than or equal to the travel time on any other paths.

Incremental Assignment (General)

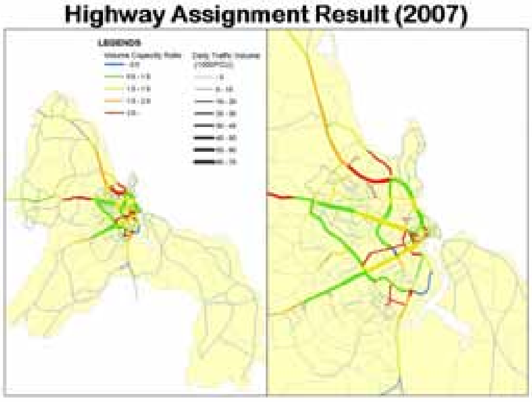
- Link capacity (Q) and designed free flow speed (Vmax) are defined by road class and road condition.

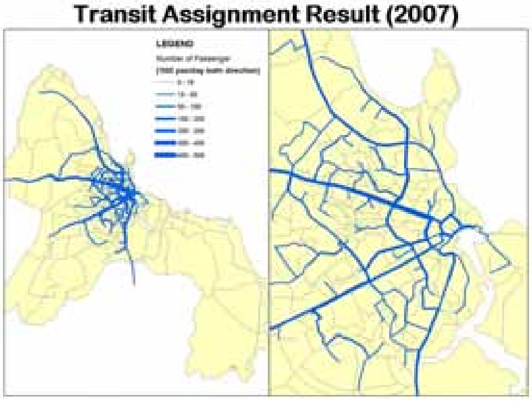


Assignment Model for DES

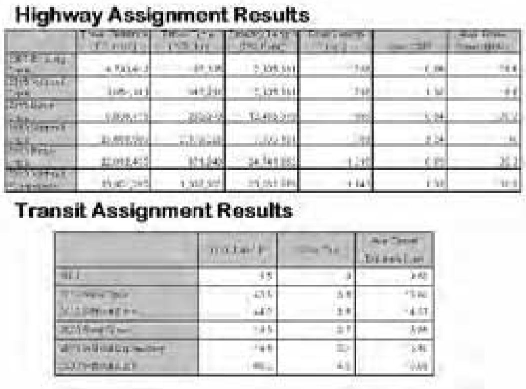
- For highway assignment for DES, 10%×10 steps incremental assignment is applied.
- Transit assignment also 10%×10 steps incremental assignment is applied. In transit assignment, searching minimum path includes not only travel time but bus fare and waiting time.

Highway Assignment Result (2007)





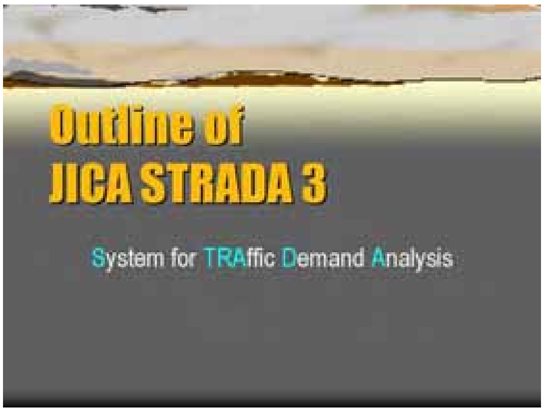
Transit Assignment Result (2007)



Highway Assignment Results

Transit Assignment Results

8) Outline of JICA STRADA



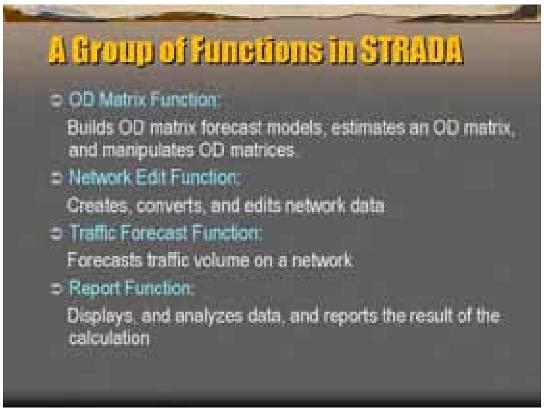
Outline of JICA STRADA 3

System for TRAffic Demand Analysis

Features of STRADA 2

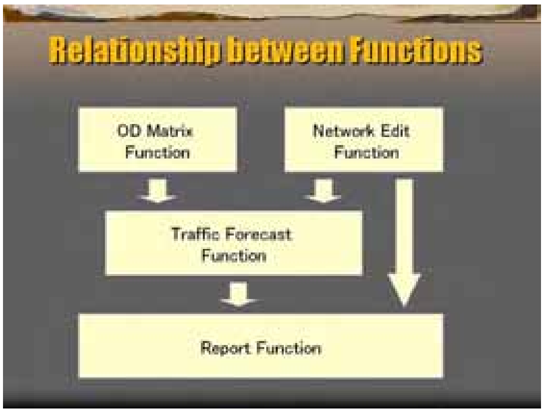
- 17 Functions work on Windows 2000/NT/XP.
- Visual user interface helps you to operate easily.
- Developed based on Four-step Methodology of demand forecast.
- Three type of assignment model are included: Incremental, Equilibrium, and Transit assignment
- High resolution color print is available.
- All data can be exported to a text format file.

