Realizarea unui sistem de transport eficient, integrat, durabil și sigur, care să promoveze dezvoltarea economică, socială și teritorială și care să asigure o bună calitate a vieții

Planul de mobilitate urbană durabilă 2016-2030

Regiunea București – Ilfov

Raport program de instruire utilizare Model Cerere de Transport

- Transportul în comun
- Transportul nemotorizat
- Intermodalitate
- Siguranța rutieră
- Transportul rutier (în mișcare și staționar)
- Logistica urbana
- Gestionarea mobilității
- Sisteme de transport inteligente

AVENSA

ROM
רום הנדסת תחבורה בע"מ
Transportation Engineering Ltd.

Modelul Cererii de Transport –Prima sesiune de instruire: Notiuni de baza MCT si metode de planificare a tranporturilor

Aspecte Generale Program Instruire

Saptamana 1 – 26-29/10 – Inspre MCT Bucuresti – Issa & Ofir				
	Dimineata	Dupa-masa	Trainer	
26/10	MCT (Ofir)	TDM Bucuresti 4-step (Issa)	Issa & Ofir	
27/10	Input MCT (Ofir)	Exemple de bune practici Telaviv(Issa)	Issa & Ofir	
29/10	Rulare model PMUD Bucuresti A-Z	Rulare model PMUD Bucuresti model A-Z	Issa	
Saptamana 2 – 24-26 November –Eyal				
24/11	GIS general (Eyal)	Coduri – T-Cad (Eyal)	Eyal	
25/11	Studii (Eyal)	Scenarii aplicate MCT (Eyal)	Eyal	
26/11	Imbunatatire MCT (Eyal)	Extragere informatii MCT (Eyal)	Eyal	

*MCT= Modelul Cererii de Transport

Pregatire detaliata pentru prima sesiune: 26-29/10/2015

Pregatire (ROM) - 6-7 licente de TransCad (ROM), proiector, materiale suport ,prezentari Power Point,

Pregatire (BERD) – Lansare invitatii

Pregatire (Universitate) –Un laborator de informatica cu 10 calculatoare si proiector conectat la calculatorul de prezentare

	Sesiune	**Scopul sesiunii**	**Trainer**	**Metoda**	**Suport**
26/10 Luni	1: 10:00-13:00	Planificarea transporturilor, politici si MCT	Ofir	Presentation	PPT
	2: 14:30-17:30	Aspecte teoretice despre modelele in 4 pasi	Issa	Prezentare si exemple model Bucuresti	PPT + IR2
27/10 Marti	1: 10:00-13:00	Bucuresti-Ilfov MCT 4 PASI	Ofir	Exemplificare cu modelul real Telaviv	Raport sondaje
	2: 14:30-17:30	Exemple de bune practici ale MCT-urilor	Issa	Model in timp real Telaviv	Da
29/10 Joi	1: 09:30-12:00	Rulare MCT A-Z	Issa	Practica	Nu
	2: 13:00-15:00	Rulare MCT A-Z	Issa	Practica	Da

Listă participanți program de instruire MCT

SAPTAMANA 1

Nr. Crt.	Nume	Institutie	Contact
1		CJ Ilfov	
2		AECOM	
3		AECOM	
4		AVENSA	
5		AVENSA	
6		Primaria Buftea	
7		METROREX	
8		CJ Ilfov	
9		UPB - Fac. Transporturi Dep. Transporturi, trafic și logistică	
10		UPB - Fac. Transporturi Dep. Transporturi, trafic și logistică	
11		METROREX	
12		UAUIM - PUG	
13		AVENSA	
14		AVENSA	
		SAPTAMANA 2	
1		METROREX SA	
2		AECOM Ingineria	
3		UPB - Fac. Transporturi Dep. Transporturi, trafic și logistică	
4		UAIM	
5		CJ Ilfov	
6		Primaria Buftea	
7		RATB	
8		UAUIM - PUG	
9		UPB - Fac. Transporturi Dep. Transporturi, trafic și logistică	

Preparing SUMP for Bucharest and Ilfov

SUMP Conference 2015

Why do Bucharest-Ilfov Need a SUMP?

It is the most congested city in Europe in 2014

According to TomTom worldwide traffic survey

Second to Moscow and Istanbul but much before Warsaw, Rome, Paris or Stockholm), with evening congestion worse than morning, especially Friday)

It is among top 20 cities worldwide recorded sharp decline in population from 1990

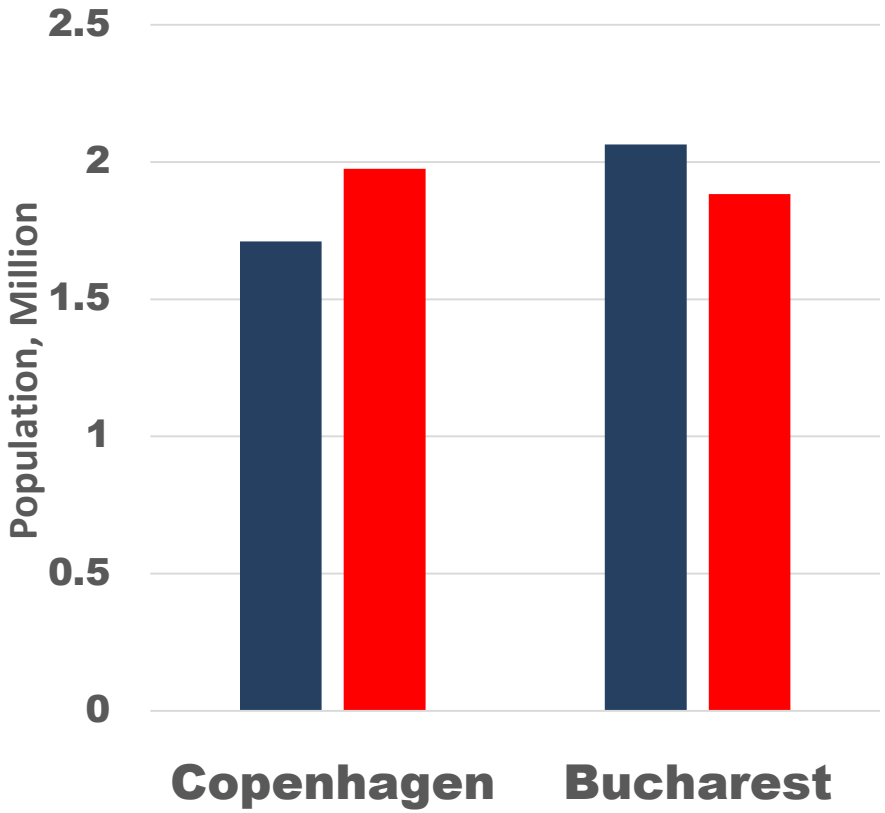
According to UN study covering more than 600 cities worldwide

Based on current trends, expected population in 2025 will be ~4% less than in 1990

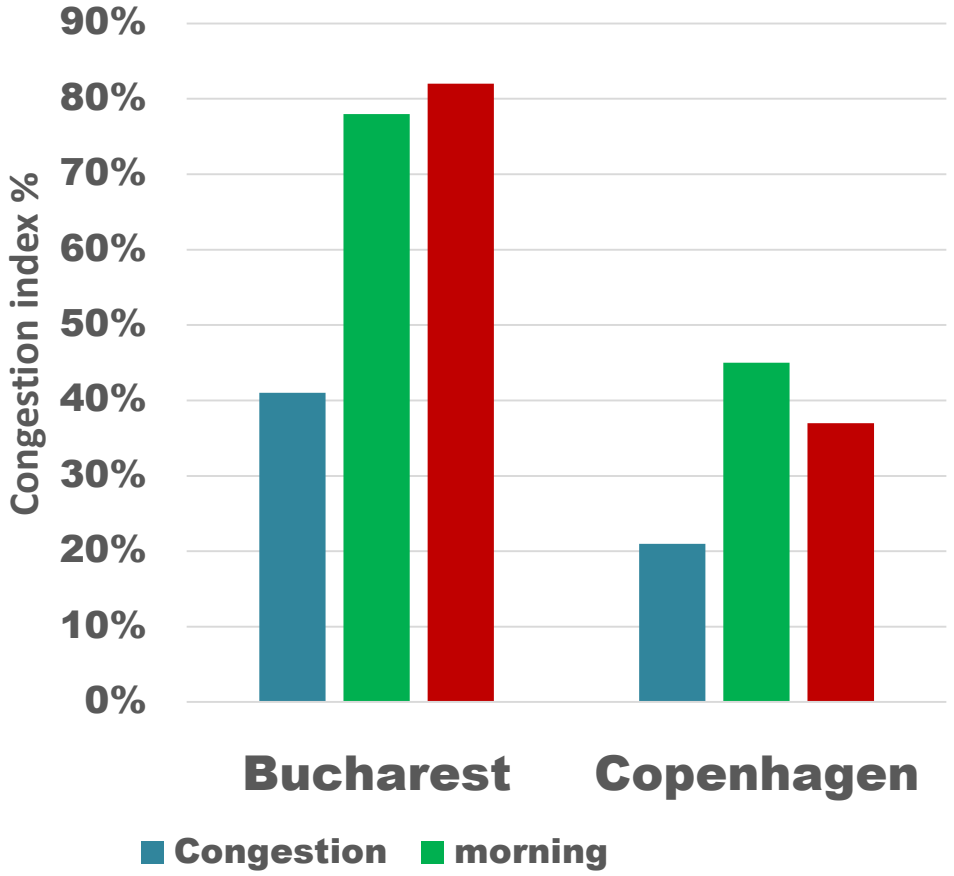
Without SUMP traffic conditions will only get worse (Bucharest → Moscow)
SUMP can improve traffic and has a potential to attract much more young people to live and work permanently in Bucharest

Bucharest vs. Copenhagen

Population 1990-2014

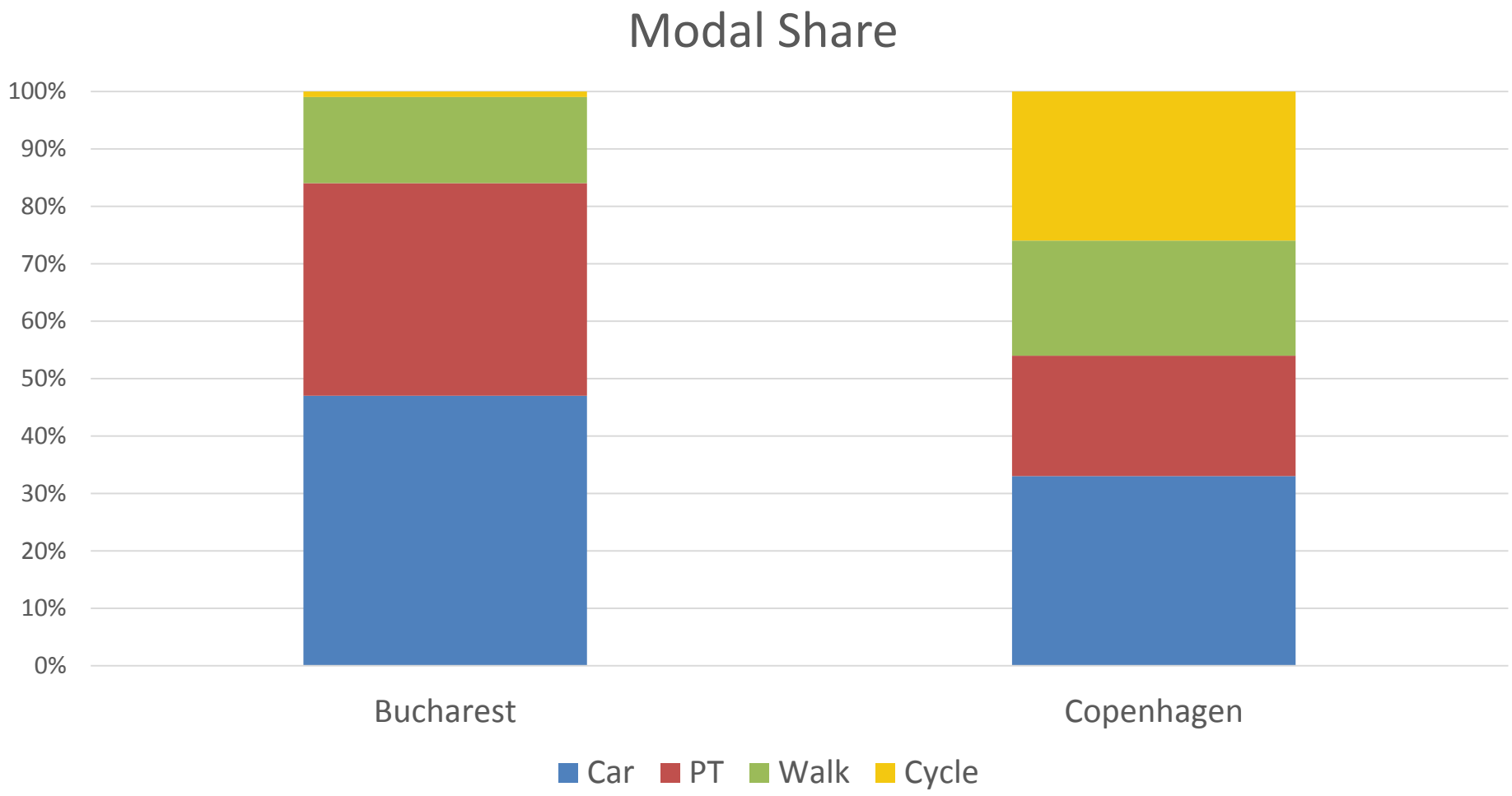


Congestion index 2014



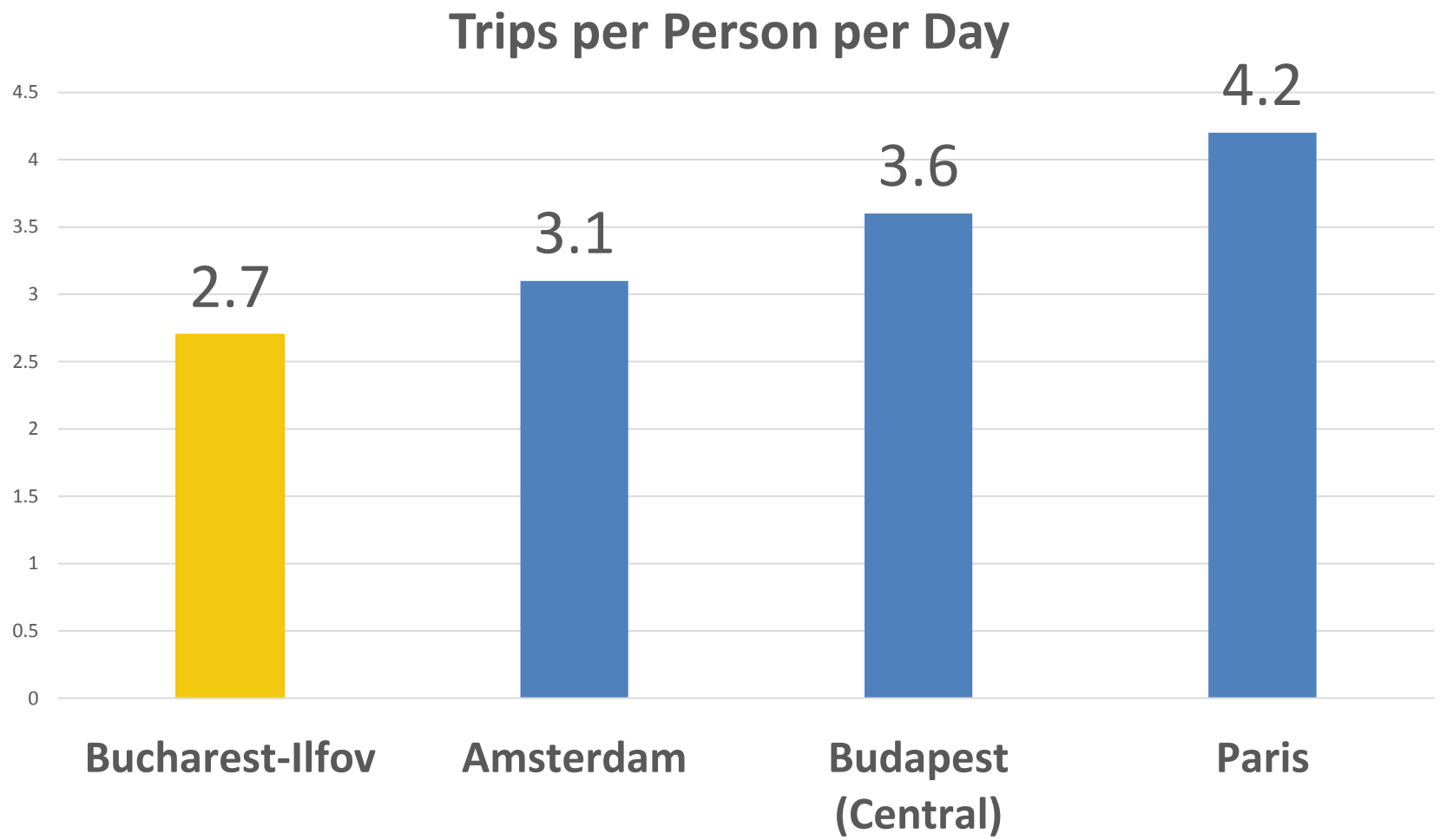
There are many worldwide evidences regarding the connection of SUMP and population growth
Even in USD – Portland is a good example

Bucharest vs. Copenhagen

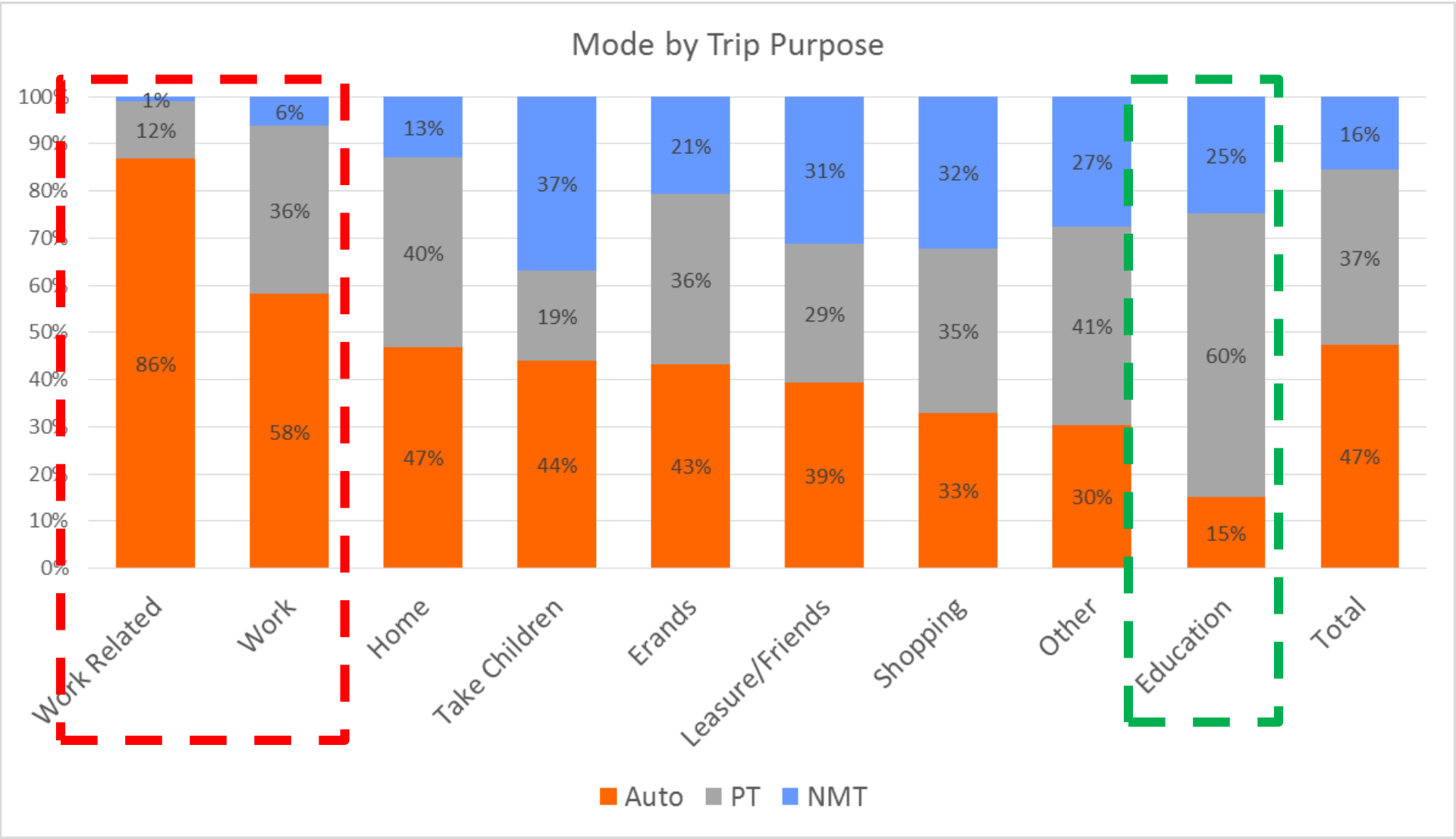


The common belief is that the major difference is the bicycle use. But.....