Opening Window



A Group of Functions in STRADA

- OD Matrix Function:
  Builds OD matrix forecast models, estimates an OD matrix, and manipulates OD matrices.
- Network Edit Function:
  Creates, converts, and edits network data
- Traffic Forecast Function:
  Forecasts traffic volume on a network
- Report Function:
  Displays, and analyzes data, and reports the result of the calculation



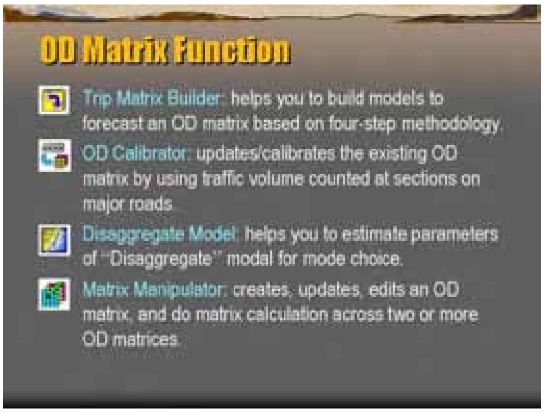
Relationship between Functions

OD Matrix Function

Network Edit Function

Traffic Forecast Function

Report Function



OD Matrix Function

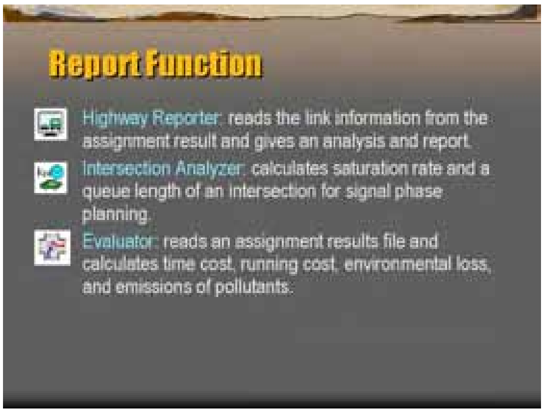
- Trip Matrix Builder: helps you to build models to forecast an OD matrix based on four-step methodology.
- OD Calibrator: updates/calibrates the existing OD matrix by using traffic volume counted at sections on major roads.
- Disaggregate Model: helps you to estimate parameters of "Disaggregate" modal for mode choice.
- Matrix Manipulator: creates, updates, edits an OD matrix, and do matrix calculation across two or more OD matrices.

Network Edit Function

- GIS Converter: performs the file conversion between STRADA and GIS software such as MapInfo and ArcView.
- Network Editor: helps you to build and modify the network data, and set parameters for the assignment models.
- Transit Line Editor: enables you to write and modify a network for public transit lines that are necessary for the transit assignment function.

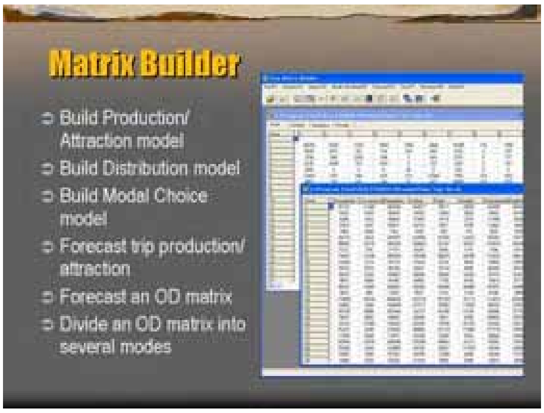
Traffic Forecast Function

- Incremental Assignment
- Equilibrium Assignment
- Stochastic UEA: "Stochastic User Equilibrium Assignment Model"
- Time of Day UEA: "Hourly Equilibrium Assignment Model"
- Combined Model: "Combined Modal Split and Assignment Model"
- Transit Assignment
- LP Assignment: "Linear Programming"



Report Function

- Highway Reporter: reads the link information from the assignment result and gives an analysis and report.
- Intersection Analyzer: calculates saturation rate and a queue length of an intersection for signal phase planning.
- Evaluator: reads an assignment results file and calculates time cost, running cost, environmental loss, and emissions of pollutants.

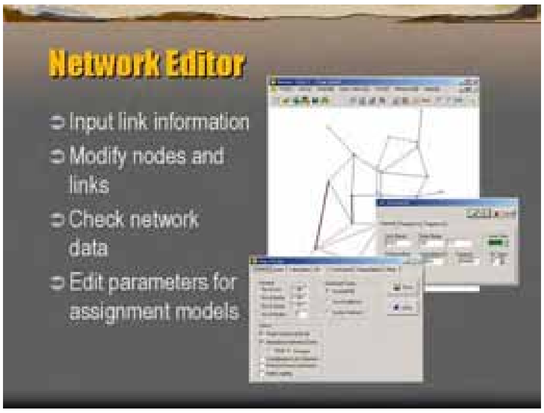


Matrix Builder

- Build Production/ Attraction model
- Build Distribution model
- Build Modal Choice model
- Forecast trip production/ attraction
- Forecast an OD matrix
- Divide an OD matrix into several modes

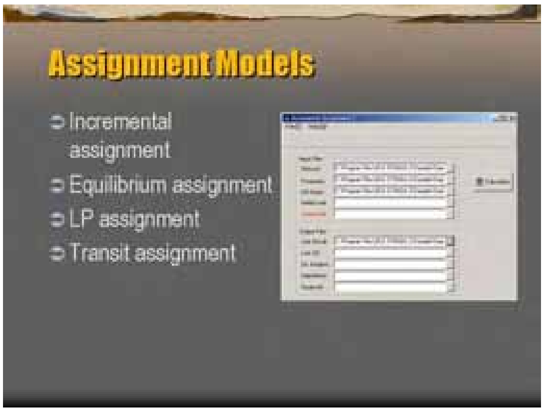
Matrix Manipulator

- Create OD matrix data file
- Update OD matrix data
- Calculate total number of trips
- Control total adjustment



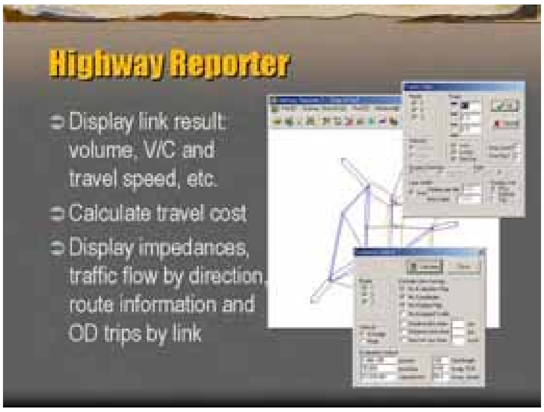
Network Editor

- Input link information
- Modify nodes and links
- Check network data
- Edit parameters for assignment models