Bucharest vs. Other European Cities

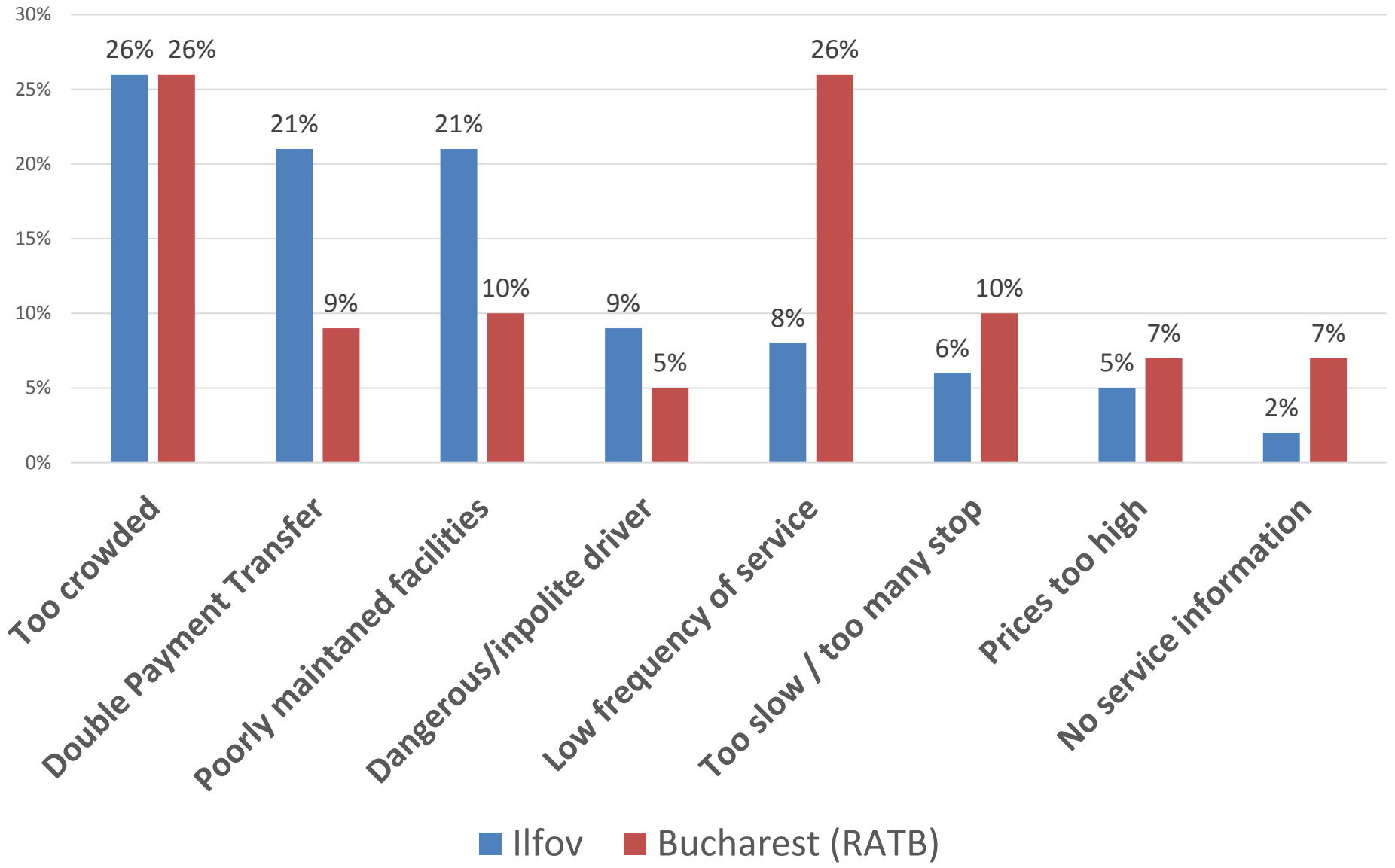


Bucharest-Ilfov Mode Split by Trip Purpose



Source: 2014 THS

Bucharest-Ilfov Public Transport Passenger Review

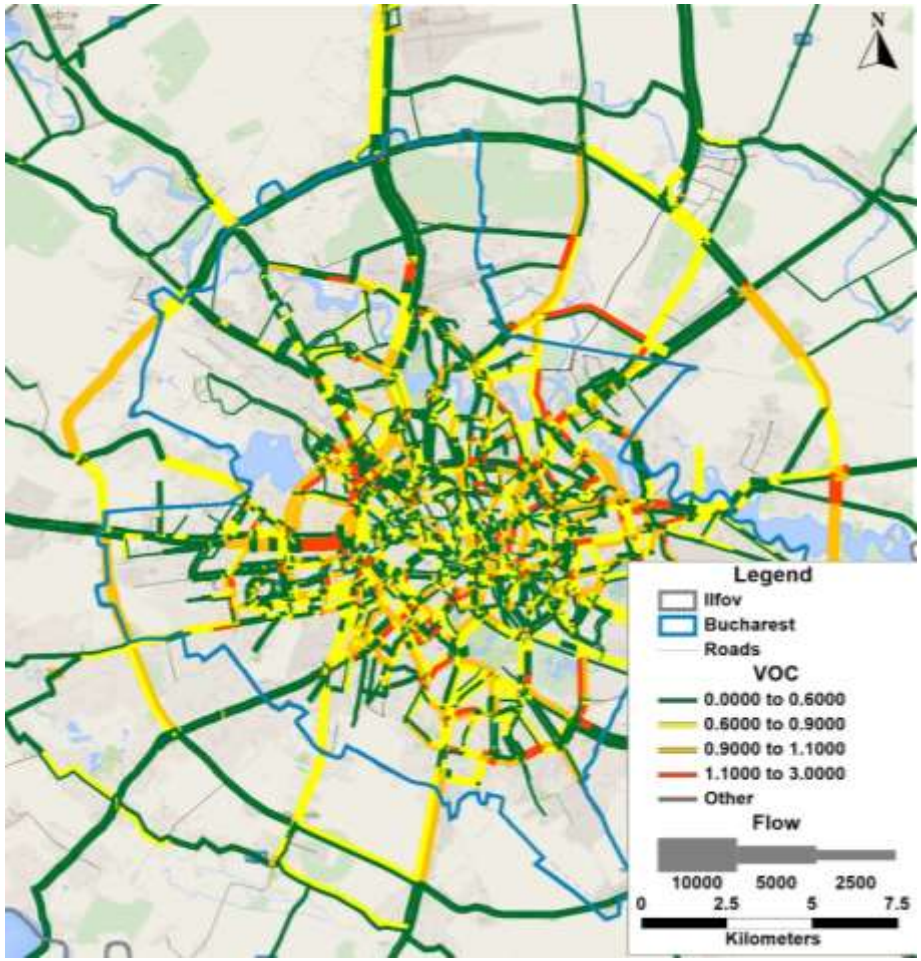


Comparison of Strategies

Area	Copenhagen	Bucharest
Land use	TOD around radial rail lines	No integration of land use & transport
Urbanization	Pedestrinization of streets, constant promotion of street life (one big party)	Most of the streets' ROW is allocated to cars, not enough pedestrian zones and poor sidewalks
Car restraint	Rejection of massive freeway system	Most investments on roads
Parking policy	Reduce parking availability by 3% per year	Practically no restriction on car parking
Bicycle	Full network, parking facilities, priority to bicycles in traffic	Practically no active promotion of cycling
Public Transport	Full integration, network of fully separated LRT complementing the metro lines	No integration, trams do not have dedicated ROW, tram do not complement metro

How will SUMP Analyze Potential Strategies?

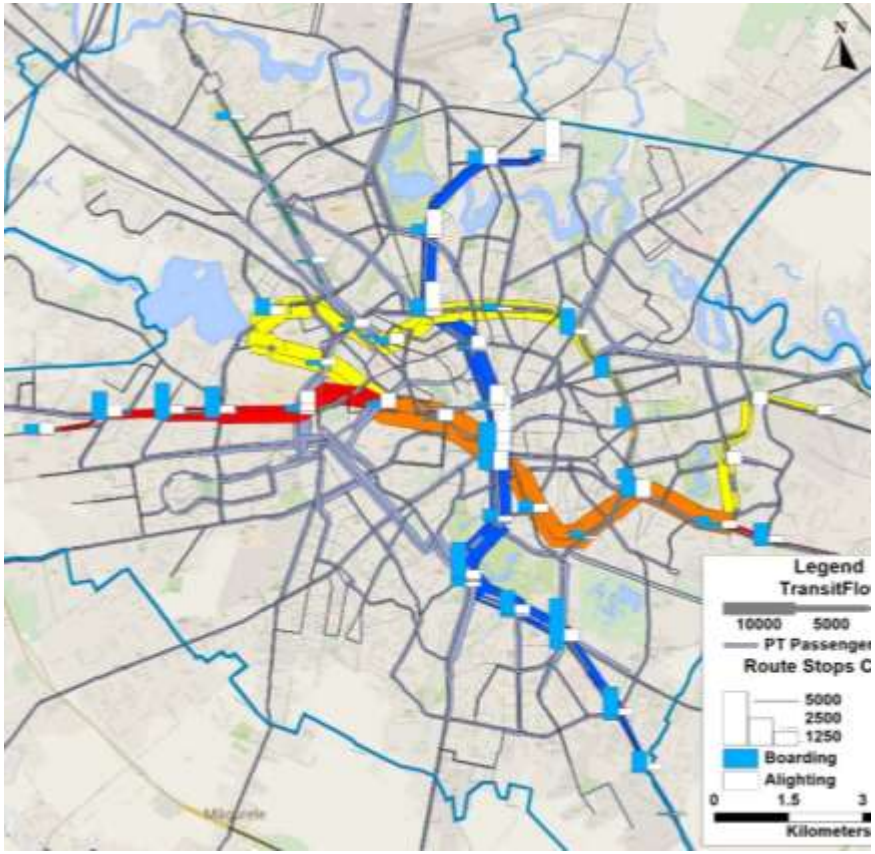
2015 AM Peak Auto Assignment



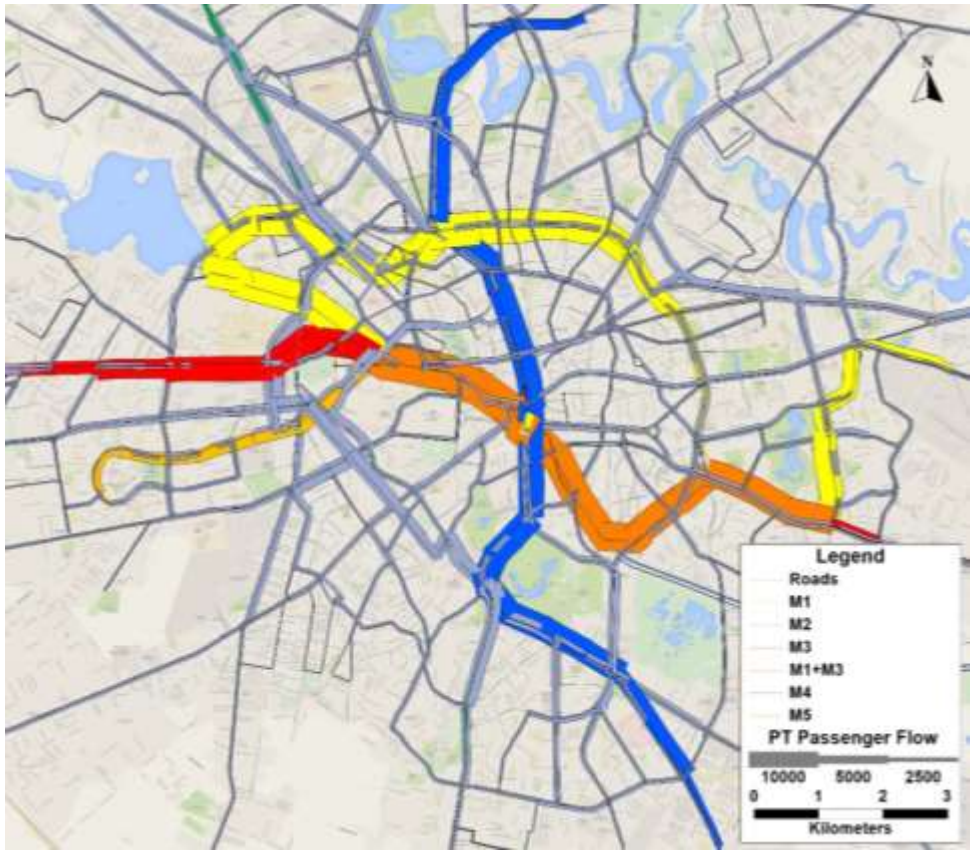
2030 AM Peak Auto Assignment

How will SUMP Analyze Potential Strategies?

2015 AM Peak PT Assignment

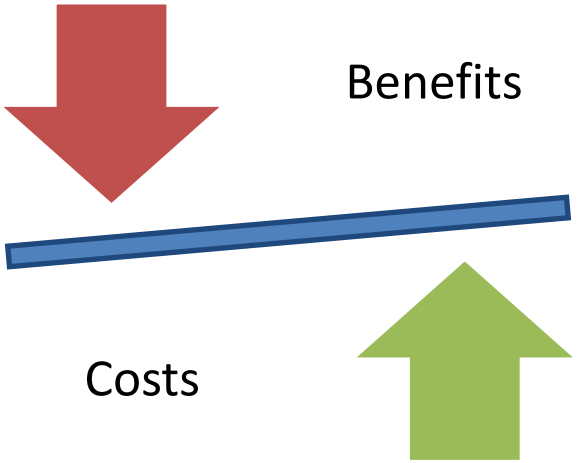


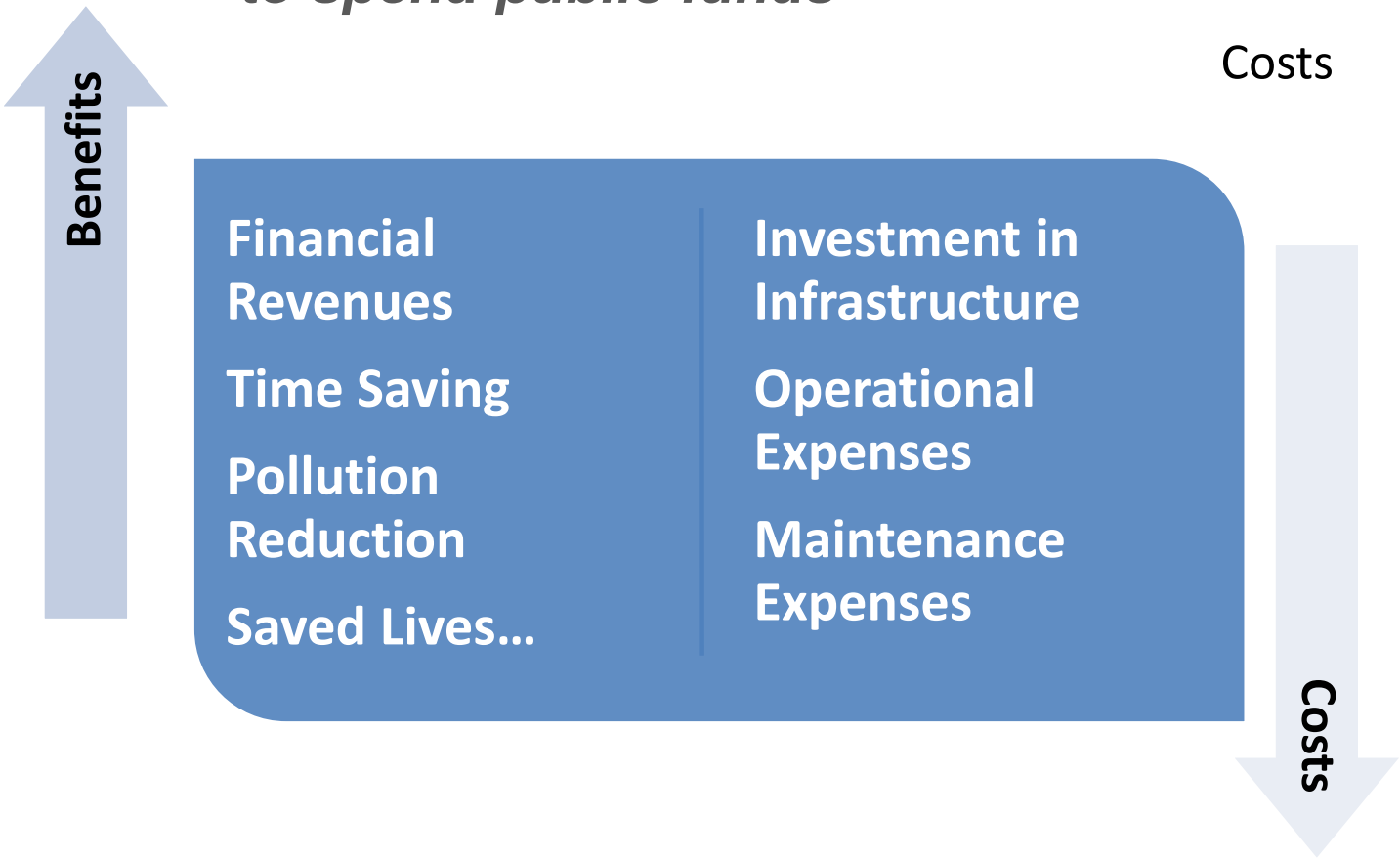
2030 AM Peak PT Assignment



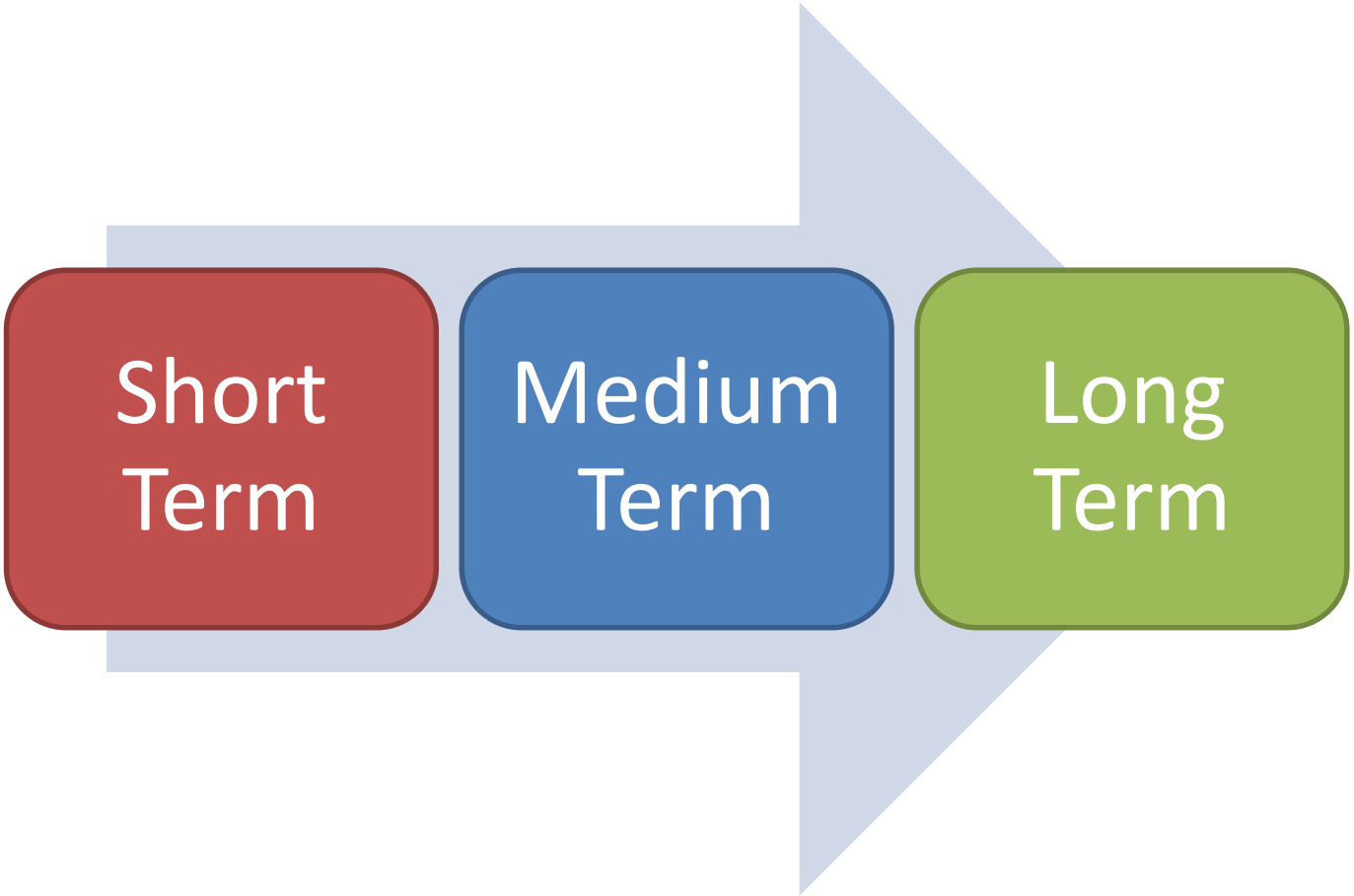
How will SUMP Analyze Potential Strategies?

Economic indicators for different investment scenarios show which alternative is the most efficient way to spend public funds





So What Should Bucharest do in order to Flourish?