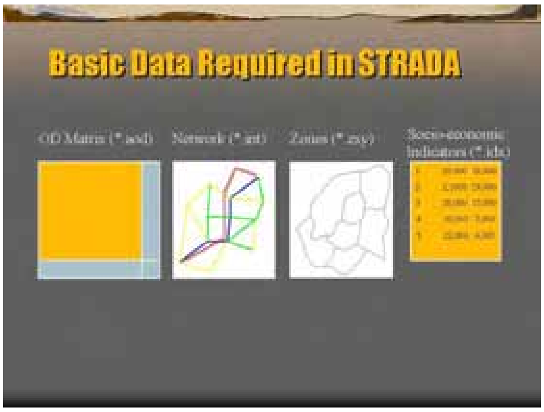
Assignment Models

- Incremental assignment
- Equilibrium assignment
- LP assignment
- Transit assignment

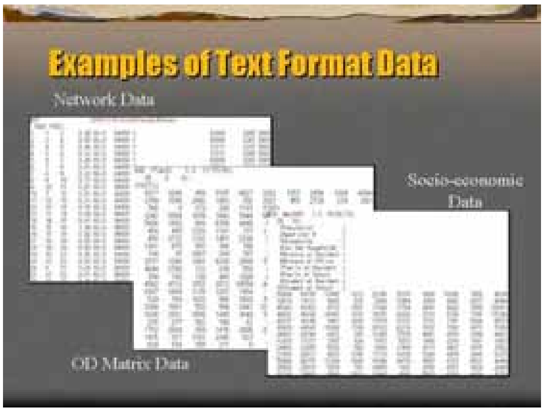


Highway Reporter

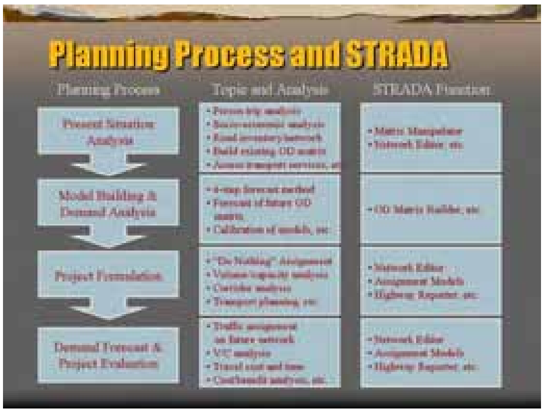
- Display link result: volume, V/C and travel speed, etc.
- Calculate travel cost
- Display impedances, traffic flow by direction, route information and OD trips by link



Basic Data Required in STRADA

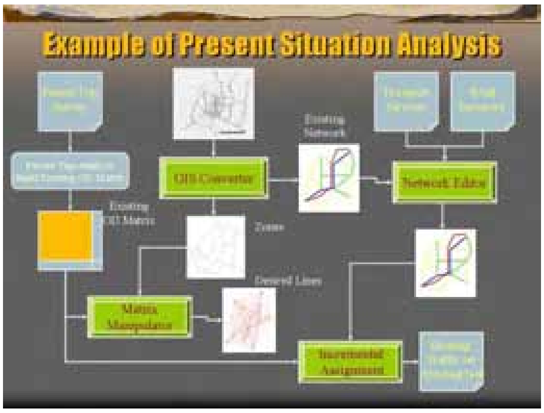


Examples of Text Format Data



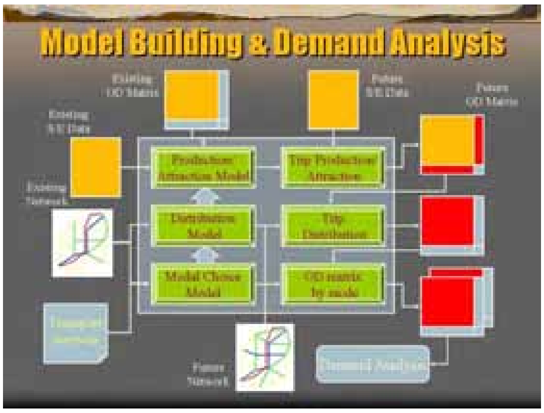
Planning Process and STRADA

Planning Process	Topic and Analysis	STRADA Function
Present Situation Analysis	• Person trip analysis • Socio-economic analysis • Road inventory/network • Build existing OD matrix • Access transport services, etc	• Matrix Manipulator • Network Editor, etc
Model Building & Demand Analysis	• 4-step forecast method • Forecast of future OD matrix • Calibration of models, etc	• OD Matrix Builder, etc
Project Formulation	• "Do Nothing" Assignment • Volume/capacity analysis • Corridor analysis • Transport planning, etc	• Network Editor • Assignment Models • Highway Reporter, etc
Demand Forecast & Project Evaluation	• Traffic assignment on future network • V/C analysis • Travel cost and time • Cost/benefit analysis, etc	• Network Editor • Assignment Models • Highway Reporter, etc



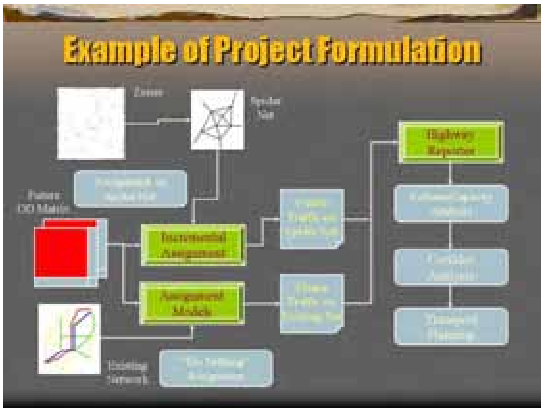
Example of Present Situation Analysis

Person Trip Survey
Person Trip Analysis Build Existing OD Matrix
Existing OD Matrix
GIS Converter
Existing Network
Zones
Desired Lines
Matrix Manipulator
Transport Services
Road Inventory
Network Editor
Incremental Assignment
Existing Traffic on Existing Net