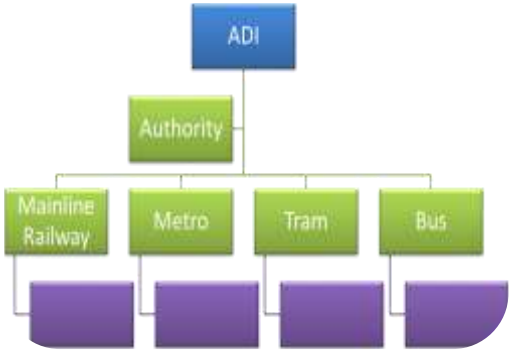


Short Term- *Must Haves*

Fare Policy

Parking Policy

Maintenance Gap

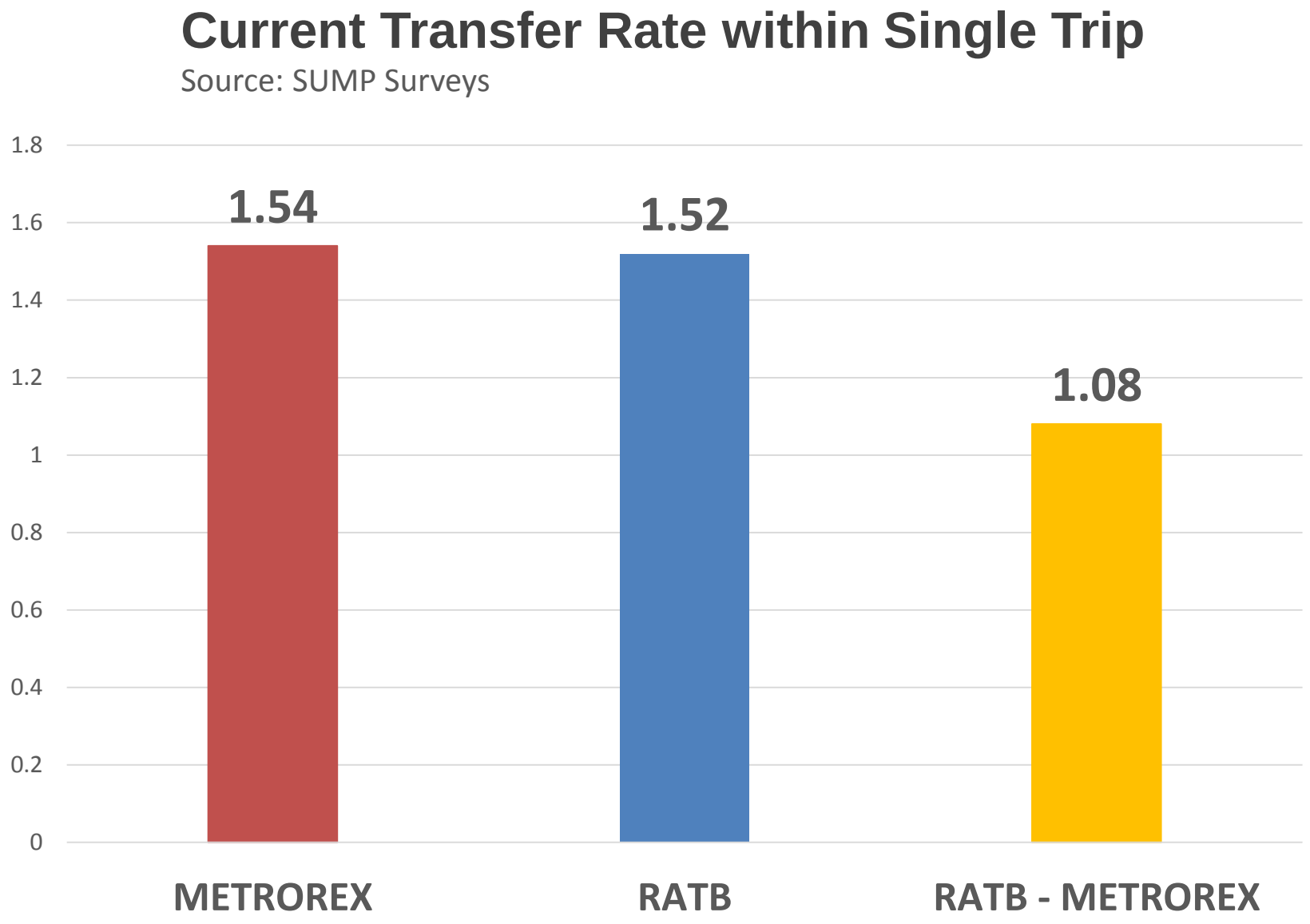


Institutional Restructuring

Pedestrian and Cycle

Safety

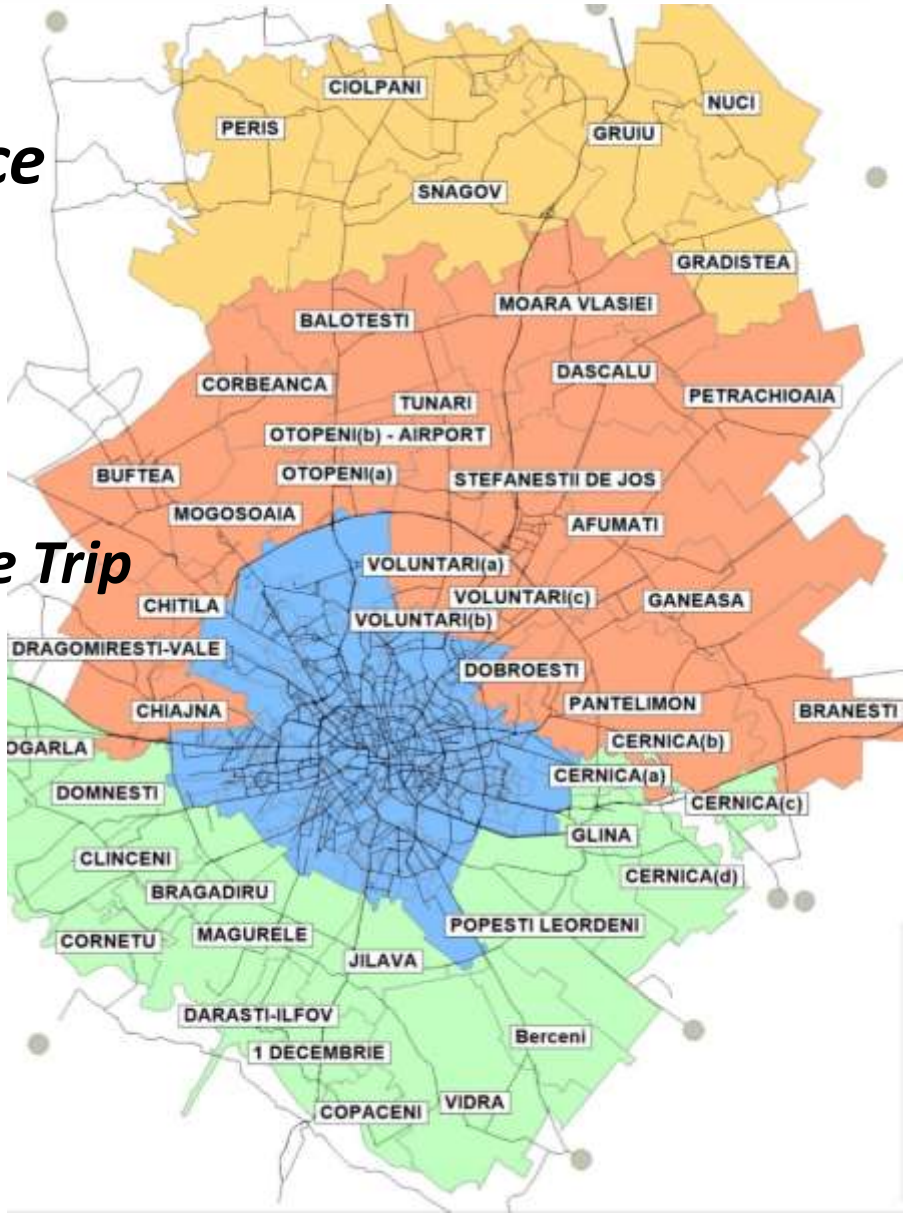
Short Term- *Integrated PT Fare Policy*



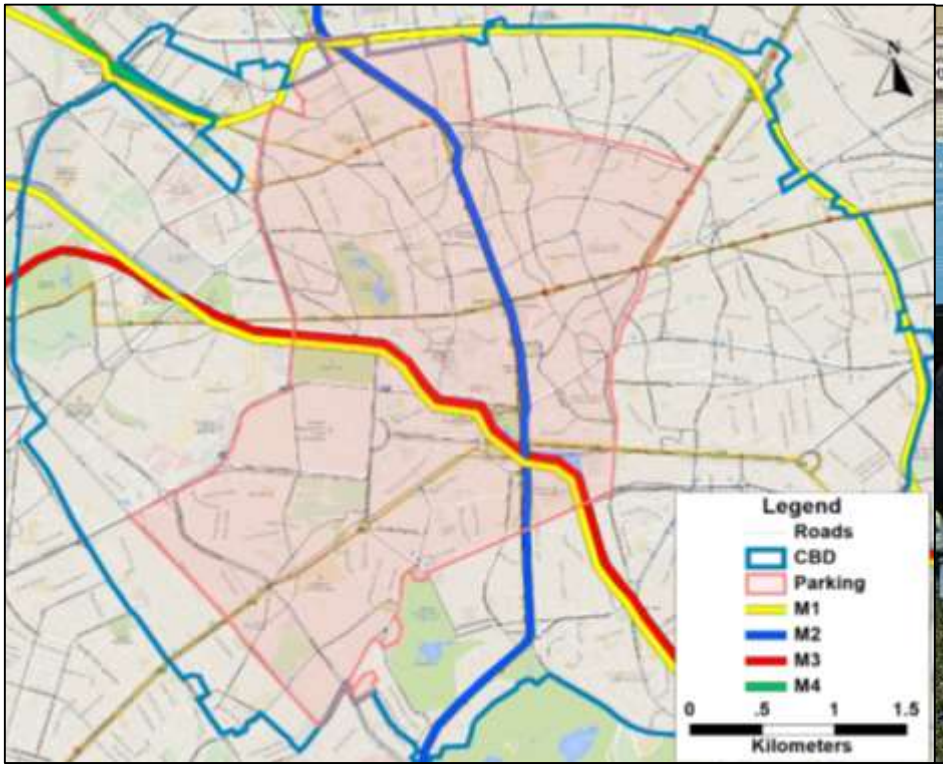
Short Term- Integrated PT Fare Policy

Adopt Universal Best Practice

- ✓ *Geographical Fare Policy- Zonal/Distance based*
- ✓ *90 min. Transfer within Single Trip*
- ✓ *Single Ticket for all Modes*



Short Term- *Parking Policy in Bucharest City Center*



The space of one parking place

53% of drivers in Bucharest park on the road for free!

- ✓ 68% of drivers would pay 2 RON
- ✓ 56% of drivers would pay 5 RON
- ✓ **Potential parking fees = 650M-1.2B RON Annually**

Making choices on available public space and quality of life

Short Term- Sharing Space, Pedestrian and Cycling

Medium Term- *Hierarchal Transport System*

Urban Mass Rapid Transit

Medium distance, fast, medium & high capacity Services within the city

Metro

LRT

BRT

Local Transport

Connect people from all neighborhoods

Bus Priority

City Trolley bus

Hubs

Bike Rent system

Suburban Services

Long distance, high speed

Suburb BRT

Suburban Bus

Park and Ride

Main line railway

Airport

NETWORK

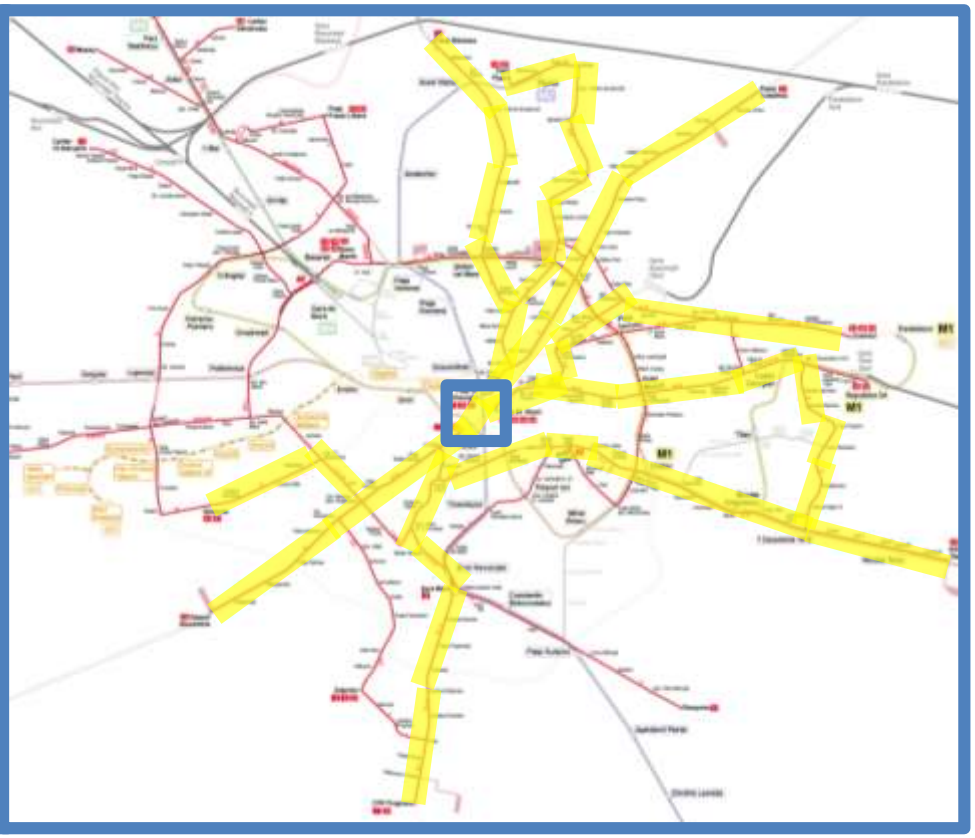
Medium Term- *Urban Mass Rapid Transit Development*

Medium Term- *Local Bus Priority Development*

Medium Term- Network Connectivity

LRT through Piaţa Unirii

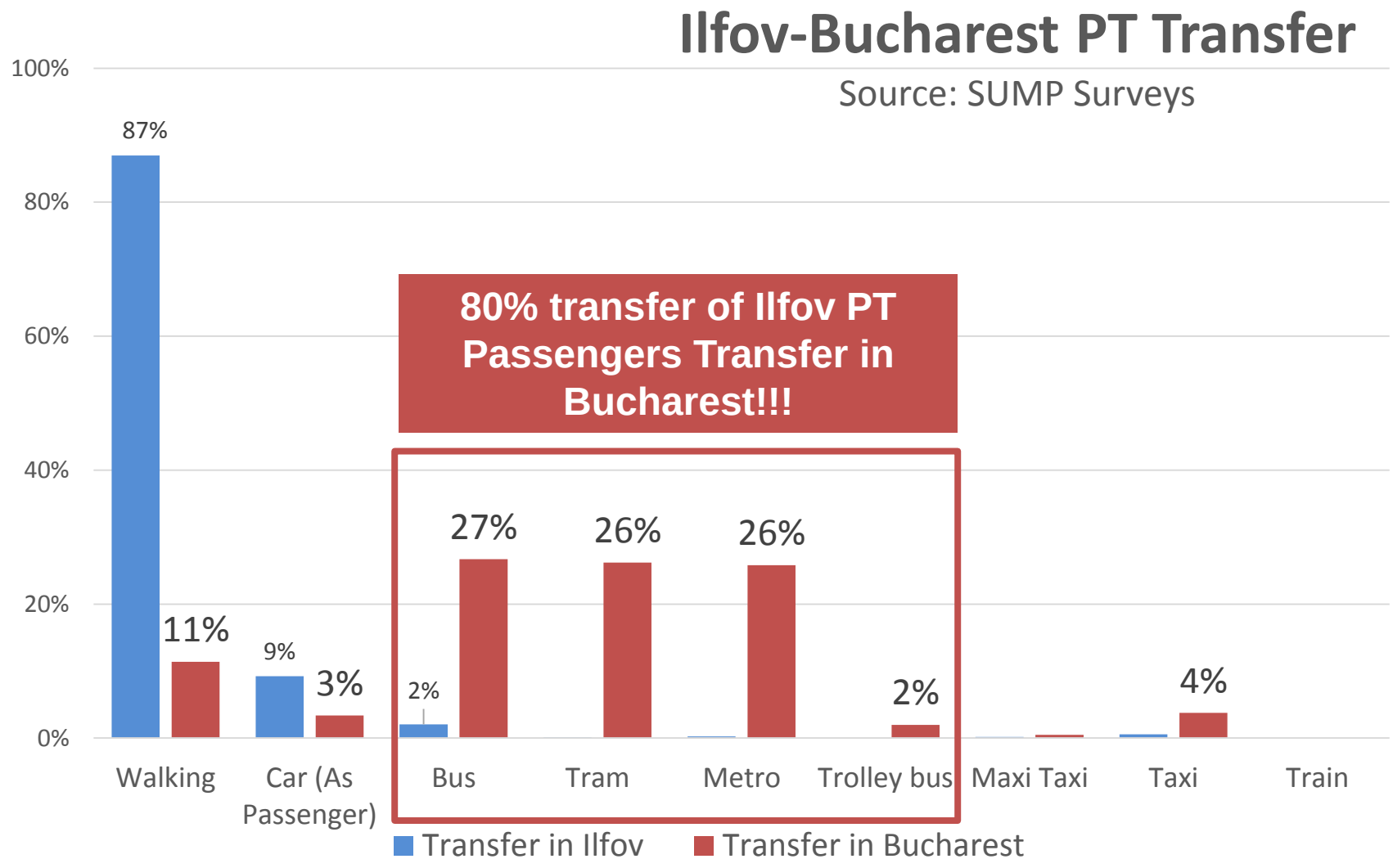
Double Track South & East of Piaţa Unirii