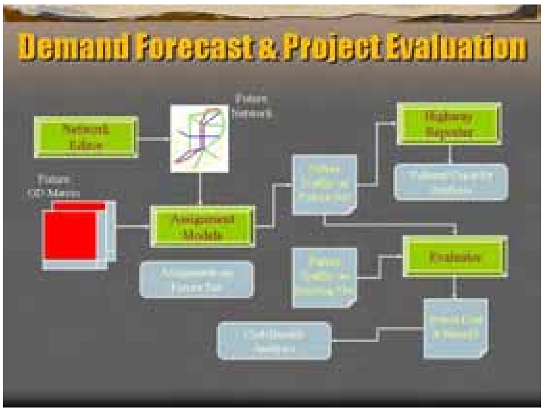
Model Building & Demand Analysis

Existing OD Matrix
Future S/E Data
Future OD Matrix
Existing S/E Data
Existing Network
Production Attraction Model
Trip Production Attraction
Distribution Model
Trip Distribution
Modal Choice Model
OD matrix by mode
Transport Services
Future Network
Demand Analysis



Example of Project Formulation

Zones
Spider Net
Assignment on Spider Net
Future OD Matrix
Incremental Assignment
Assignment Models
Future Traffic on Spider Net
Future Traffic on Existing Net
Highway Reporter
Volume/Capacity Analysis
Corridor Analysis
Transport Planning
Existing Network
"Do Nothing" Assignment



Demand Forecast & Project Evaluation

Network Editor
Future Network
Future OD Matrix
Assignment Models
Assignment on Future Net
Future Traffic on Future Net
Future Traffic on Existing Net
Highway Reporter
Volume/Capacity Analysis
Evaluator
Travel Cost & Benefit
Cost/Benefit Analysis

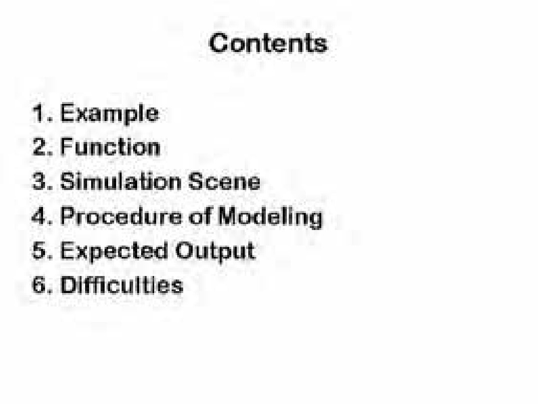
9) Introduction of Microscopic Simulation

Dar es Salaam
Transport Policy and System Development
Master Plan

Introduction of Microscopic Simulation

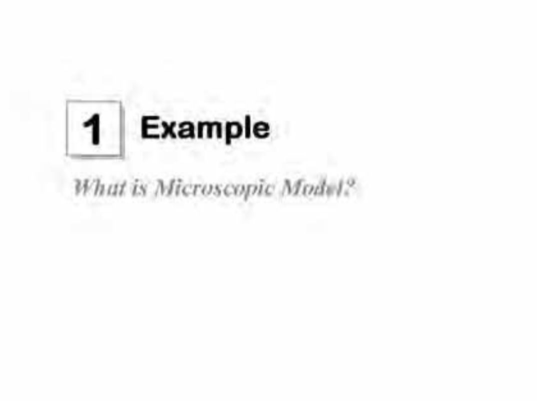
Japan International Cooperation Agency

Pacific Consultants International (PCI)
in association with
Construction Project Consultants Inc. (CPC)



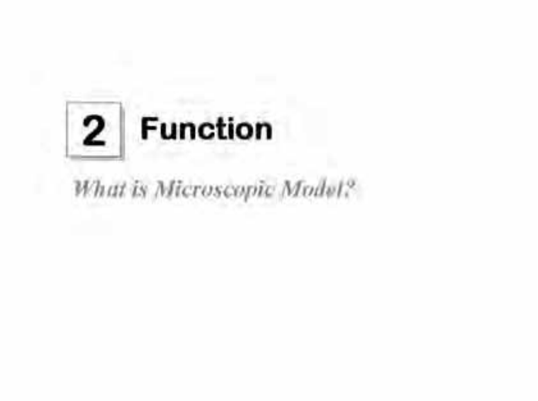
Contents

1. Example
2. Function
3. Simulation Scene
4. Procedure of Modeling
5. Expected Output
6. Difficulties



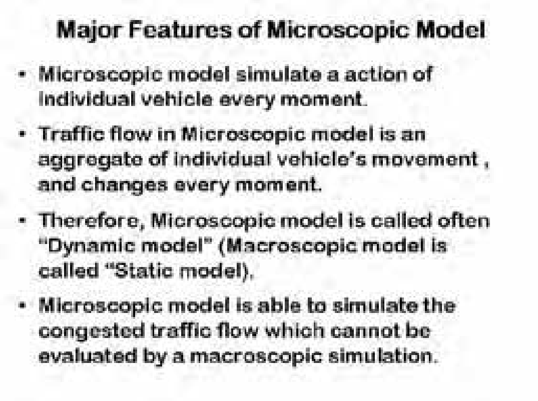
1 Example

What is Microscopic Model?



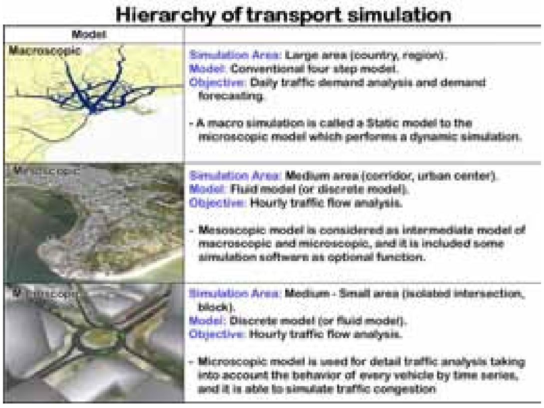
2 Function

What is Microscopic Model?



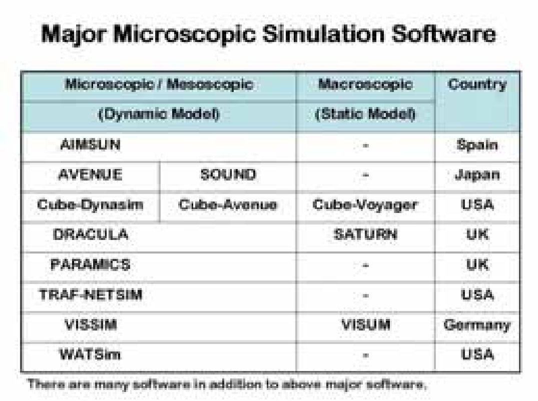
Major Features of Microscopic Model

- Microscopic model simulate a action of individual vehicle every moment.
- Traffic flow in Microscopic model is an aggregate of individual vehicle's movement , and changes every moment.
- Therefore, Microscopic model is called often "Dynamic model" (Macroscopic model is called "Static model).
- Microscopic model is able to simulate the congested traffic flow which cannot be evaluated by a macroscopic simulation.



Hierarchy of transport simulation

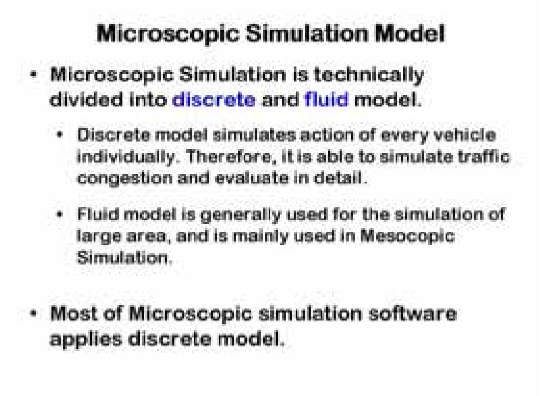
Model	
Macroscopic	Simulation Area: Large area (country, region). Model: Conventional four step model. Objective: Daily traffic demand analysis and demand forecasting. - A macro simulation is called a Static model to the microscopic model which performs a dynamic simulation.
Mesoscopic	Simulation Area: Medium area (corridor, urban center). Model: Fluid model (or discrete model). Objective: Hourly traffic flow analysis. - Mesoscopic model is considered as intermediate model of macroscopic and microscopic, and it is included some simulation software as optional function.
Microscopic	Simulation Area: Medium - Small area (isolated intersection, block). Model: Discrete model (or fluid model). Objective: Hourly traffic flow analysis. - Microscopic model is used for detail traffic analysis taking into account the behavior of every vehicle by time series, and it is able to simulate traffic congestion



Major Microscopic Simulation Software

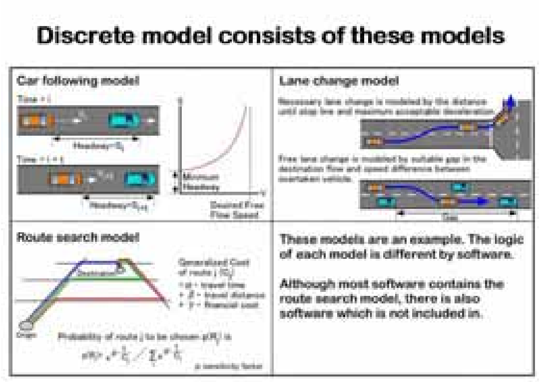
Microscopic / Mesoscopic		Macroscopic	Country
(Dynamic Model)		(Static Model)	
AIMSUN		-	Spain
AVENUE	SOUND	-	Japan
Cube-Dynasim	Cube-Avenue	Cube-Voyager	USA
DRACULA		SATURN	UK
PARAMICS		-	UK
TRAF-NETSIM		-	USA
VISSIM		VISUM	Germany
WATSim		-	USA

There are many software in addition to above major software.



Microscopic Simulation Model

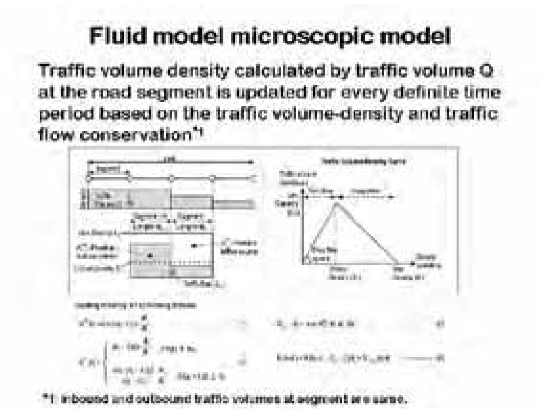
- Microscopic Simulation is technically divided into discrete and fluid model.
  - Discrete model simulates action of every vehicle individually. Therefore, it is able to simulate traffic congestion and evaluate in detail.
  - Fluid model is generally used for the simulation of large area, and is mainly used in Mesocopic Simulation.
- Most of Microscopic simulation software applies discrete model.



Discrete model consists of these models

These models are an example. The logic of each model is different by software.

Although most software contains the route search model, there is also software which is not included in.



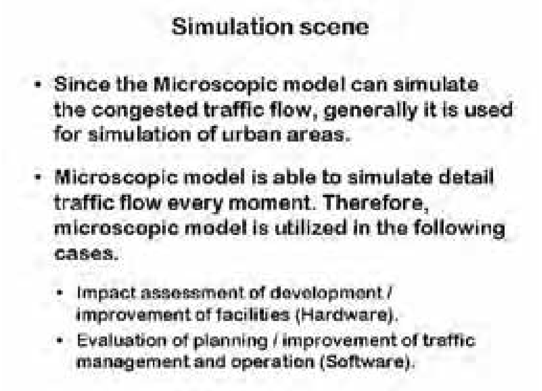
Fluid model microscopic model

Traffic volume density calculated by traffic volume Q at the road segment is updated for every definite time period based on the traffic volume-density and traffic flow conservation*1

*1: inbound and outbound traffic volumes at segment are same.