Tram/LRT Connectable Network through Piaţa Unirii in the Future

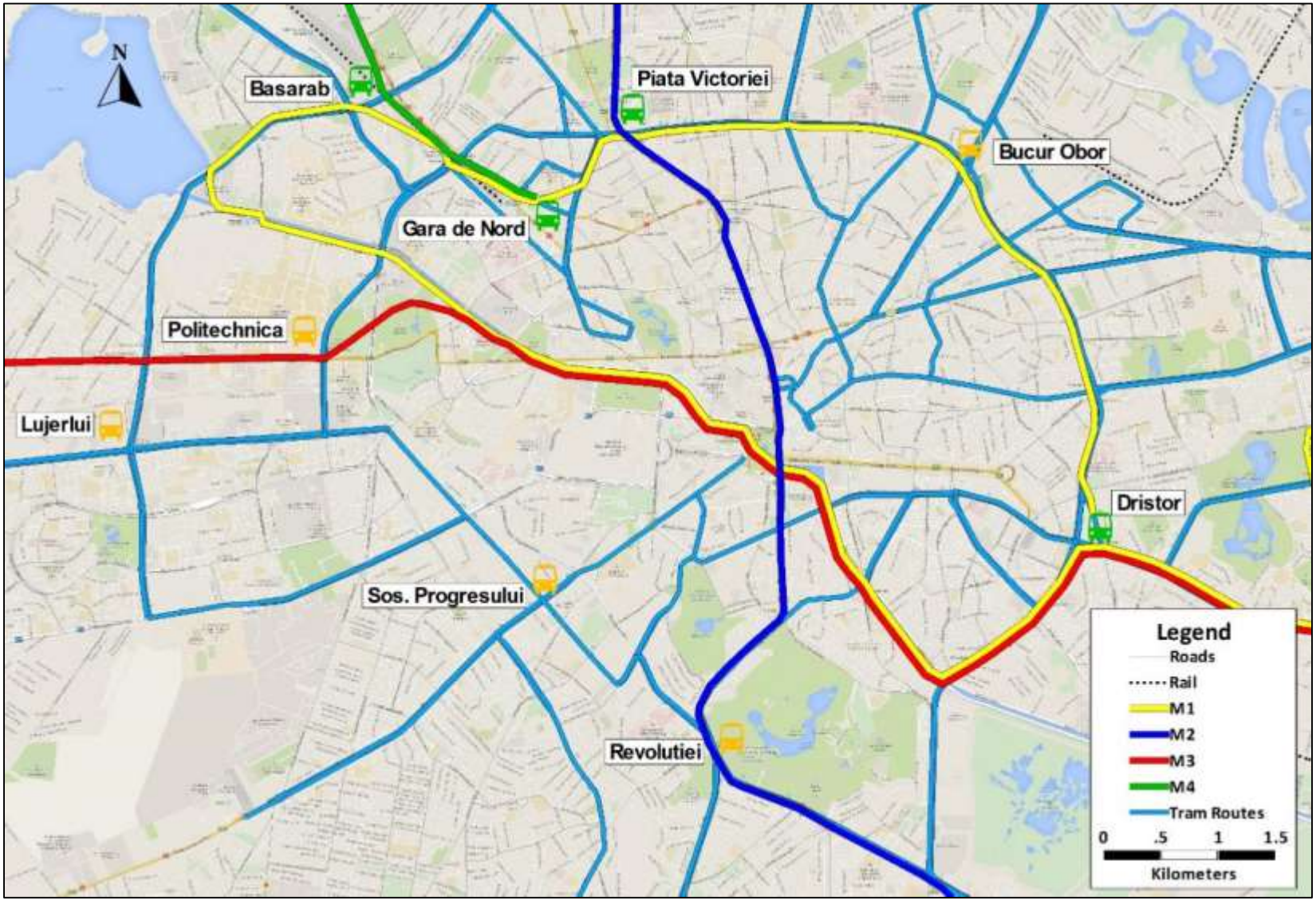
Medium Term- Network Connectivity

Multi Modal Hubs

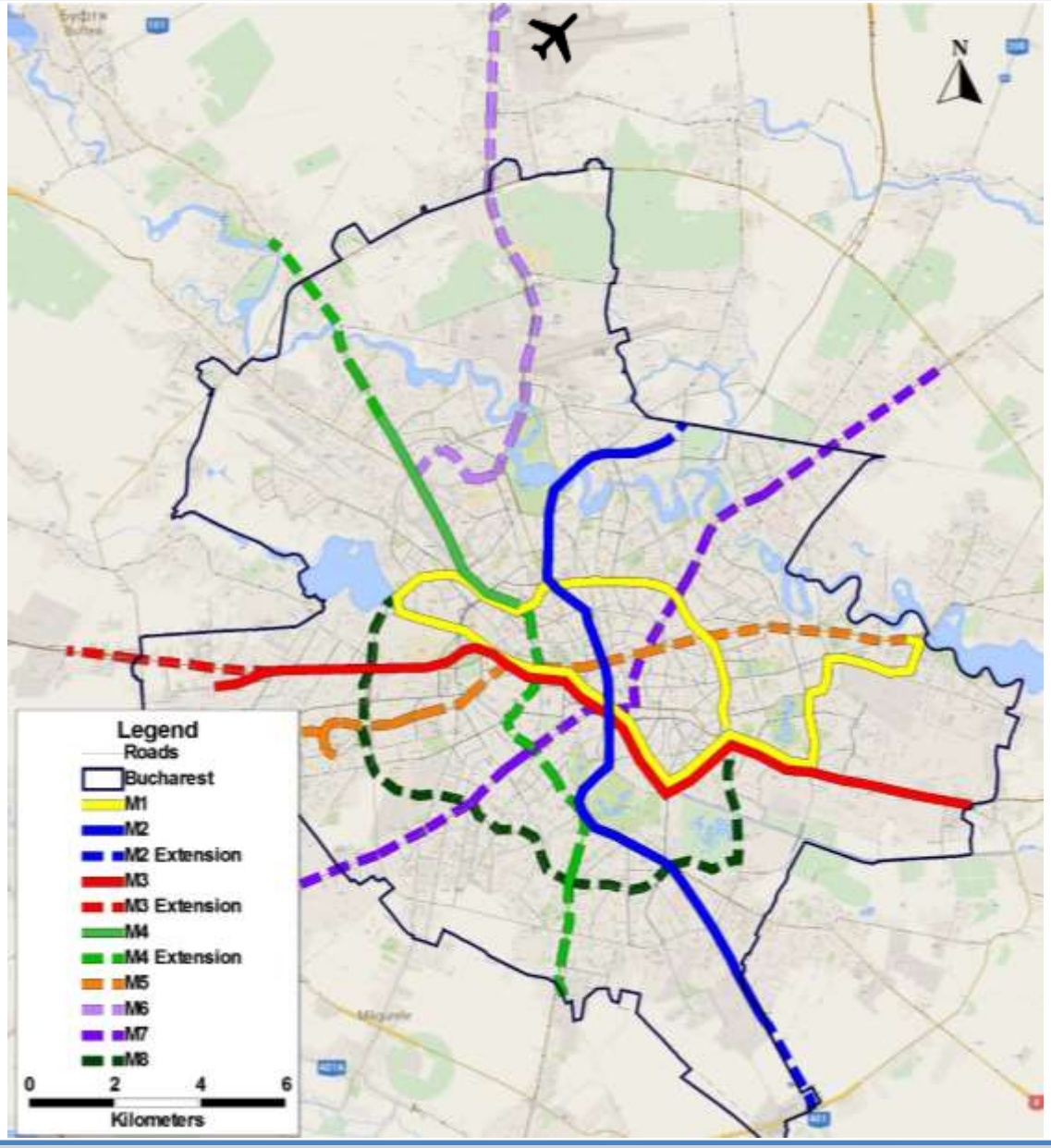


Medium Term- Network Connectivity

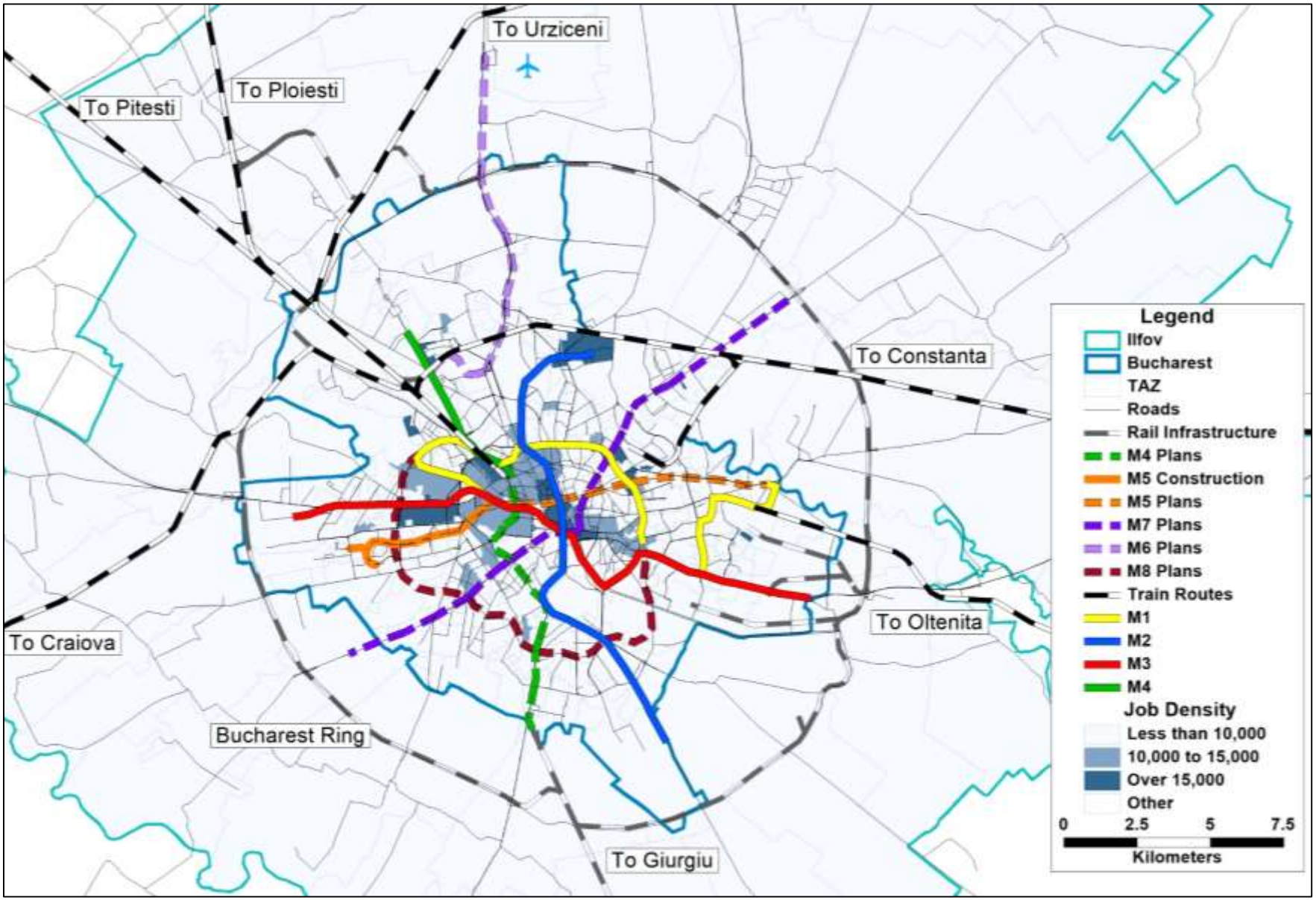
Multi Modal Hubs



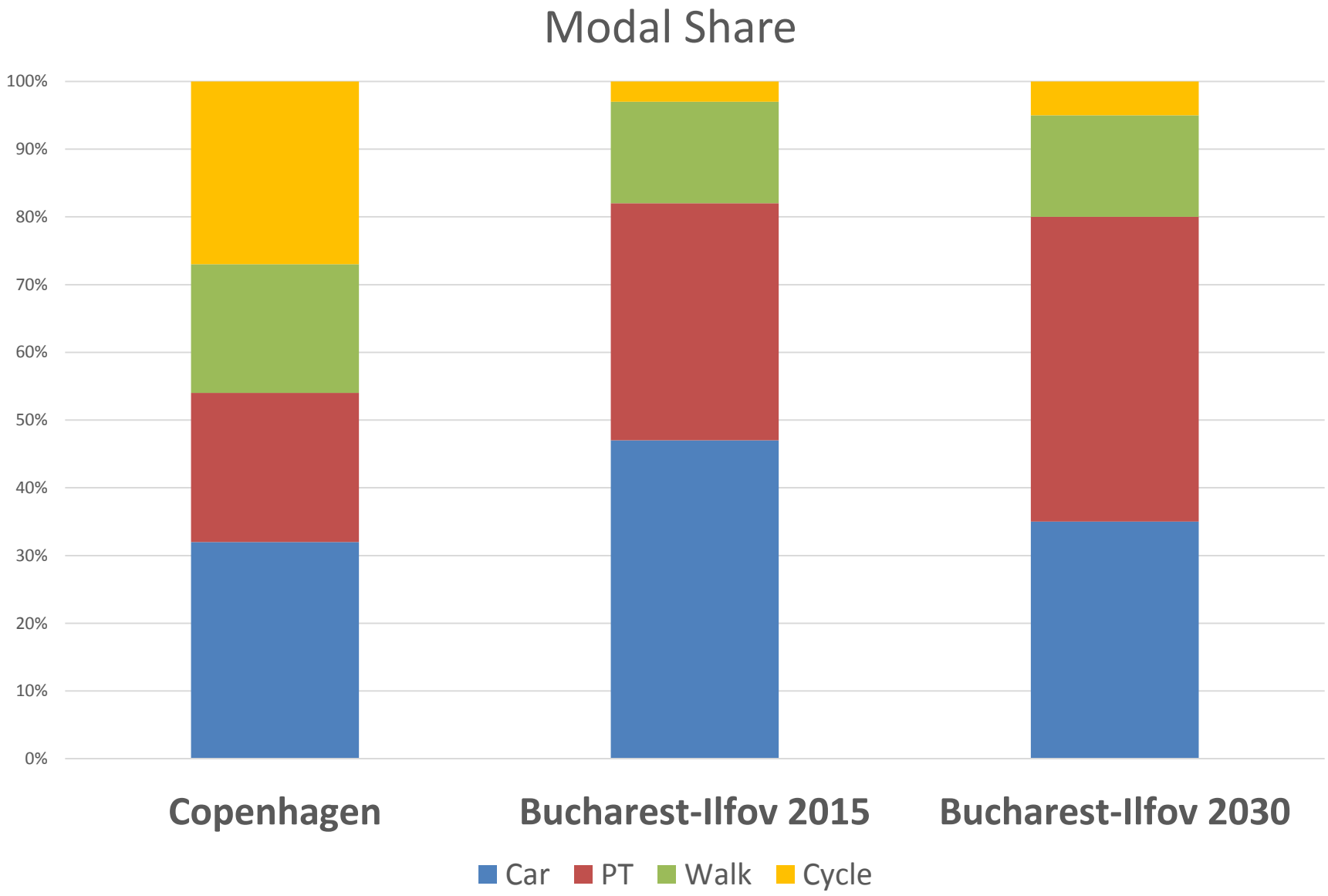
Long Term- *Additional Urban Mass Rapid Transit*



Long Term- Improve Sub-Urban Rail Performance



One Way to Measure Success of SUMP



Sustainable Urban Mobility

TRAINING SESSION 1B

Transportation planning and TDM

European Bank
for Reconstruction and Development

ROM
רום הנדסת תחבורה בע"מ
Transportation Engineering Ltd.

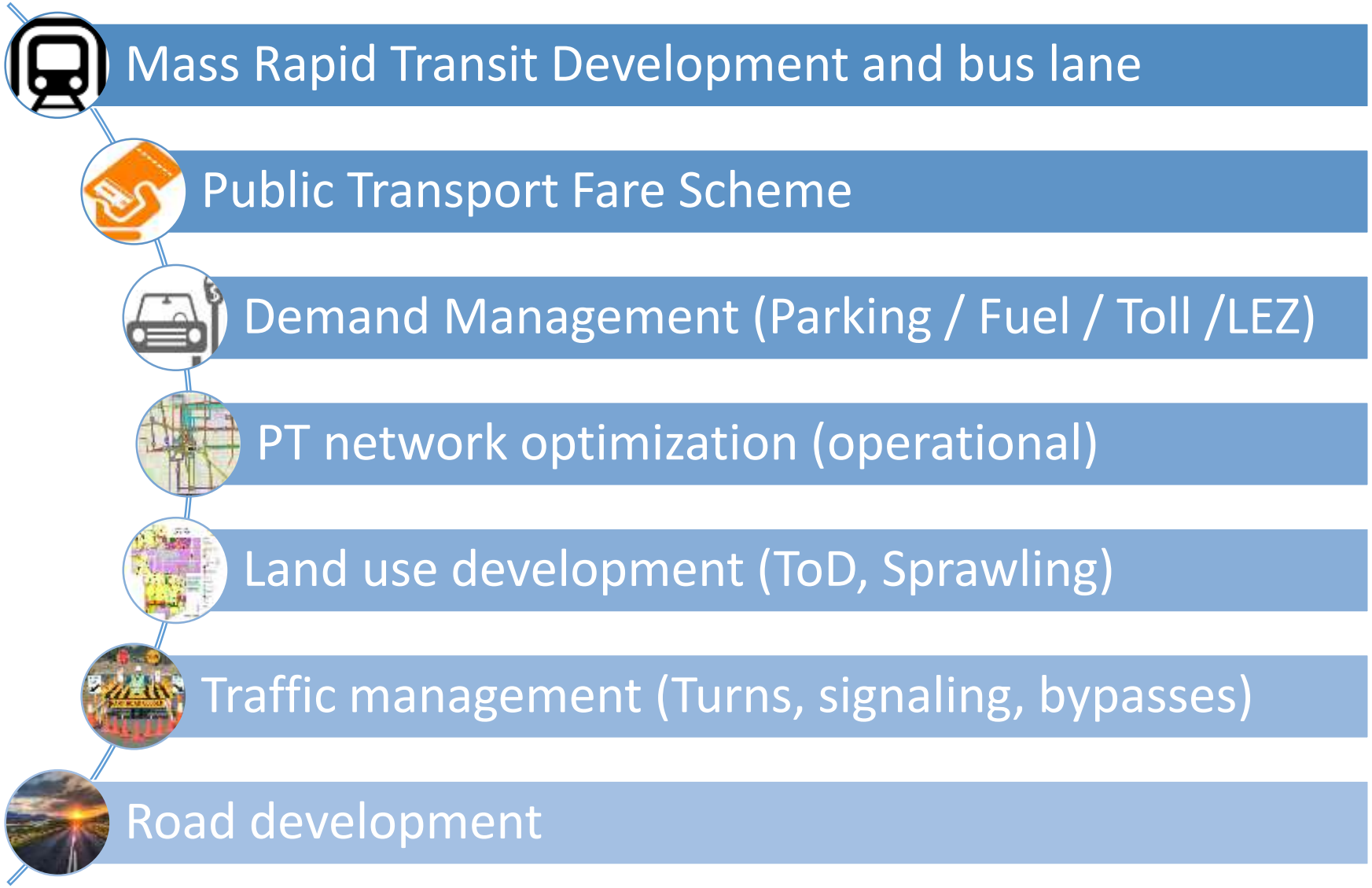
AVENSA

Issues to discuss

1. Defining Policies
2. Use of Travel-Demand-Model
3. Transport planning community

Part 1: Defining Policies

Supported Policies



Sustainable approach and Integration

SUSTAINABLE URBAN TRANSPORT APPROACH:

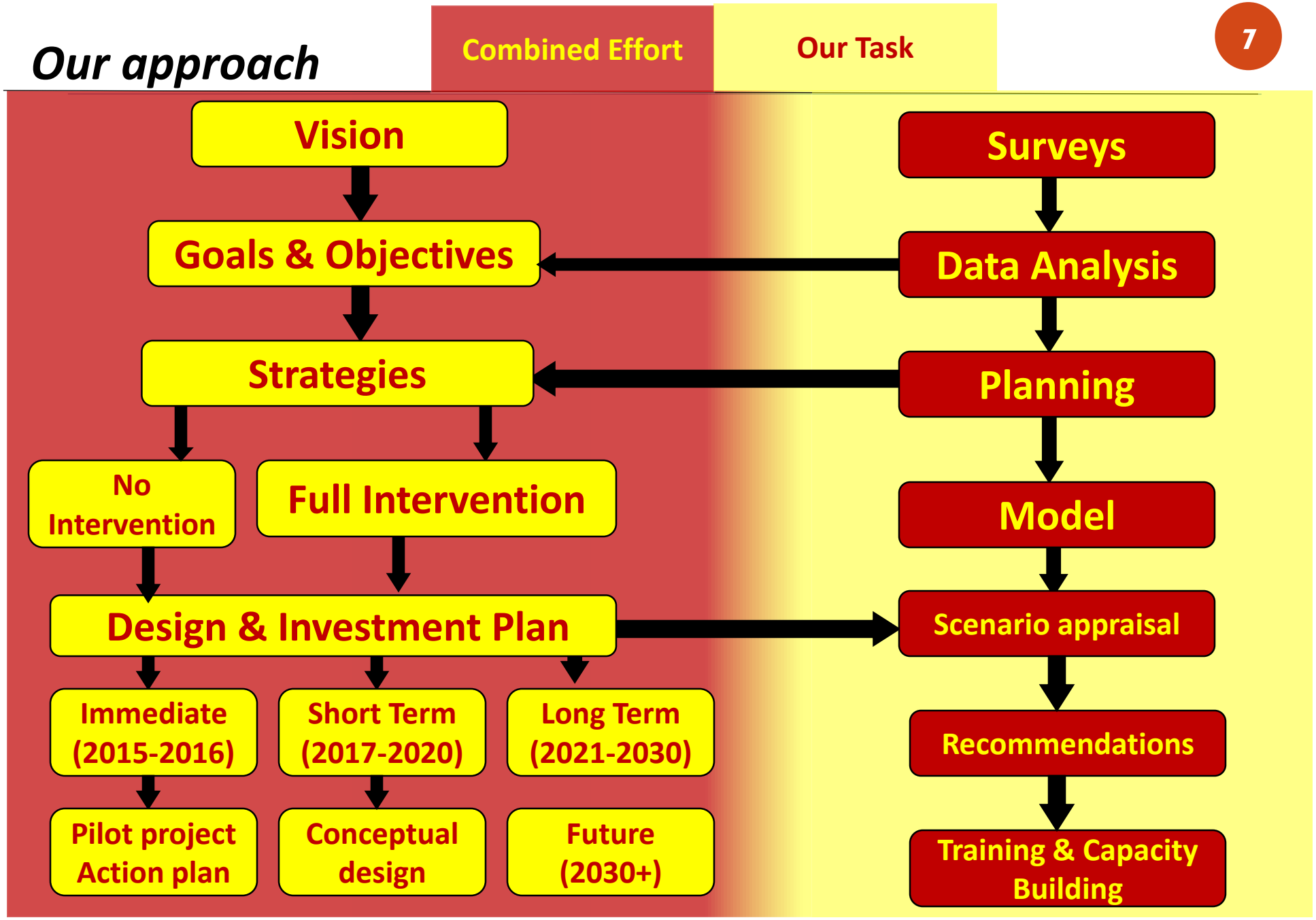
- ❑ Holistic Multi-Modal approach (“Door-To-Door)
- ❑ “Move passenger, NOT vehicles”
- ❑ SUT prioritization (MRT, PT, NMT, Traffic Management)
- ❑ Politically acceptable and feasible
- ❑ Financially sustainable
- ❑ Cultural and image aspects
- ❑ TOP DOWN and BOTTOM UP

Integration-Integration-Integration

Policies to be considered

ID	Measures	Benefits for SUT	Modeling impact
1	priority to PT vehides (PT lanes, Intersection priority)	Increase PT share Reduce Auto VKMT Reduce PT operational VHT	Mode choice model should be sensitive to improvement in PT travel time
2	Installing NMT infrastructure (Cycling path, pedestrian mall, sidewalks, cycling rental scheme, etc)	Increase NMT share Reduce Auto VKMT	Mode choice should be sensitive to improvement in NMT facilities
3	Congestion pricing or Low-Emission-Zone (LEZ) / HOT Lanes	Reduce crossing traffic Reduce pollution / polluting vehicles Shift to Auto-NMT or HOV	Module to consider following options: 1. Mode change 2. Time of day change 3. Destination change 4. Route change (assignment) 5. Occupancy change 6. Trip cancel
4	Traffic management / Traffic relaxing	Improve traffic flow Reduce congestion Limit crossing traffic	Reflect management in Auto assignment Will impact Mode choice split
5	MRT development (LRT/Metro/BRT)	Increase PT share Reduce Auto VKMT Reduce PT operational VHT Improve PT Level of service	Mode choice model should be sensitive to improvement in PT travel time New modes will be designed in the MC model (source – TFL, the demand for PT, a practical guide) + SP
6	Improvement of PT facilities (stop, ITS, terminals)	Improve PT Level of service Increase PT share Reduce Auto VKMT	Mode choice model should be sensitive to improvement in PT Level of service (source – TFL, the demand for PT, a practical guide) +SP
7	Transit oriented development	Increase PT share Reduce Auto VKMT Improve urban viability	Mode choice model should be sensitive to improvement in PT Level of service (source – TFL, the demand for PT, a practical guide)
8	Bus scheme improvement (frequency/ fare reduction/ fare scheme/ network)	Improve PT Level of service Increase PT share Reduce Auto VKMT	Mode choice model should be sensitive to improvement in PT Level of service (source – TFL, the demand for PT, a practical guide) + SP
9	Parking policy (reduction on street of parking within the city center, on-street parking management system)	Increase PT share Reduce Auto VKMT in city center Increase Municipality revenue	Reflect management in Auto assignment Will impact Mode choice split
10	"Soft sustainable policies" (encouragement of PT usage, parking refunding, purchasing of bicycle,	Mode choice model will be sensitive to Soft improvement in specific modes (source – TFL, the demand for PT, a practical guide)	

Our approach



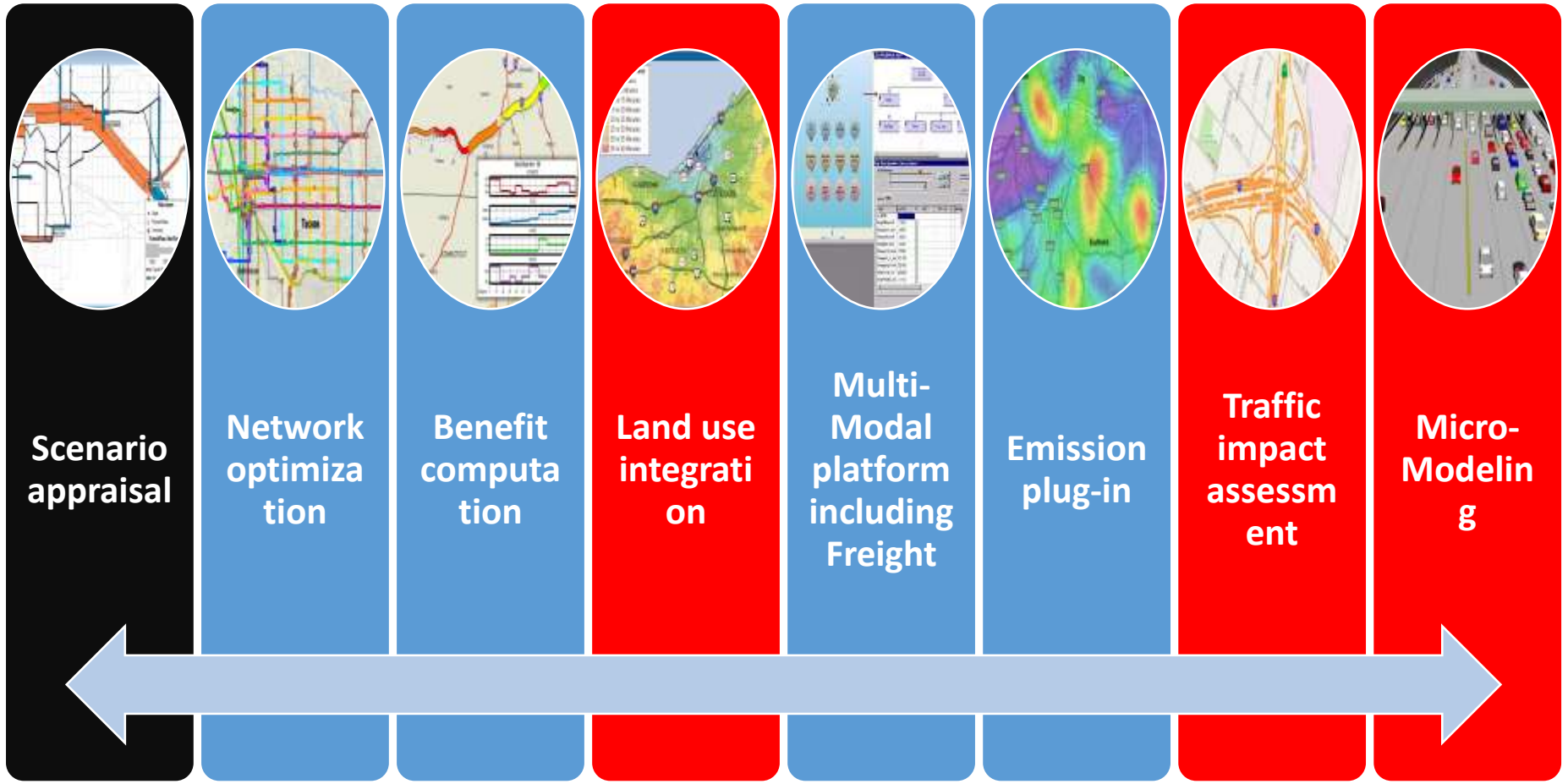
Part 2: Use of Travel-Demand-Model

The Travel Demand Model (TDM)

- A statistical tools that replicate real-time spatial behavior of people and commodities
- TDM have two main parts:
  - **SUPPLY**: The Networks and Level of service
  - **DEMAND**: The actual trips of people and goods
- Unique for each modeling area due to different supply (networks) and demand (Behavior and demographics)

TDM are calibrated to current situation but are developed to forecast FUTURE scenarios

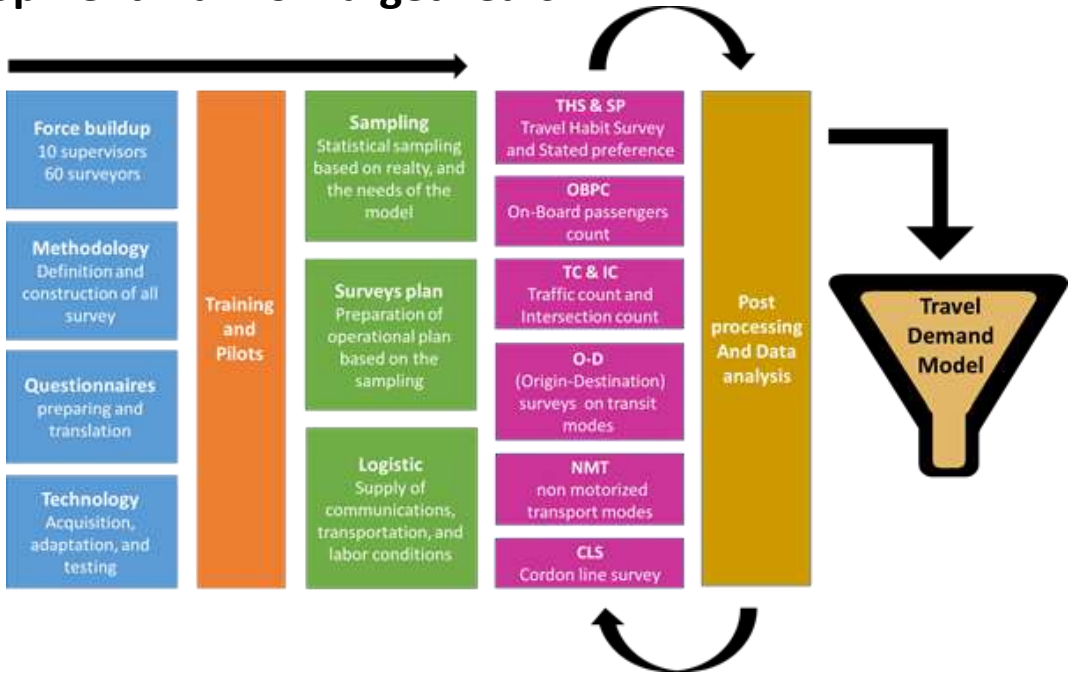
Standard requirements from TDM



Selected package should have the above built-in capacity and should be user friendly