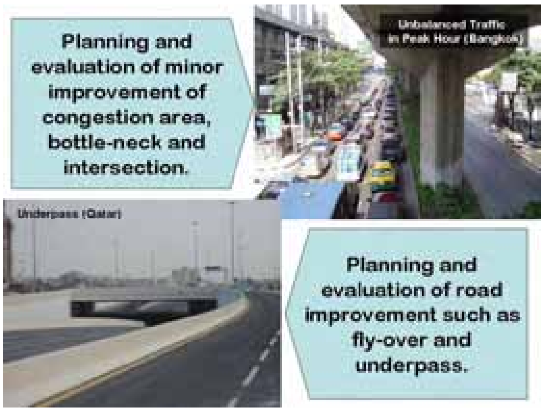
3 Simulation Scene

For what and when does Microscopic model use?



Simulation scene

- Since the Microscopic model can simulate the congested traffic flow, generally it is used for simulation of urban areas.
- Microscopic model is able to simulate detail traffic flow every moment. Therefore, microscopic model is utilized in the following cases.
  - Impact assessment of development / improvement of facilities (Hardware).
  - Evaluation of planning / improvement of traffic management and operation (Software).

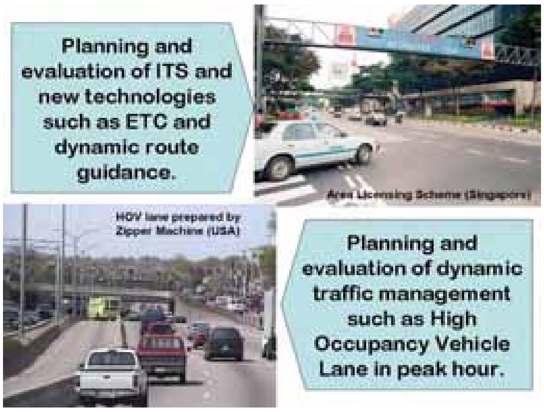


Planning and evaluation of minor improvement of congestion area, bottle-neck and intersection.

Planning and evaluation of road improvement such as fly-over and underpass.

Planning and evaluation of development of urban transport facilities such as bus lane, station plaza.

Planning and evaluation of traffic management for area development, large-scale commercial facility and event.



Planning and evaluation of ITS and new technologies such as ETC and dynamic route guidance.

Planning and evaluation of dynamic traffic management such as High Occupancy Vehicle Lane in peak hour.

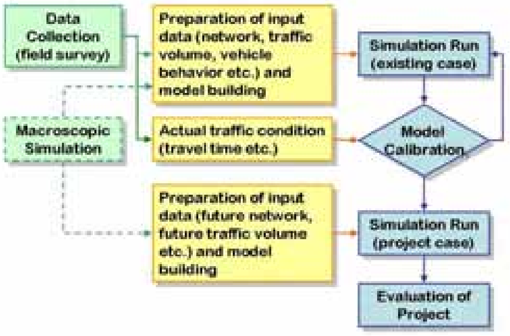
Planning and evaluation of traffic regulations under construction.

Planning and evaluation of traffic control under accident or disaster.

4 Procedure of Modeling

How to build Microscopic Model?

General work flow of Microscopic model



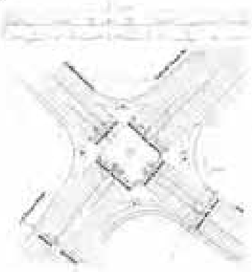
Required input data for Microscopic model

(1) Road network and related facilities,
(2) Traffic volume,
(3) Public transport services, and
(4) Vehicle and Drivers behavior.

(1) Road Network and related Facilities

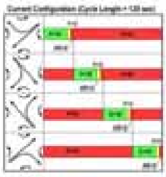
Microscopic model requires detail road facility information (CAD level).

- Geometric design (alignment, gradient)
- Number of lanes, lane width and length,
- Lane function (bus priority lane etc.)
- Turning lane and tapered length, stop-line at intersection



(1) Road Network and related Facilities

- Traffic signal configuration (cycle length, phase, split, offset) ,



- Cycle Length: The time required for one full cycle of signal indications, given in seconds.
- Phase: The portion of the cycle that is devoted to servicing a given traffic movement.
- Split: A percentage of a cycle length or in seconds allocated to each of the various phases in a signal cycle.
- Offset: A gap of the timing of neighboring traffic signal for minimizing time loss of the mainstream direction.

- Regulatory speed, traffic sign (stop/slowly),
- Parking capacity etc.

(2) Traffic Volume

Most of Microscopic model software can accept following two kinds of traffic volume input.

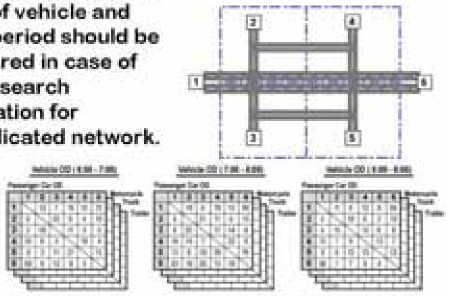
i) O-D matrices by type of vehicle for route search, and

ii) Inbound traffic and turn movement for fixed route simulation.

A suitable method is chosen by the objectives of a simulation.

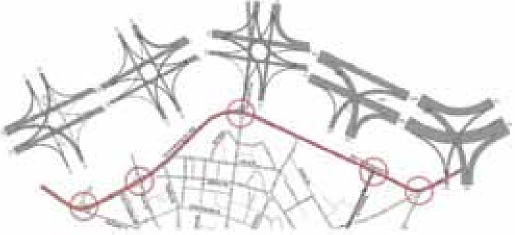
i) Traffic Volume by O-D Matrices

O-D matrices table by type of vehicle and time period should be prepared in case of route search simulation for complicated network.



ii) Traffic Volume by Turning Volume

Turning traffic volume at isolated intersection or all intersections in a corridor by vehicle type and by time period should be prepared for the simulation.



(3) Public Transport Services

- Location of bus stop (including length of bus bay) or station,
- Operation (route, frequency), and
- Dwell time at bus stop / station.

(4) Vehicle and Driver's behavior

Required parameters of driver's behavior

- Desired and distribution of acceleration / deceleration by vehicle type,
- Distribution of desired free-flow speed by vehicle type,
- Vehicle response to yellow signal,
- acceptable gap, and
- minimum headway etc.