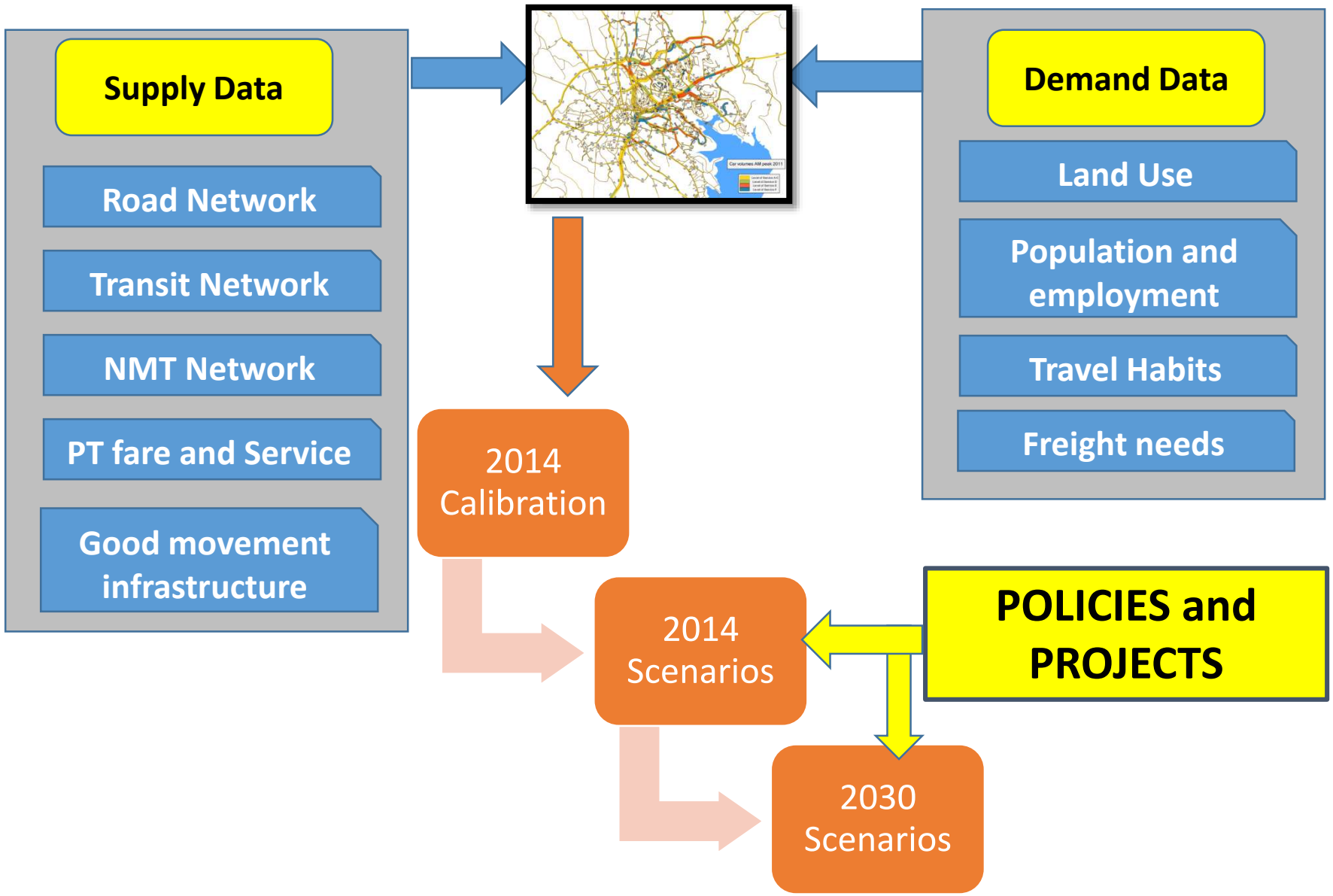
TDM Input

- Land use & Socio-Demographic
- Networks – Roads, Metro/Tram/Trolley Routes, Cycling paths, Bus stops
- Pattern of travel and behavior & People's preferences
- Public Transport Operation- Routes, Stops, Frequency
- Urban Development Plan for Target Years



A Sound TDM Requires a Wide Data Collection Effort Including Various Types of Surveys

The Travel Demand Model (TDM)

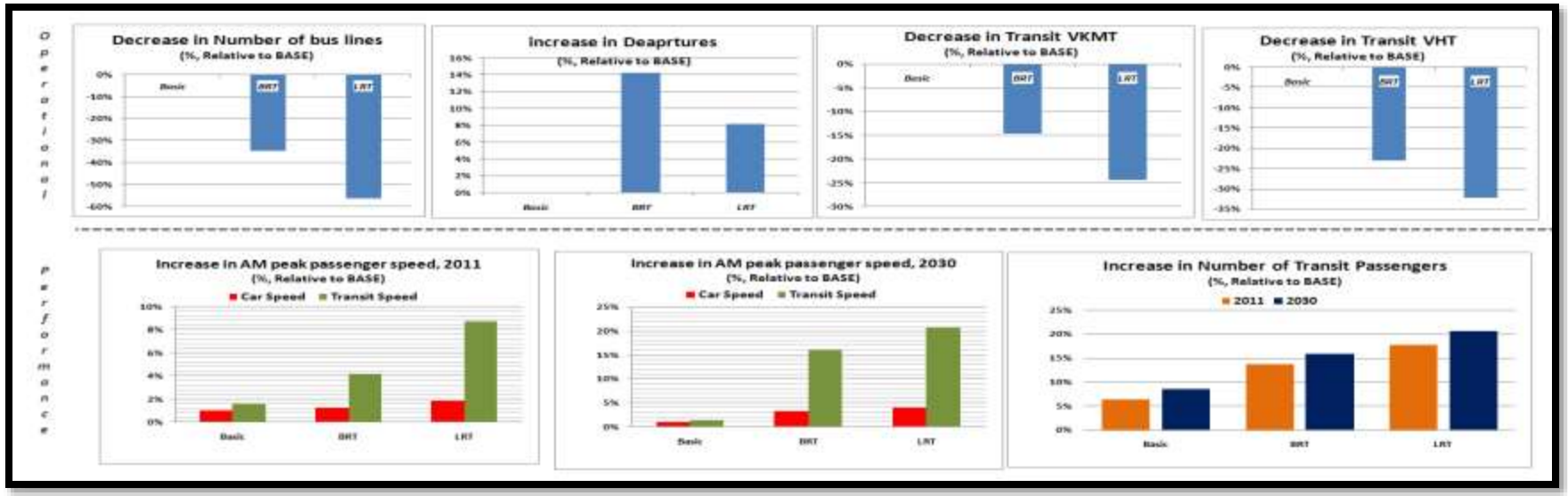


PLATFORM for TDM

- **The software platform is JUST one more tool in the toolbox of the planner, along with: common sense (VERY important!), quick manual routines and professional experience**
- **However, the software should meet minimal requirements:**
  - **Good computational performance on large problems**
  - **Good visualization and reporting**
  - **Build-in GIS and relational database capabilities**
  - **Well documented and easy to understand operation**

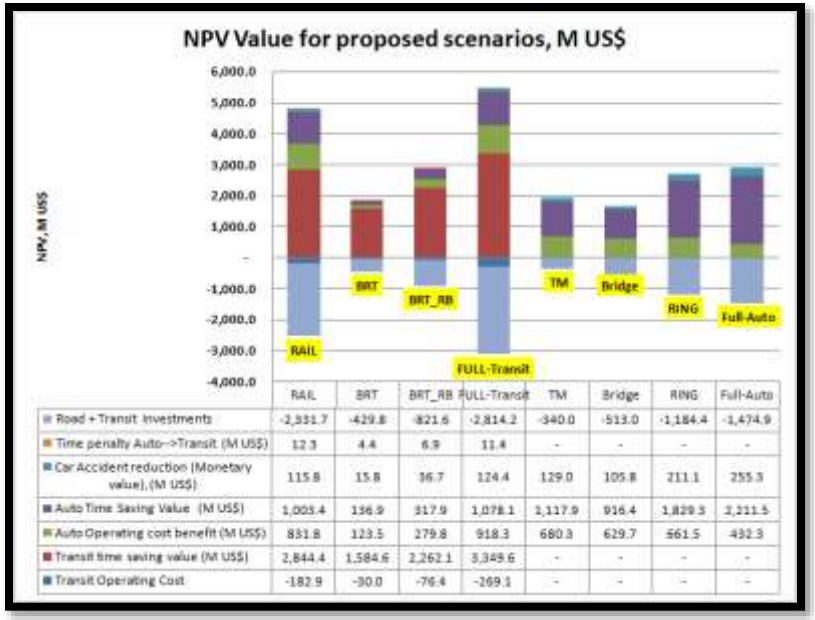
Data and the model can work under various platforms. The question is which one is most suitable and user friendly. In any case model can be transformed from one platform to another easily

Cost-Benefit Analysis Computation



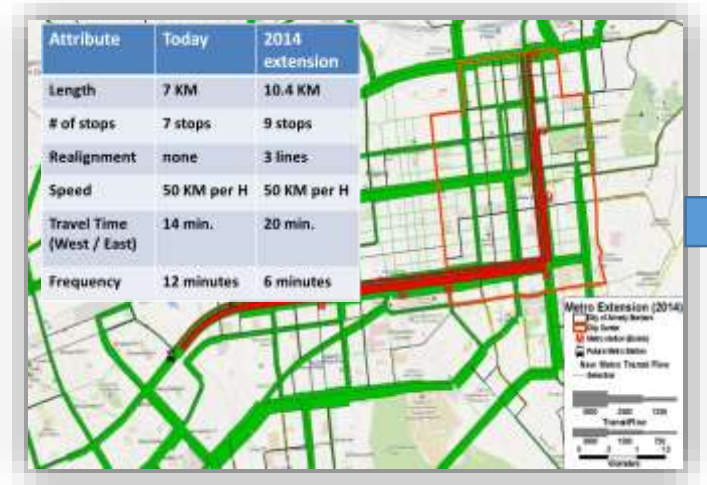
Decision makers require knowledge of the economic / social / environmental benefits and costs which can be evaluated using TDM

International investors require a solid demand forecasting tool to assess project cash flow and rate of return.

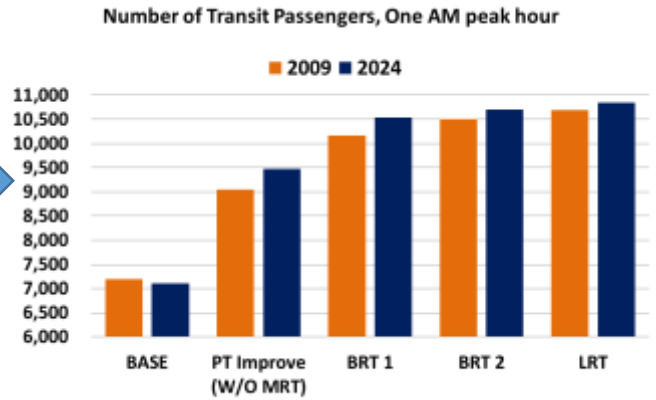


	RAIL	BRT	BRT_RB	FULL-Transit	TM	Bridge	RING	Full-Auto
Road + Transit Investments	-2,331.7	-429.8	-821.6	-2,814.2	-340.0	-513.0	-1,184.4	-1,474.9
Time penalty Auto-->Transit (M US$)	12.3	4.4	6.9	11.4	-	-	-	-
Car Accident reduction (Monetary value), (M US$)	115.8	15.8	36.7	124.4	129.0	105.8	211.1	255.3
Auto Time Saving Value (M US$)	1,005.4	136.9	317.9	1,078.1	1,117.9	916.4	1,829.3	2,211.5
Auto Operating cost benefit (M US$)	831.8	123.5	279.8	918.3	680.3	629.7	561.5	432.3
Transit time saving value (M US$)	2,844.4	1,584.6	2,262.1	3,349.6	-	-	-	-
Transit Operating Cost	-182.9	-30.0	-76.4	-269.1	-	-	-	-

Measure benefits (time, cost, comfort, etc)



Mode Shift

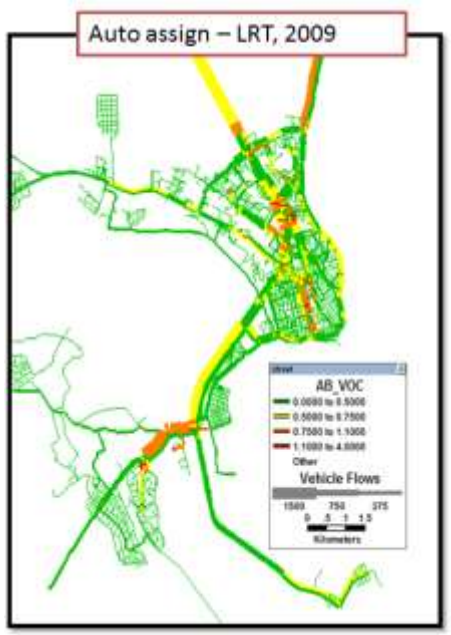


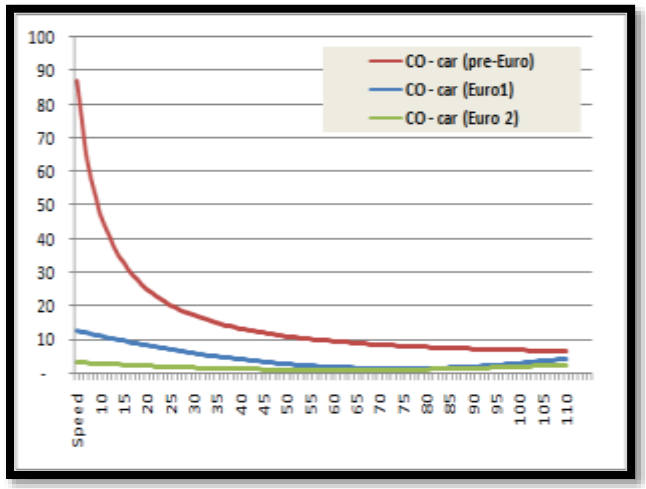
TDM enables us to measure quickly system and personal Benefits from any proposed project or for different investment scenarios

Attribute	Today	2014 extension
Ridership (peak)	1,700	4,970
Ridership (Daily)	17,500	46,718
Continue (MAX), peak hour	942	2,825
Transfer Rate	1.21	1.24
Time Saving (PT), Daily	-	2% (9K hours)
In-Vehicle Time (system, minutes)	36.7	35.9
Shift from AUTO (Daily)	-	4,570 people

Benefits

Pollutant estimation for different scenarios





By taking model outputs of traffic flow and congestion, and calculating against emission benchmarks, total emissions for a given scenario can be estimated

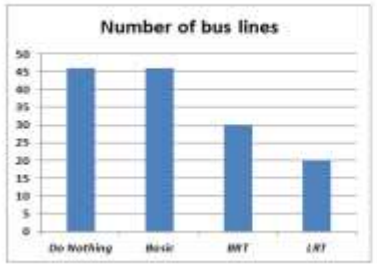
TRANSIT- BRT Emissions for Transit scenario, Tones of pollutants (PM in kg.)

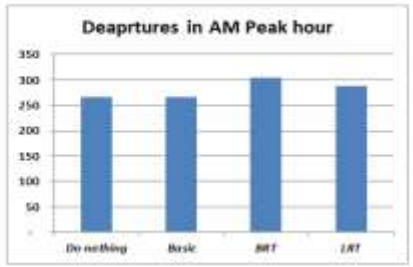
BRT Emissions								
Scenario	VKMT	VHT	Avg. Speed	CO	NOX	HC	PM (kg)	UCO2
Base 2012	1,575	39	40.13	0.006	0.043	0.004	1.180	1.329
BRT 2012	5,092	133	38.29	0.020	0.140	0.012	3.814	4.295
Rail 2012	1,575	39	40.13	0.006	0.043	0.004	1.180	1.329
Full 2012	5,092	133	38.29	0.020	0.140	0.012	3.814	4.295
Base 2020	1,575	39	40.13	0.006	0.044	0.004	1.211	1.314
BRT 2020	7,875	211	37.38	0.030	0.222	0.020	6.055	6.569
Rail 2020	-	-	-	-	-	-	-	-
BRT + RB 2020	7,875	211	37.38	0.030	0.222	0.020	6.055	6.569
Full 2020	7,875	211	37.38	0.030	0.222	0.020	6.055	6.569

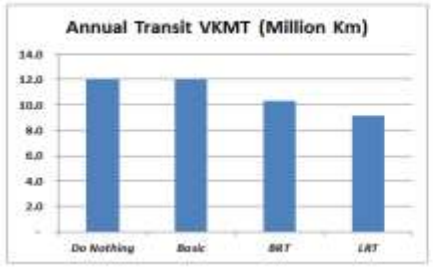
PT Network optimization and planning

Selected Graphs

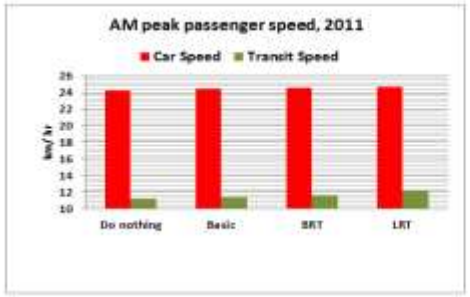
Operational

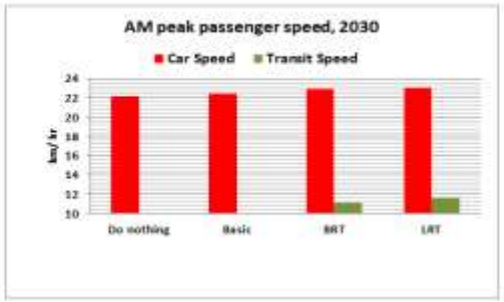


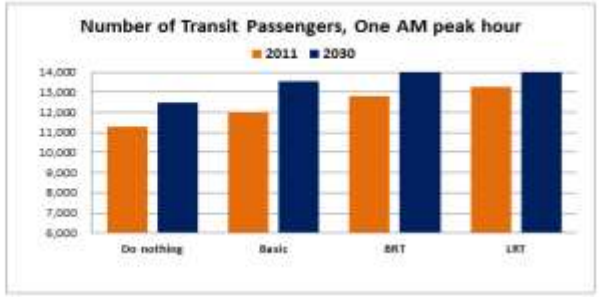




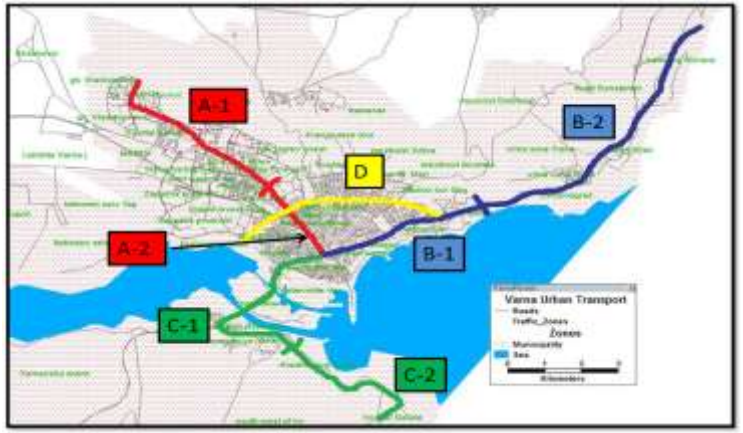
Performance







Model can appraise different PT networks and compare service and Operational to yield optimal PT networks

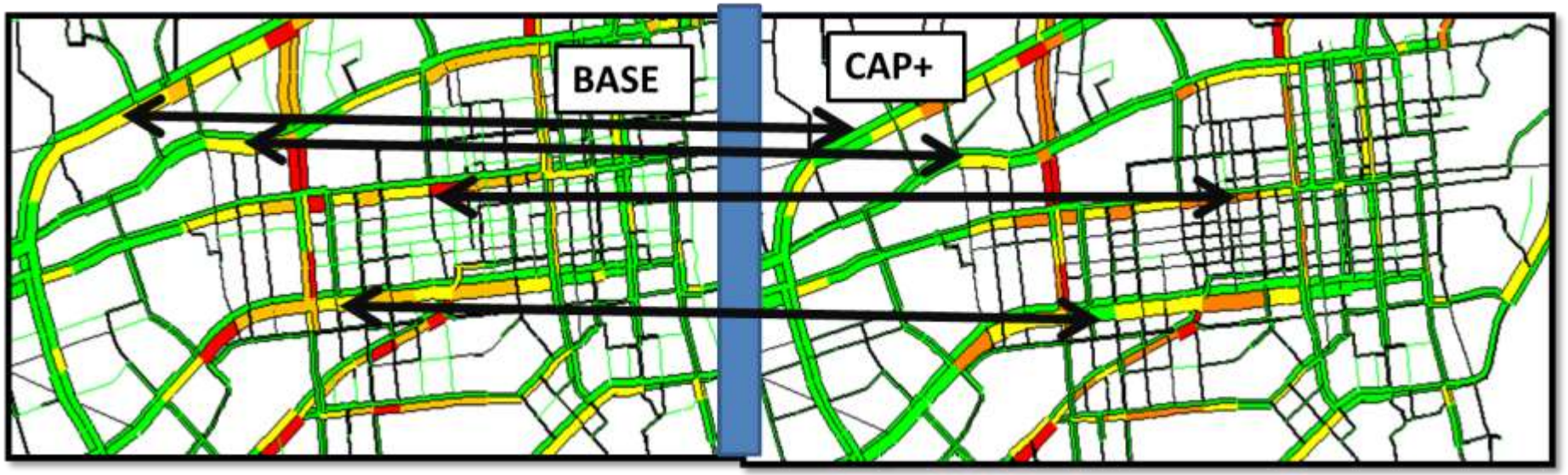


Urban Development feedback

The impact of Urban Development can be analyzed using the TDM to measure the capacity of networks to sustain urban growth

	BASE	EMP+	diff	Change
Trips	79,000	81,000	2,000	3%
VKMT	719,175	732,167	22,201	2%
VHT	36,829	38,146	2,456	4%
Distance	9.1	9.0	-0.1	-1%
Travel Time	28.0	28.3	1.13	1%
Speed	19.5	19.2	(0.66)	-2%

Traffic Impact Analysis

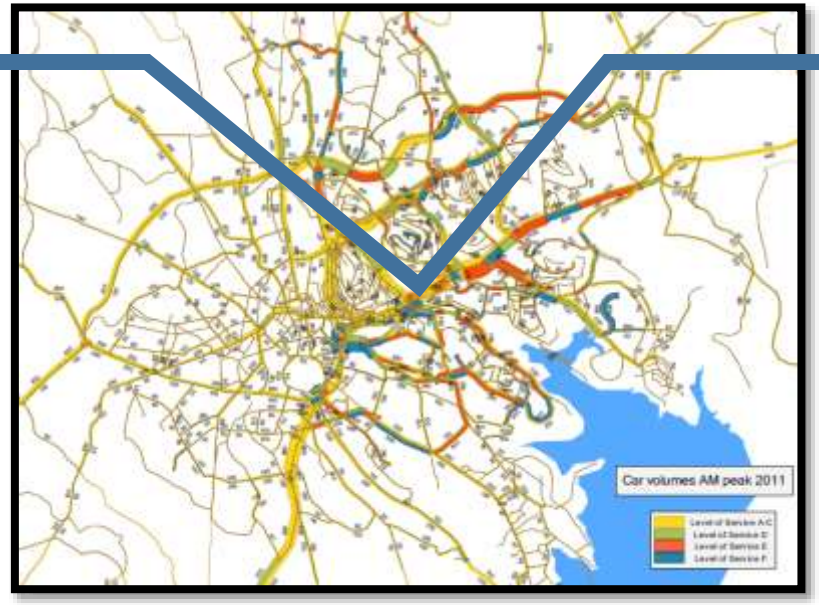


Traffic Impact Analysis allows for calculating the impact of new facilities. TransCAD's newest version also includes a processor for analyzing traffic impacts of multiple changes in the network and demand.