Required vehicle specification

- vehicle size
- weight
- fuel consumption
- emission factor

5 Expected Output

What is the result of a Microscopic Model?

Measures of Effectiveness (MOEs) by Microscopic model are;

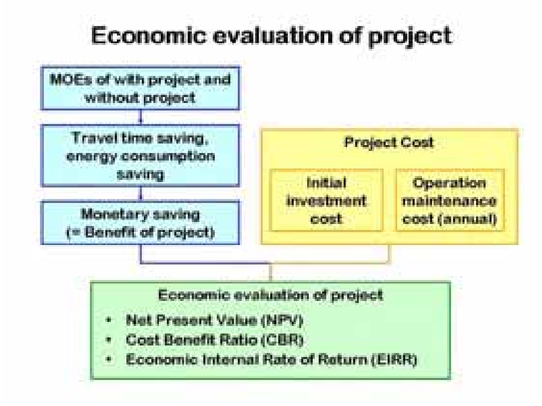
- Vehicle density and traffic volume (by link, lane, time),
- Total and average travel time (by link, lane, time),
- Total and average delay time (by link, lane, time),
- Average and maximum queue length at intersection,
- Average speed (by link, lane, time),
- Number of stops and delay at intersection,
- Travel distance, and
- Fuel consumption and emission etc.

- Identification of location and factor of traffic problem.
- Economic, financial evaluation of project.

Traffic in morning peak is concentrating on the specific streets and direction.

Speed reduction is observed at major intersections and roundabout.

Delay is observed at not only major intersections, roundabout but also near bus stops.



Economic evaluation of project

MOEs of with project and without project

Travel time saving, energy consumption saving

Monetary saving (= Benefit of project)

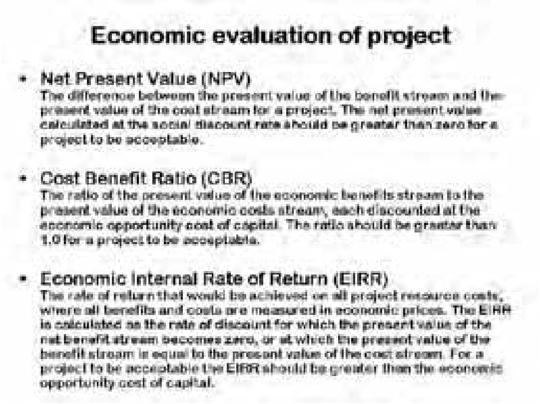
Project Cost

Initial investment cost

Operation maintenance cost (annual)

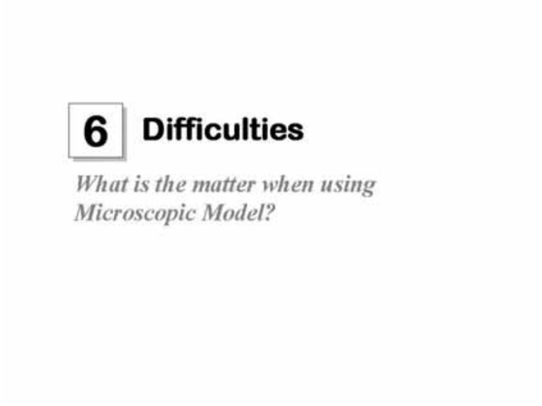
Economic evaluation of project

- Net Present Value (NPV)
- Cost Benefit Ratio (CBR)
- Economic Internal Rate of Return (EIRR)



Economic evaluation of project

- Net Present Value (NPV)
  The difference between the present value of the benefit stream and the present value of the cost stream for a project. The net present value calculated at the social discount rate should be greater than zero for a project to be acceptable.
- Cost Benefit Ratio (CBR)
  The ratio of the present value of the economic benefits stream to the present value of the economic costs stream, each discounted at the economic opportunity cost of capital. The ratio should be greater than 1.0 for a project to be acceptable.
- Economic Internal Rate of Return (EIRR)
  The rate of return that would be achieved on all project resource costs, where all benefits and costs are measured in economic prices. The EIRR is calculated as the rate of discount for which the present value of the net benefit stream becomes zero, or at which the present value of the benefit stream is equal to the present value of the cost stream. For a project to be acceptable the EIRR should be greater than the economic opportunity cost of capital.



6 Difficulties

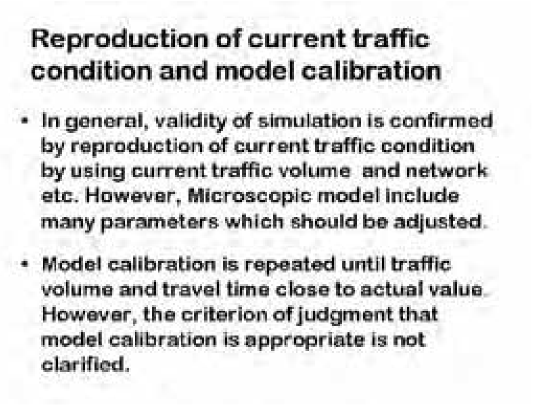
What is the matter when using Microscopic Model?

Data collection

- Microscopic model requires a lot of detail information as input data. In order to collect input data, several field surveys may be required. Periodical O-D based traffic volume, especially, is difficult to collect.

Turning traffic count survey

Roadside interview survey



Reproduction of current traffic condition and model calibration

- In general, validity of simulation is confirmed by reproduction of current traffic condition by using current traffic volume and network etc. However, Microscopic model include many parameters which should be adjusted.
- Model calibration is repeated until traffic volume and travel time close to actual value. However, the criterion of judgment that model calibration is appropriate is not clarified.

Appendix 6 Participants of Technical Workshop

S/NO.	NAME	INSTITUTION	PROFESSION	TELEPHONE NO.	E-MAIL
1.	SADIKI ANTHONY MINJA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0713 25 46 97	sadikiminja@hotmail.com
2.	BECKAM FERDINANDA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0732 52 00 11	fbeckam@yahoo.com
3.	SHEMAHONGE YOSE OZENIEL	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0713 34 46 22 0754 63 46 78	yose.shemahonge@yahoo.com
4.	CHAO BEATRICE	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0717 03 05 01	beatyshewhobringsjoy@yahoo.com
5.	MCHAMI CHARLES	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0787 98 20 01	charson2003@yahoo.com
6.	ERADIUS EDWARD	UNIVERSITY OF DSM	CIVIL & TRANSPORTATION ENGINEER	0784 – 37 94 38	erraddy2001@yahoo.co.uk
7.	WILLIAM, BONIFACE	UNIVERSITY OF DSM	CIVIL & TRANSPORTATION ENGINEER	0754 08 14 72	bwema@lycos.com
8.	IKAABA FRED	UNIVERSITY OF DSM	CIVIL & TRANSPORTATION ENGINEER	0782 41 93 74	ikaaba@yahoo.com
9.	EMMANUEL FUNGO	UNIVERSITY OF DSM	CIVIL & TRANSPORTATION ENGINEER	0713 24 01 23	efungo2001@yahoo.com
10.	AHMED O. WAMALA	UNIVERSITY OF DSM	CIVIL & TRANSPORTATION ENGINEER	0713 68 08 80	adowamala@yahoo.com
11.	MOHAMED B. KUGANDA	DAR AGENCY	CIVIL ENGINEER	0754 81 05 70	kuganda2000@yahoo.com
12.	ALLANUS NUNGU	DIT	CIVIL ENGINEER	0754 48 13 50	nunguallanus@gmx.net
13.	EMMILIANA FELIX	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0757 96 39 56	emmytotie23@yahoo.com
14.	RICHARD G. MAIMU	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0757 14 25 52	obmi20@yahoo.com

S/NO.	NAME	INSTITUTION	PROFESSION	TELEPHONE NO.	E-MAIL
15.	DR. ERICK S. URIO	DIT	CIVIL ENGINEER	0754 27 14 52	erickurio@hotmail.com
16.	MWAKITAPILWA TUMAIN PHILLEMON	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0712 16 31 06	kitapilwa@yahoo.com
17.	MASSAWE ELIZABETH E.	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0713 06 55 52	lzmasawe@ykahoo.com
18.	PIUS VENANCE MATINA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0754 67 41 67	matina75@hotmail.com
19.	VICTOR MGANDA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0713 38 11 13	vmganda1@yahoo.com
20.	MKAGALLA IBRAHIM	UDSM	ENGINEER	0714 94 18 45	
21.	FARAJI KOMBA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0754 82 33 73	kombafaraji@yahoo.com
22.	OSWALD KESSY	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0717 74 77 74	oswaldkessy@yahoo.com
23.	AHMAD RASHID	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0756 05 33 61	chamwinecho@yahoo.com chamwinecho@yahoo.com
24.	MULUNGU, GRACE	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0754 26 32 03	mulunguG1974@yahoo.com
25.	ANDREW MAGOMBANA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0787 00 34 50	amagombana@gmail.com
26.	SEVERINA MGAYA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0773 42 74 99	Mgaya2008@yahoo.com
27.	HADIJA JOSEPH	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0755 23 53 48	salollen@yahoo.com
28.	R.F. LYIMO	NIT	LECTURER	0754 02 66 98	
29.	A.L.D. MKUNZA	NIT	LECTURER	0714 77 79 92	amkunza@yahoo.co.uk

S/NO.	NAME	INSTITUTION	PROFESSION	TELEPHONE NO.	E-MAIL
30.	CHARD D.S. WEMBA	NIT	LECTURER	0787 36 96 80	namajoni@yahoo.com
31.	MRS. VICTORIA CHUMA	ARDHI UNIVERSITY	LECTURER	0786 79 98 34	victoriamwakalinga@aru.ac.tz
32.	EMMANUEL MCHOME	ARDHI UNIVERSITY	LECTURER	0754 39 38 91 0783 99 55 84	emchome@yahoo.com
33.	GEORGE MBYOPYO	ARDHI UNIVERSITY	URBAN & REGIONAL PLANNER	0754 69 28 42	mbyopyo@aru.ac.tz
34.	ENG. J. KATALA	DART	ENGINEER	0715 30 00 78	
35.	ENG. H. KABANDA	TEMEKE MUNICIPAL COUNCIL	CIVIL ENGINEER	0784 44 98 55	enghkabanda@yahoo.com
36.	M. KUGANDA	DART	ENGINEER	0754 81 05 70	kuganda@2000yahoo.com
37.	SWALEH NYENYE	DCC	CIVIL ENGINEER	0754 62 46 70	snyenye@yahoo.com
38.	AMANIEL KISIMBO	NIT	LECTURER	0784 41 87 10	kisimbo@yahoo.com
39.	SAID TAMBA	NIT	LECTURER	0754 37 37 40	tamba1tz@yahoo.com
40.	ELIFADHILI MGONJA	NIT	LECTURER	0754 27 87 20	elimgonja@yahoo.com
41.	BATHOLOMEW MARCEL	NIT	LECTURER	0713 05 68 59	Batholomew@yahoo.co
42.	AHMAD SHARIFF	NIT	LECTURER	0754 57 14 92	
43.	GILLIARD NGEWE	NIT	LECTURER	0784 60 88 13	ngewe@yahoo.co.uk
44.	HOSEA MABALWE	NIT	LECTURER	0754 76 66 61	mabalwe@yahoo.com
45.	AMON MWASANDUBE	NIT	LECTURER	0754 28 33 49	
46.	SAIMON LUSHAKUZI	NIT	LECTURER	0754 37 35 18	simonlushakuzi@yahoo.com
47.	SALVIUS CHUNGU	NIT	LECTURER	0754 78 39 99	
48.	MILLIAN CHARLES	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT		
49.	ALFRED KAMWELA	NIT	LOGISTICS & TRANSPORT MANAGEMENT STUDENT	0762 82 89 63	
50.	MRS. JANE KANUTI	DIT	LECTURER	0713 62 72 35	janekanuti@yahoo.com
51.	MWANDAMBO L.A.	UDSM	CIVIL/TRANSPORT	0715 39 35 77	
52.	ESTOMIHI N. MASAOE	UDSM CoET	CIVIL/TRANSPORT ENGINEER	2410128	emasaoe@ce.udsm.ac.tz