Characteristics (PEAK)	BASE	CAP+	Diff
Volume on link (Abay)	2,808	3,566	+758
Speed on link (Abay)	15.07	15.82	+0.75
Volume on near link (Tole-bi)	2,563	2,348	-215
Speed on link (Tole-bi)	12.33	12.96	+0.63
Total VKMT	719,175	716,878	-2,297
Total VHT	36,829	36,353	-476

Local traffic analysis (Micro-Simulation)

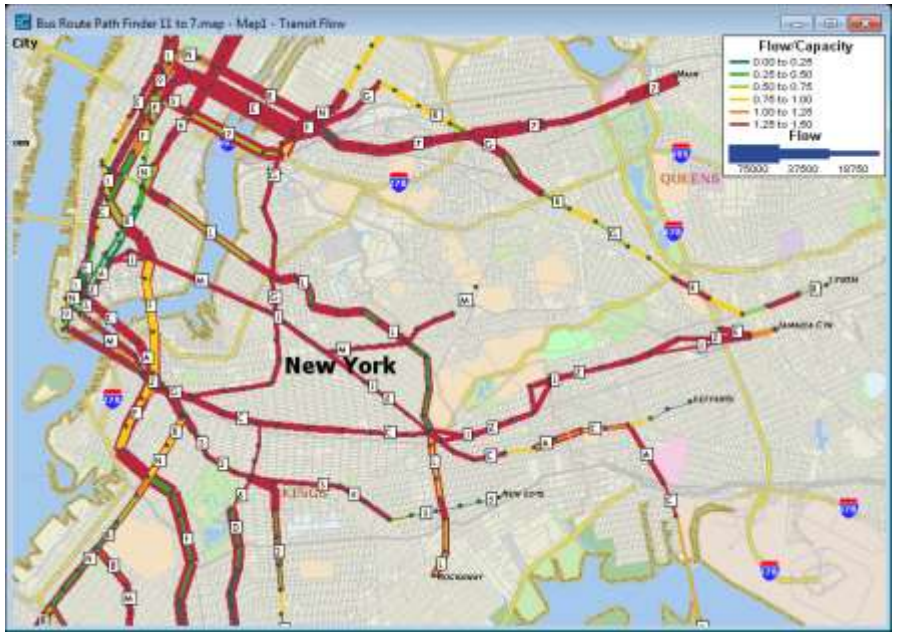
Traffic issues can be resolved using Micro-Modeling Technique. TransModeler uses TransCad output to simulate traffic flow and service

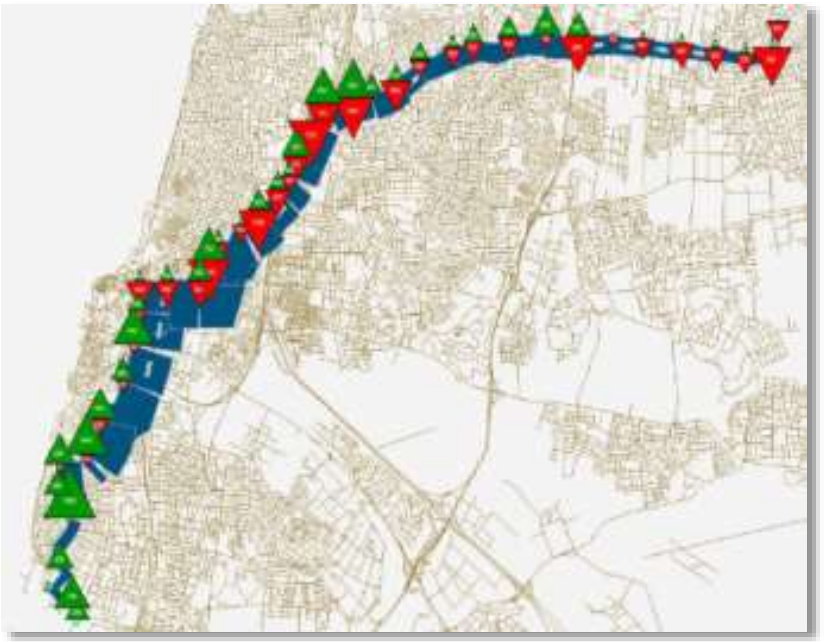


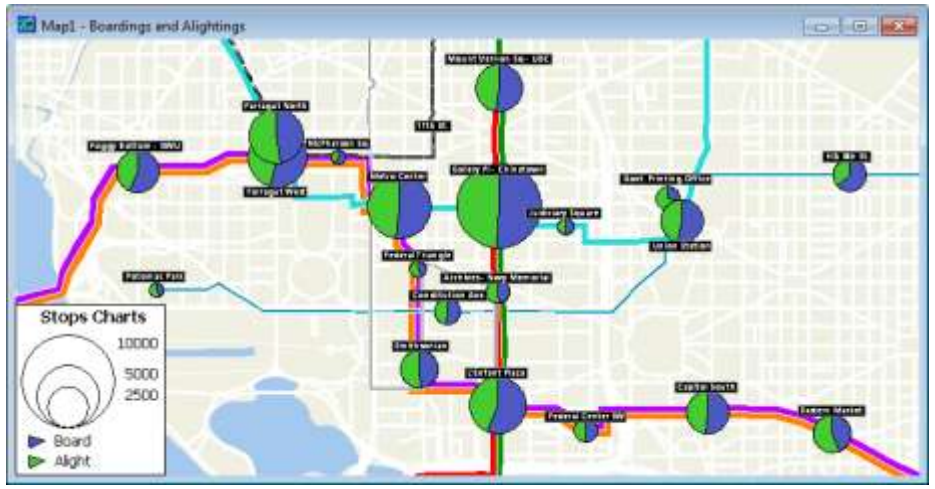
Example of Micro simulation

Powerful freight modeling

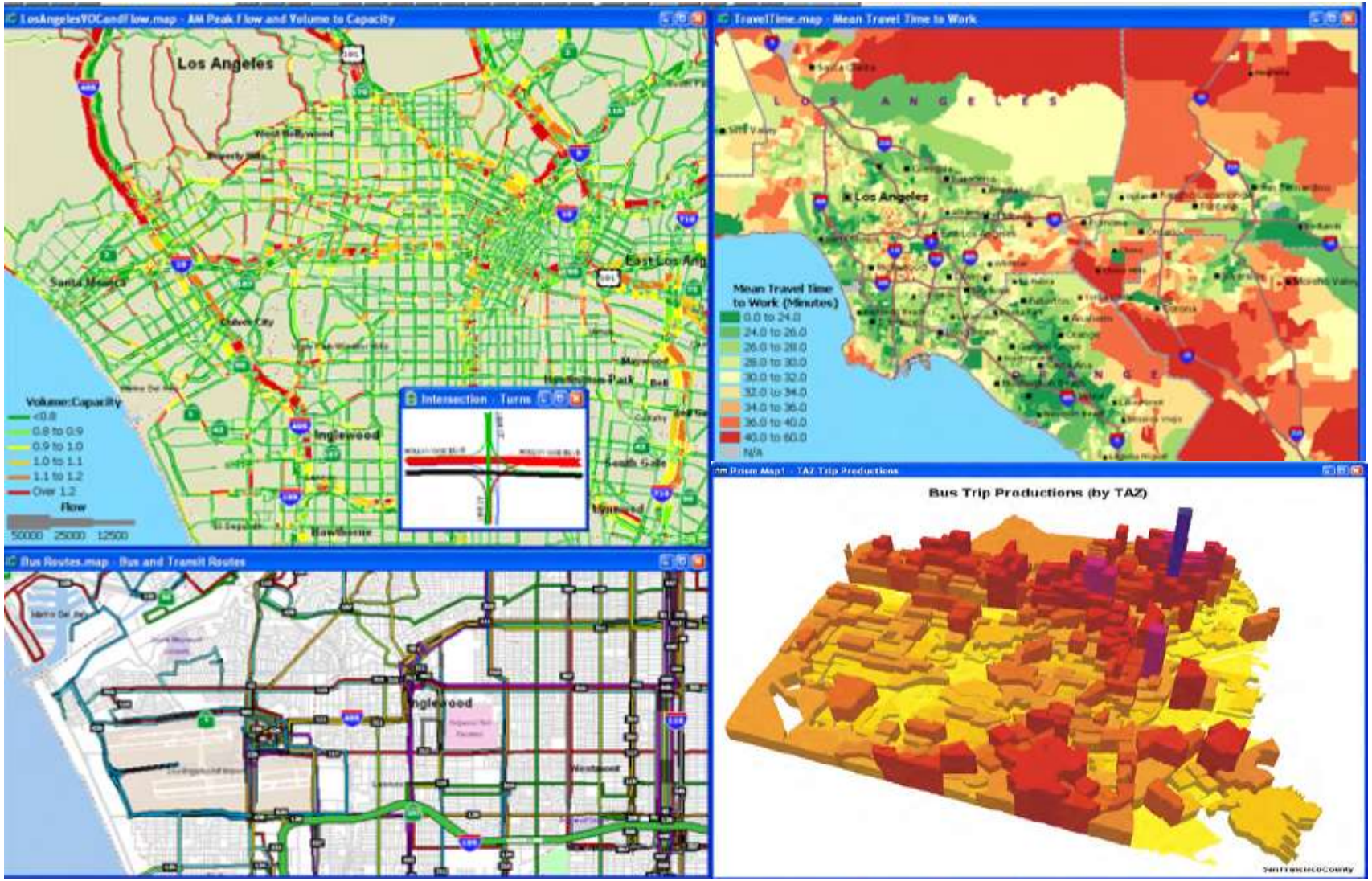
Strong PT capacity and high level display







Integrated Land-Use transportation planning tool

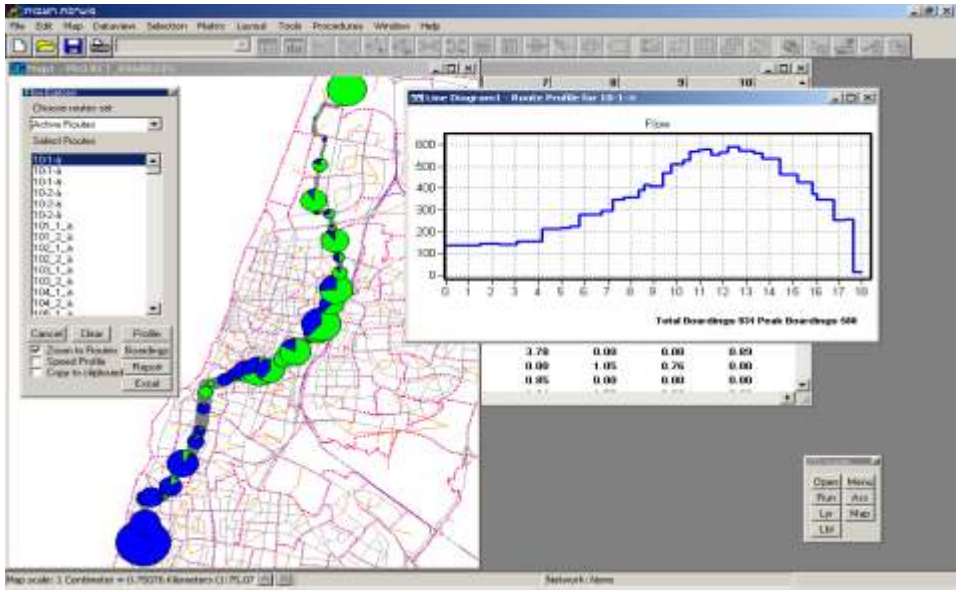


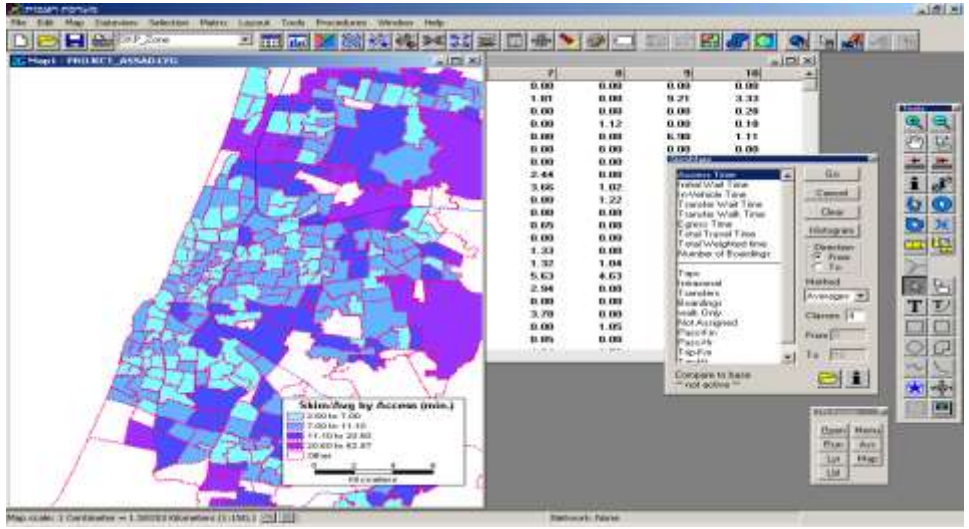
Full interface with Micro-simulation and traffic

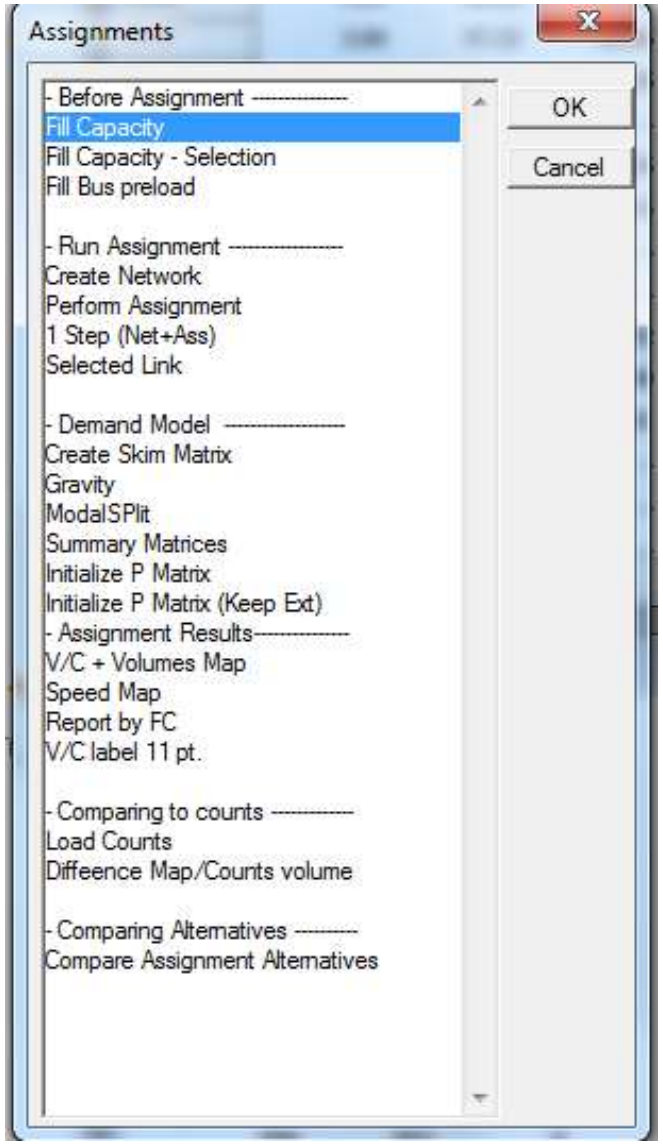
TransCad World-wide (2013)

Become a leading software in US, South America, Asia-Pacific and gaining popularity in the EU

Model shell

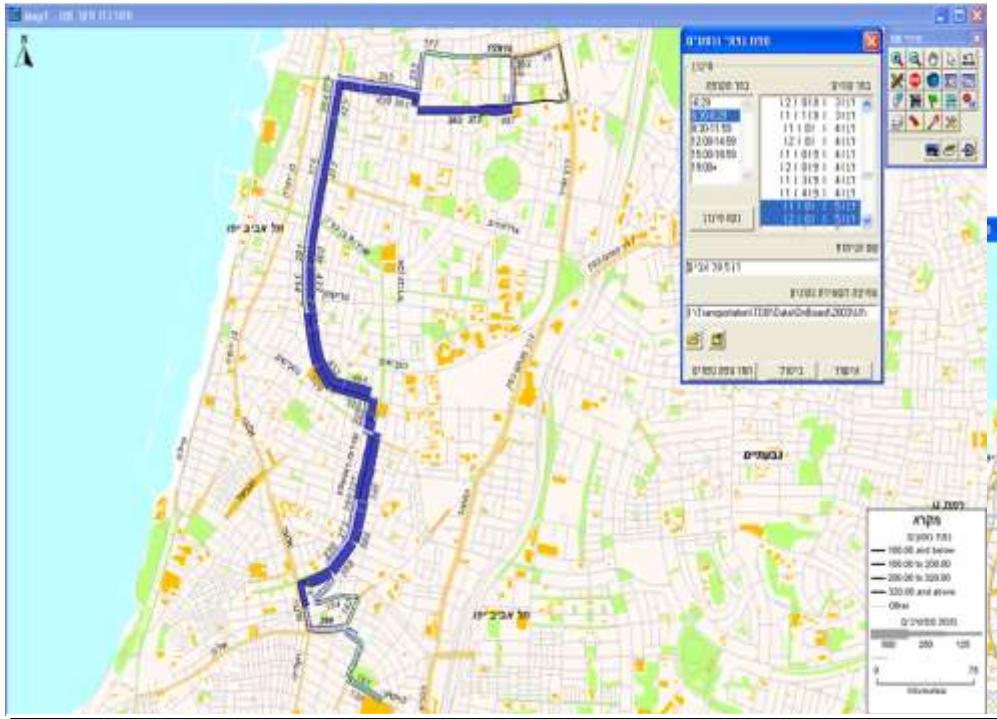




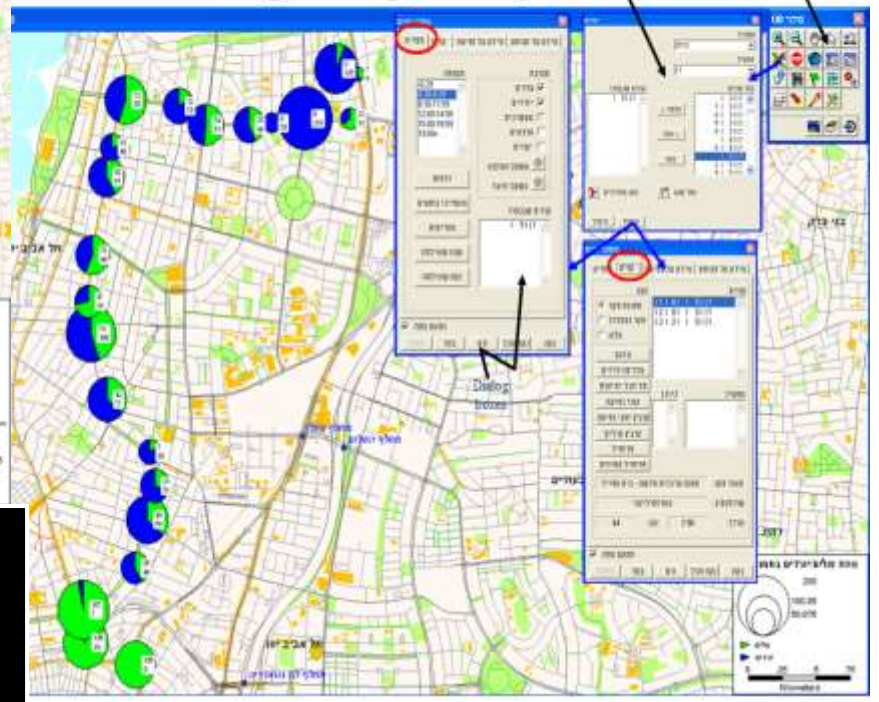

Assignments
- Before Assignment ----------
Fill Capacity
Fill Capacity - Selection
Fill Bus preload
- Run Assignment ----------
Create Network
Perform Assignment
1 Step (Net+Ass)
Selected Link
- Demand Model ----------
Create Skim Matrix
Gravity
ModalSPlit
Summary Matrices
Initialize P Matrix
Initialize P Matrix (Keep Ext)
- Assignment Results----------
V/C + Volumes Map
Speed Map
Report by FC
V/C label 11 pt.
- Comparing to counts ----------
Load Counts
Diffeence Map/Counts volume
- Comparing Alternatives ---------
Compare Assignment Alternatives
OK
Cancel

Model shell

Examples: Route passengers map



Examples: Route boarding and alightings map



High level representation and analysis of data that will be developed uniquely for Bucharest on the top of the standard T-Cad package by consultant

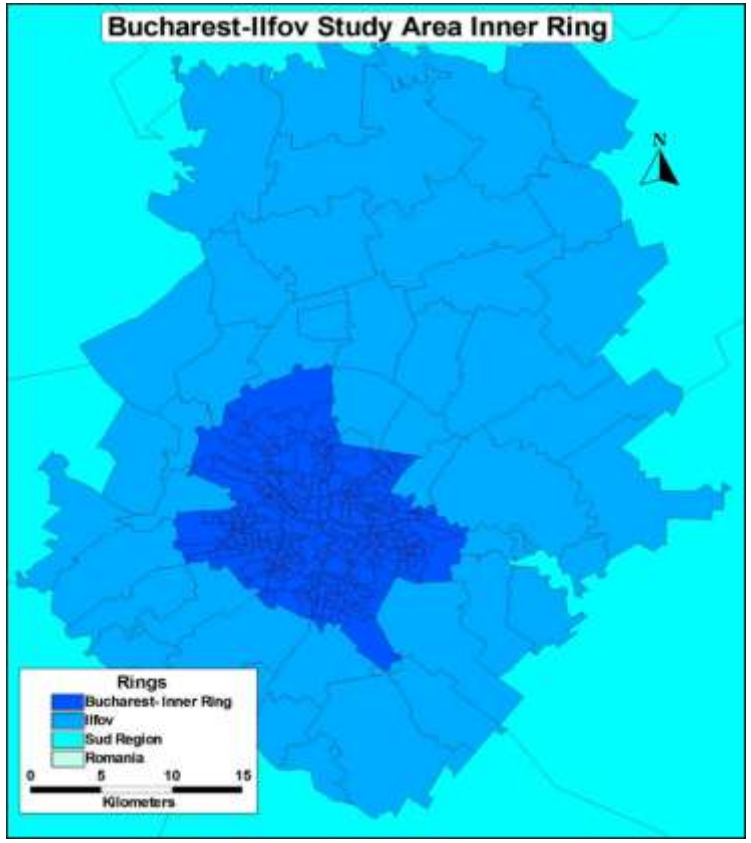
Part 3: TDM Inputs and Data

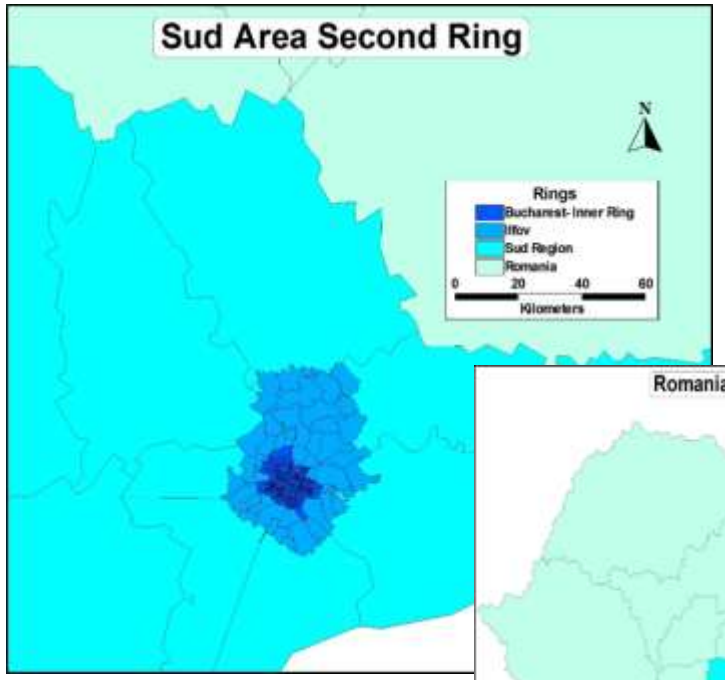
DATA for TDM

- **TDM absorbs great amount of data, that may come from various sources:**
  - **Census : socio-economic, “land use”, economic indicators**
  - **Networks, fares matrix**
  - **Surveys (travel habits, count, on board, GPS, interview, Ods, etc)**
  - **Operational (from PT operators for instance)**
  - **Master plan (for future networks and land use)**
  - **Parking, traffic management**

Model works in an aggregated fashion (ZONE BASED) so most of the data needs to fit to the zone system

Zone system for Bucharest





Developing model has 3 times more zones than previous one and include both Ilfov and beyond. This will provide much more accurate modeling framework and will refer to the city as a Metropolitian

Surveys undergoing – with over 70 students ☺

Innovative data collection and Surveys

Tablet Field survey

Computerized Travel-Habit Surrey

Real-Time Data analysis, QA and QC

GPS tracking

Trip-builder

TDM Input- Surveys

Travel Habits Survey

- 2014 THS with SP
- 2008 THS

4 Origin-Destination Surveys

On Board passenger Counts

Goods Movement

Traffic Counts

GPS Survey

Commuters' Survey

Google Traffic Speed

Network - Data

Road network

Field	Source	Purpose
Type	Field Survey	Calculation of capacity
Status	Project Inventory	Scenarios
Separation	Field Survey	Capacity calculation
Max Speed	National Standards	Calculation of trip times
Lanes	Field Survey	Calculation of capacity
Parking	Field Survey	Calculation of impedence
Traffic Control	Field Survey	Calculation of impedence
PT Infrastructure	Field Survey	Delineate presence of PT infrastructure on a link

Public Transport Scheme

Field	Source	Purpose
Type	Consultant Coding	Differentiate between PT modes
Intervals AM	Official Operator Timetables	Time between vehicle trips
Length	Consultant Mapping	Calculation of ride times
Frequency	Consultant Calculation	Vehicle trips per hour
Fleet	RATB	
VKMT/VHT	GIS	

Part 4: TDM Structure

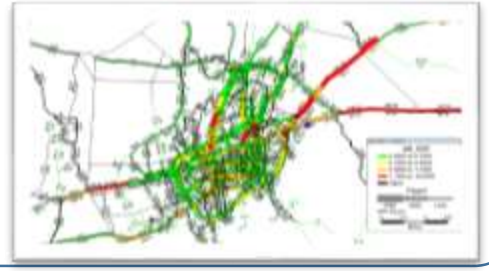
4 step model

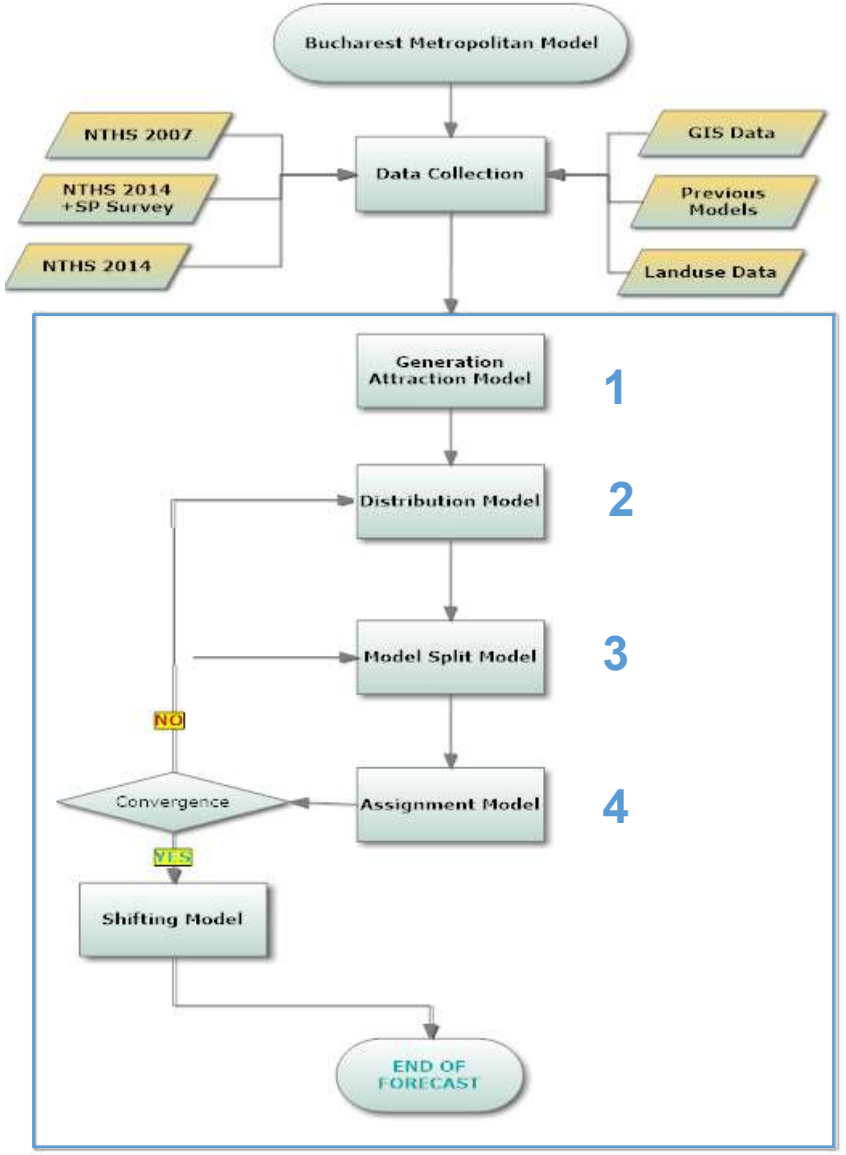
Trip Generation – Based on trip productions from origins to destinations to and from transportation analysis zones (TAZ).

Trip Distribution – Based on trip generation, define the destinations for each origin. This typically uses a gravity model.

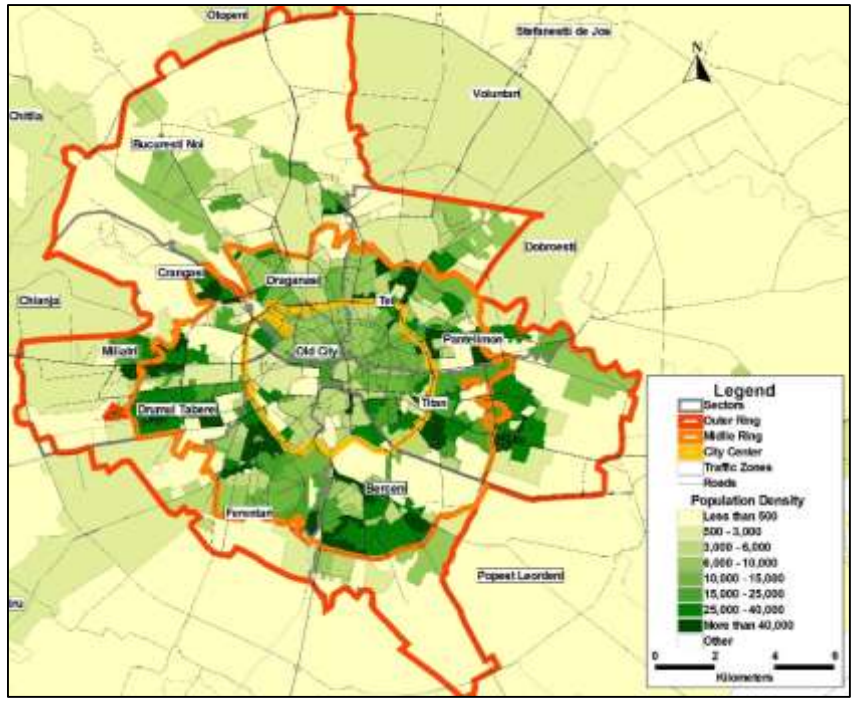
Mode Choice – The various modes are selected, which may include auto, bus, light rail, heavy rail, metro, walking, bicycling and other modes.

Assignment – Trips are assigned to specific paths (roads or routes) and an output is given to account for congestion, pollution, traffic flow, levels of service, etc.




Bucharest Metropolitan Model
NTHS 2007
NTHS 2014 +SP Survey
NTHS 2014
Data Collection
GIS Data
Previous Models
Landuse Data
Generation Attraction Model
1
Distribution Model
2
Model Split Model
3
NO
Convergence
Assignment Model
4
YES
Shifting Model
END OF FORECAST

TDM Step 1- Trip Generation



- Population by zone
- Area of Traffic Analysis Zone
- Gender Distribution
- Workforce Distribution
- Age Distribution
- Education Level Distribution
- Household size distribution
- Dwelling size distribution

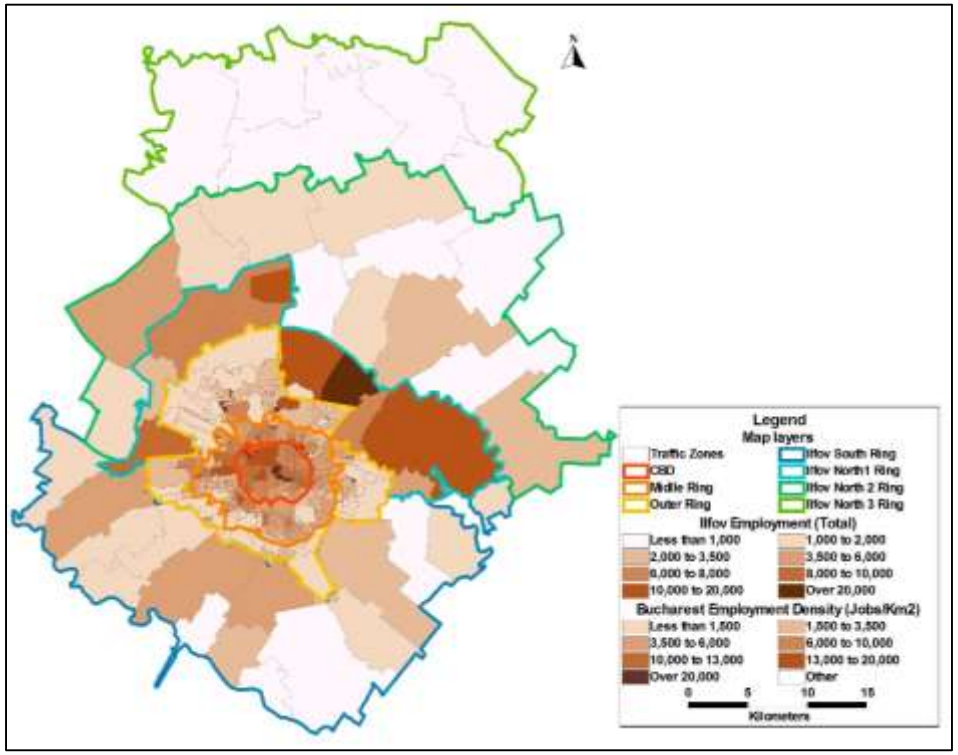
Production= From where People Come

Home, Other than Home

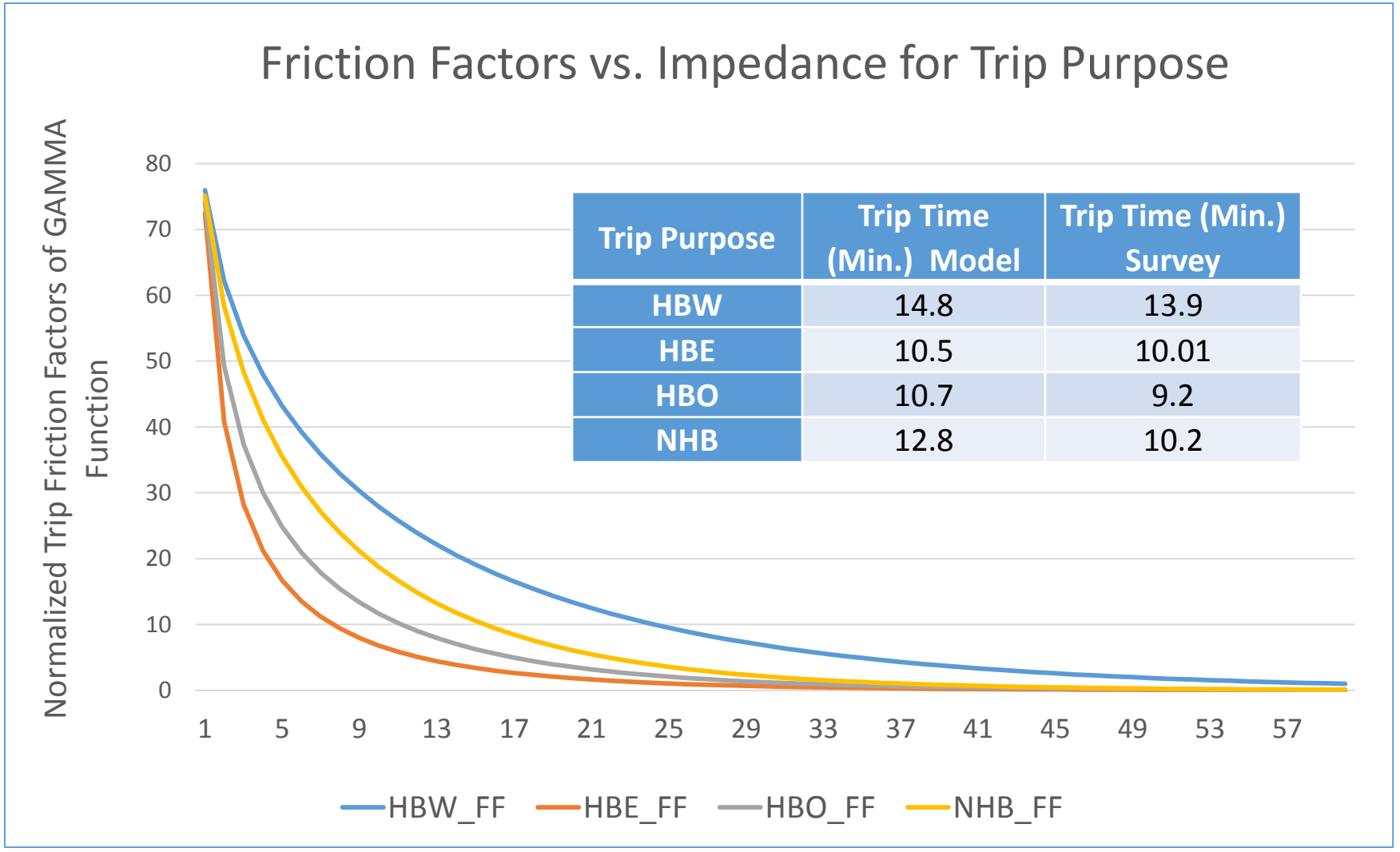
$$Trip\ Generation\ by\ Zone = f\{Explanatory\ Variables\}$$

Attraction= Where do People Go:

Work, School, Leisure

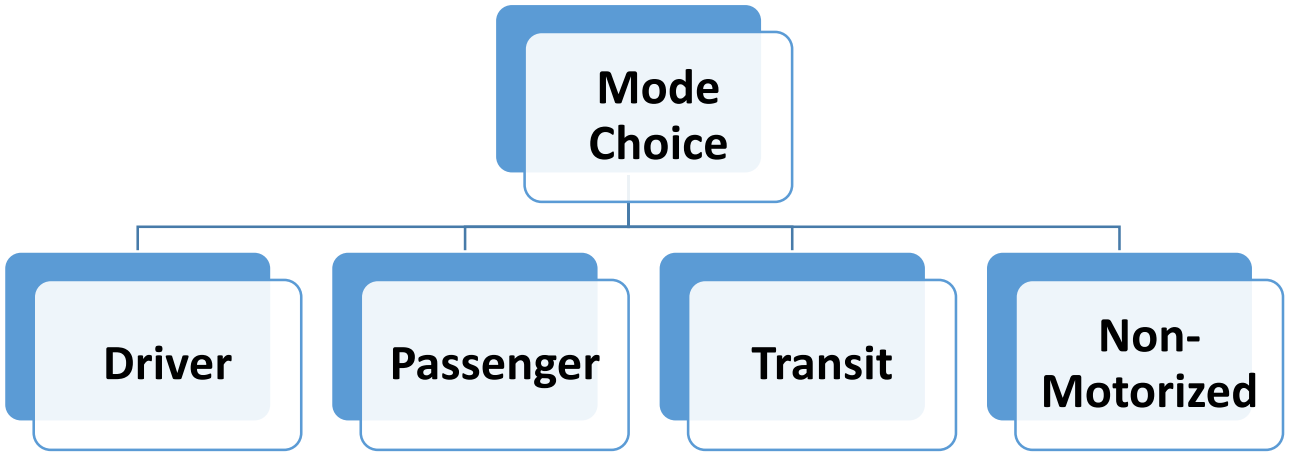


TDM Step 2- Trip Distribution



Trip Purpose	Trip Time (Min.) Model	Trip Time (Min.) Survey
HBW	14.8	13.9
HBE	10.5	10.01
HBO	10.7	9.2
NHB	12.8	10.2

TDM Step 3- Mode Split



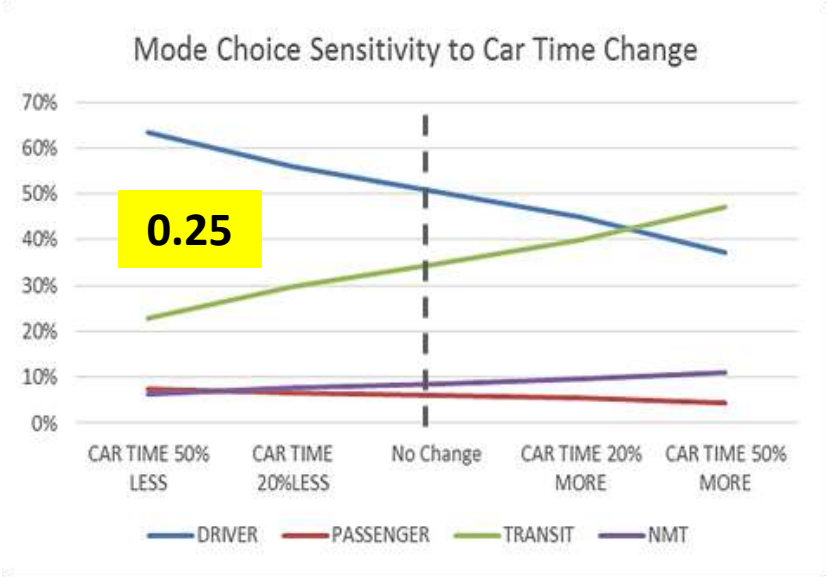
Consider: How do these factors affect your decision?

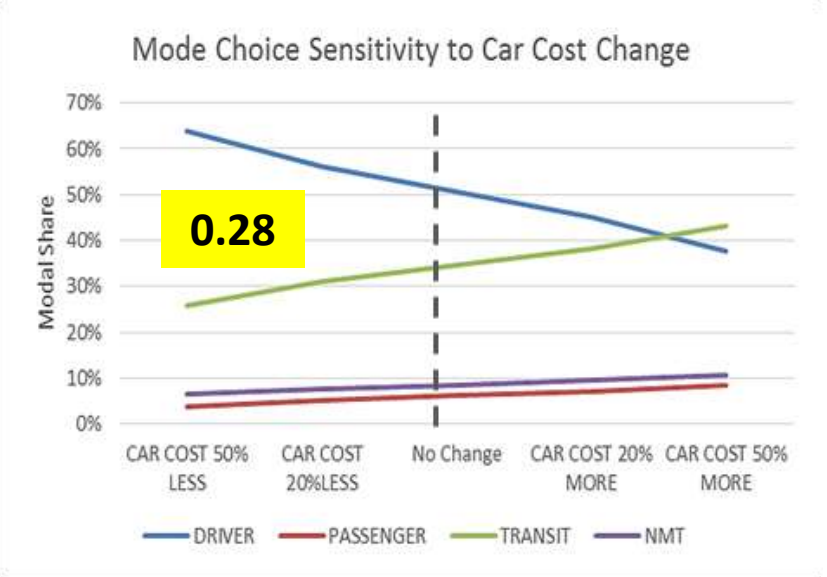
- Travel time
- Fare
- Wait-time
- Convenience
- Auto ownership
- Availability (is a given mode even an option?)

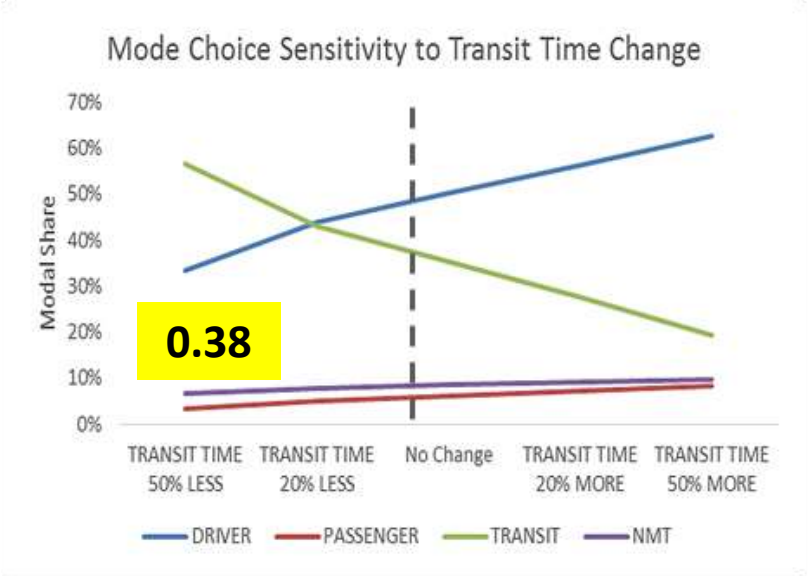
Choice	HBW	HBE	HBO	NHB
DRIVER	49.7%	5.3%	17.9%	39.0%
PASSENGER	8.4%	8.6%	5.7%	7.3%
PT	33.2%	54.9%	21.6%	31.7%
NMT	8.1%	29.6%	54.1%	20.8%

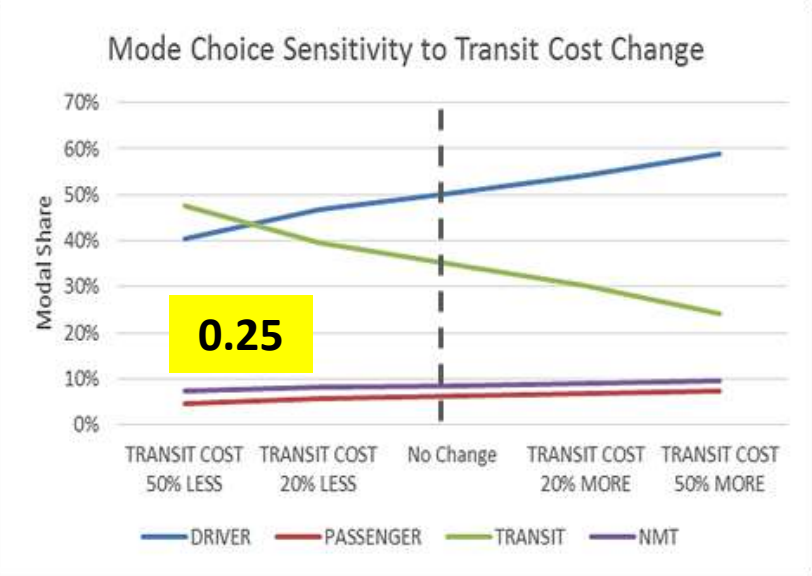
The Probability of Choosing a Specific Mode is Often a Function of: Number of cars in the household, Car availability for the individual, Gender, Whether the person works

Mode Choice Sensitivity

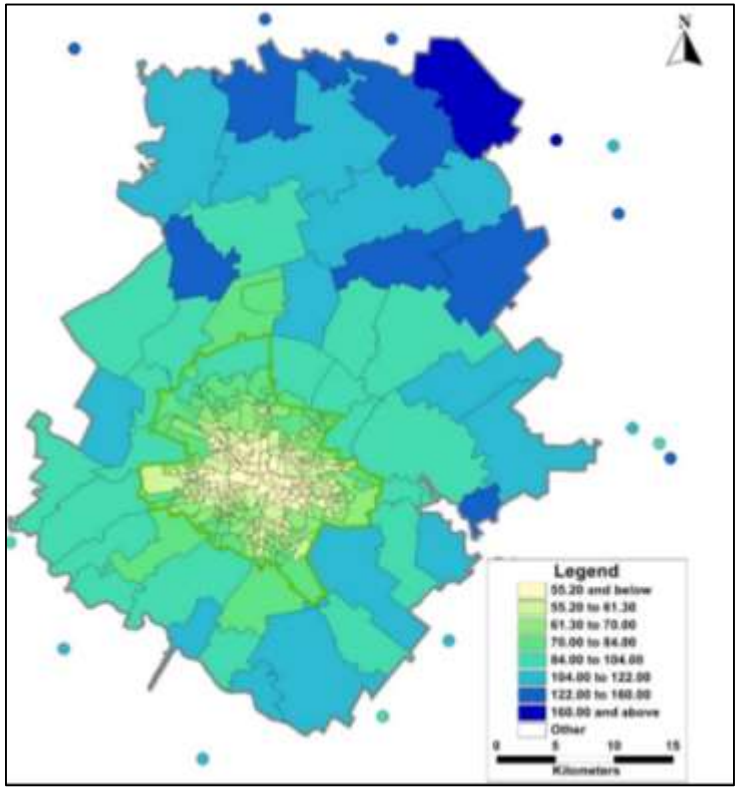




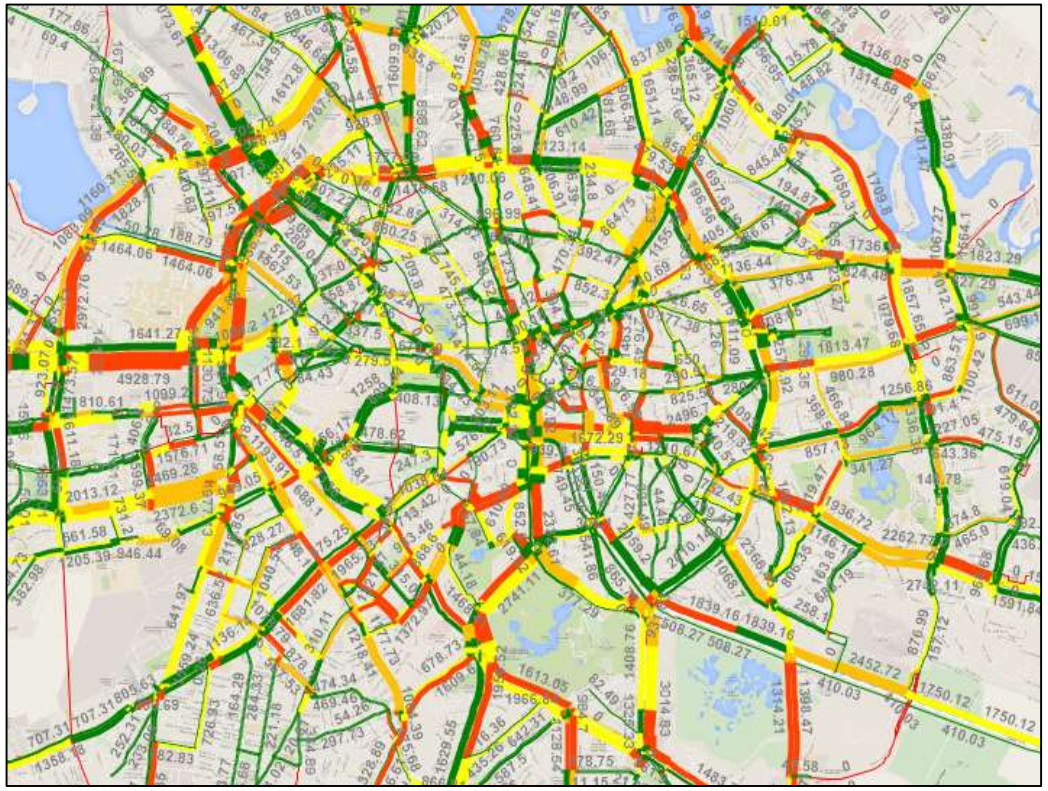




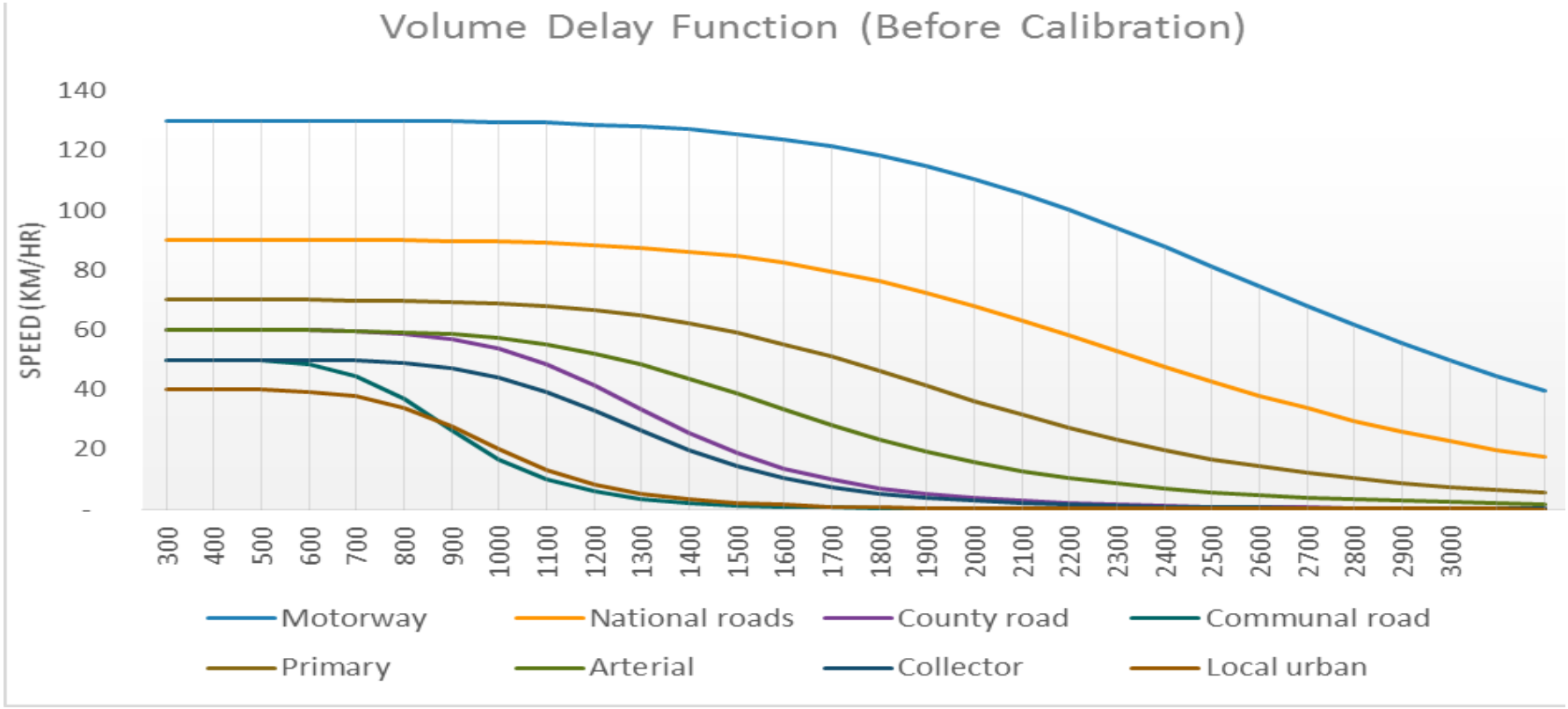
Public Transport Average Travel Time



Vehicle Over Capacity- AM Peak Bucharest



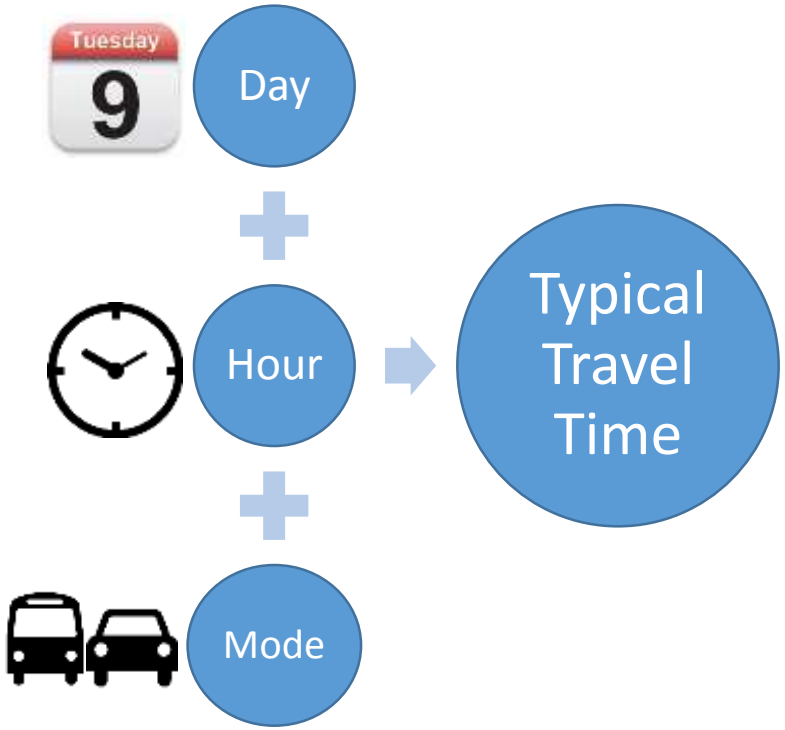
Network – Volume Delay Function

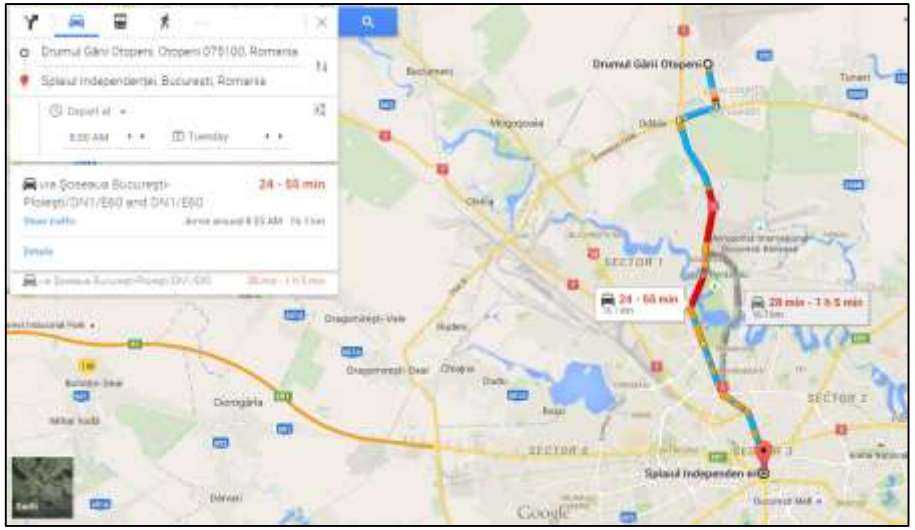


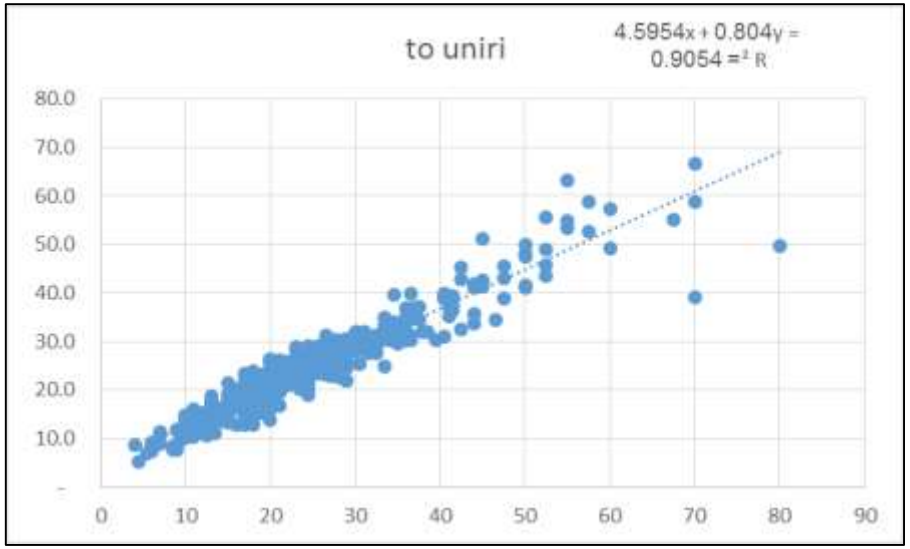
$$T_f = T_o * \left(1 + \alpha * \left[\frac{V}{C}\right]^{\beta}\right)$$

Initial Capacity = Lanes * Lane Capacity * Separation Factor * Parking Factor * Traffic Control

Developed Excel Macro that compiles data mining from Google Traffic database

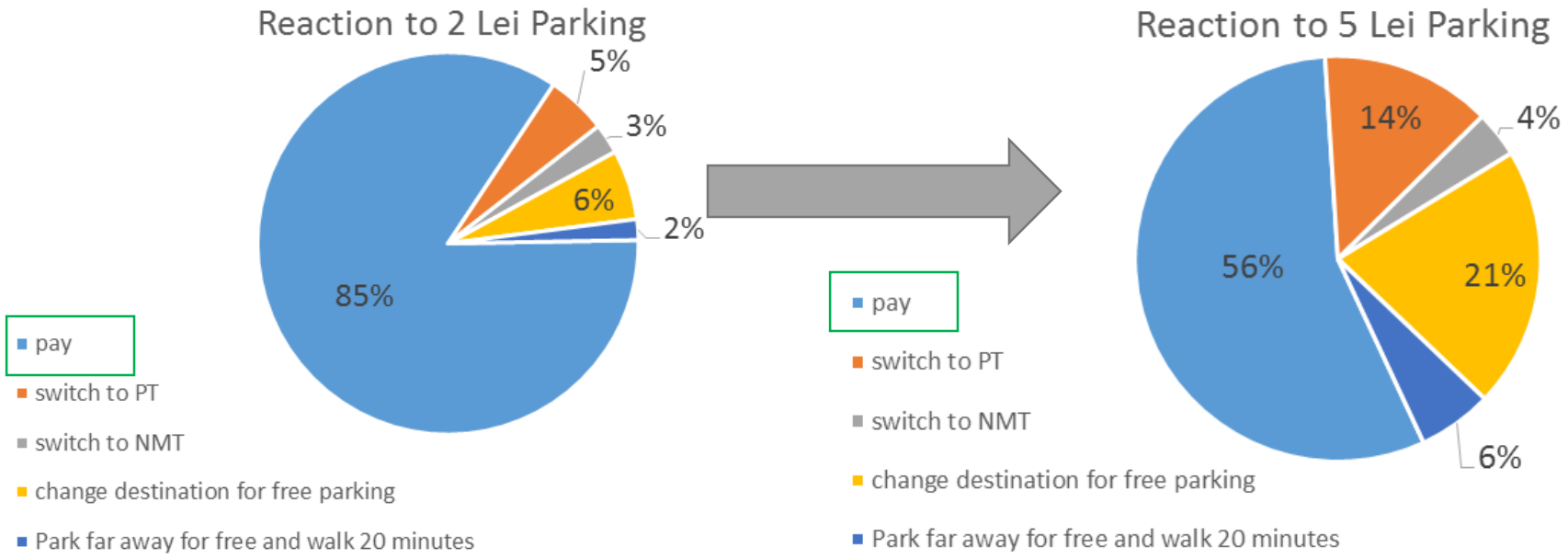


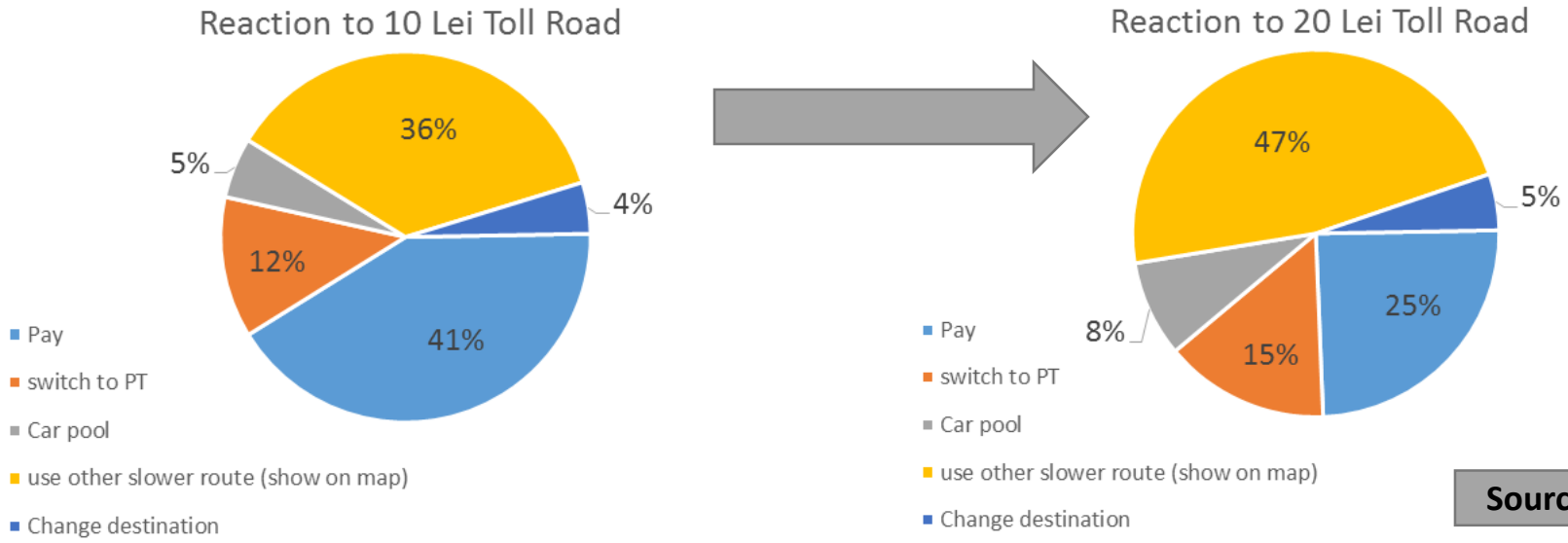




Route	Average Time
To Unirii- Google	24.74
To Unirii- Model	24.48
From Unirii- Google	21.91
From Unirii- Model	19.41

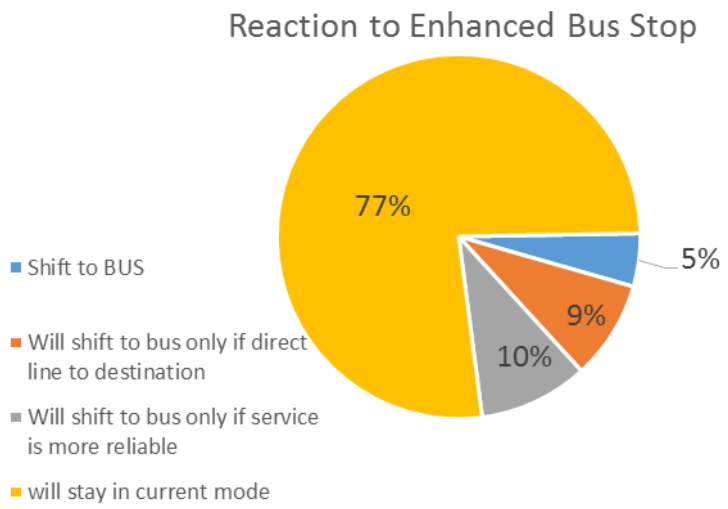
Potential for Change – Reducing Car Dependency

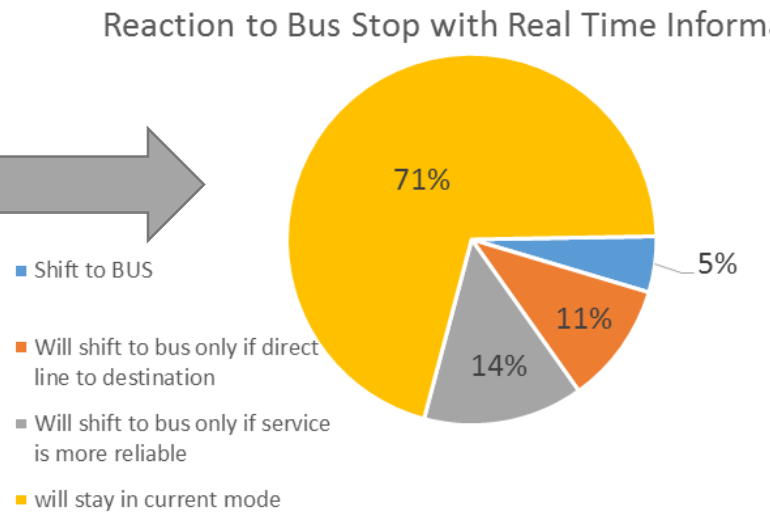


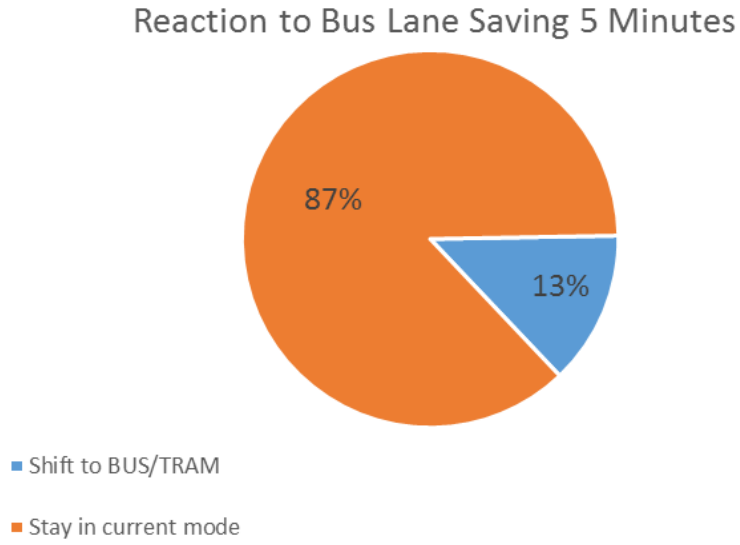


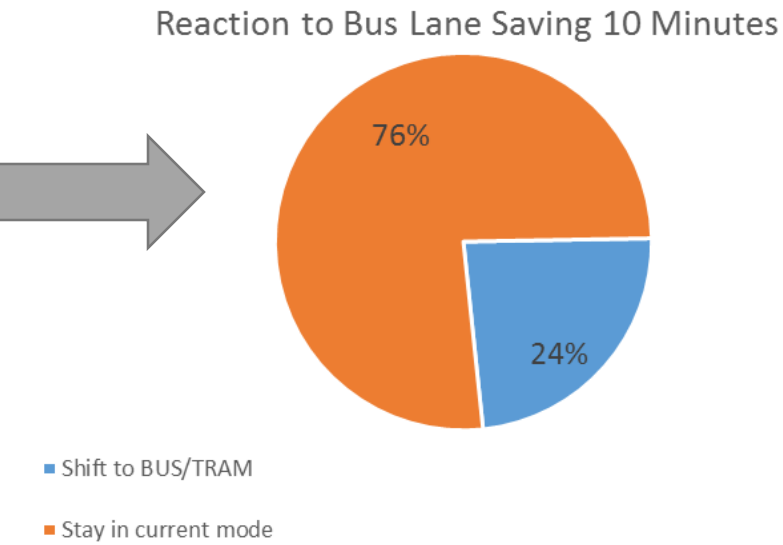
Source: 2014 THS

Potential for Change – Encouraging Transit Usage









Source: 2014 THS

Sustainable Urban Mobility

TRAINING SESSION 1B

Transportation planning and TDM

European Bank
for Reconstruction and Development

ROM
רום הנדסת תחבורה בע"מ
Transportation Engineering Ltd.

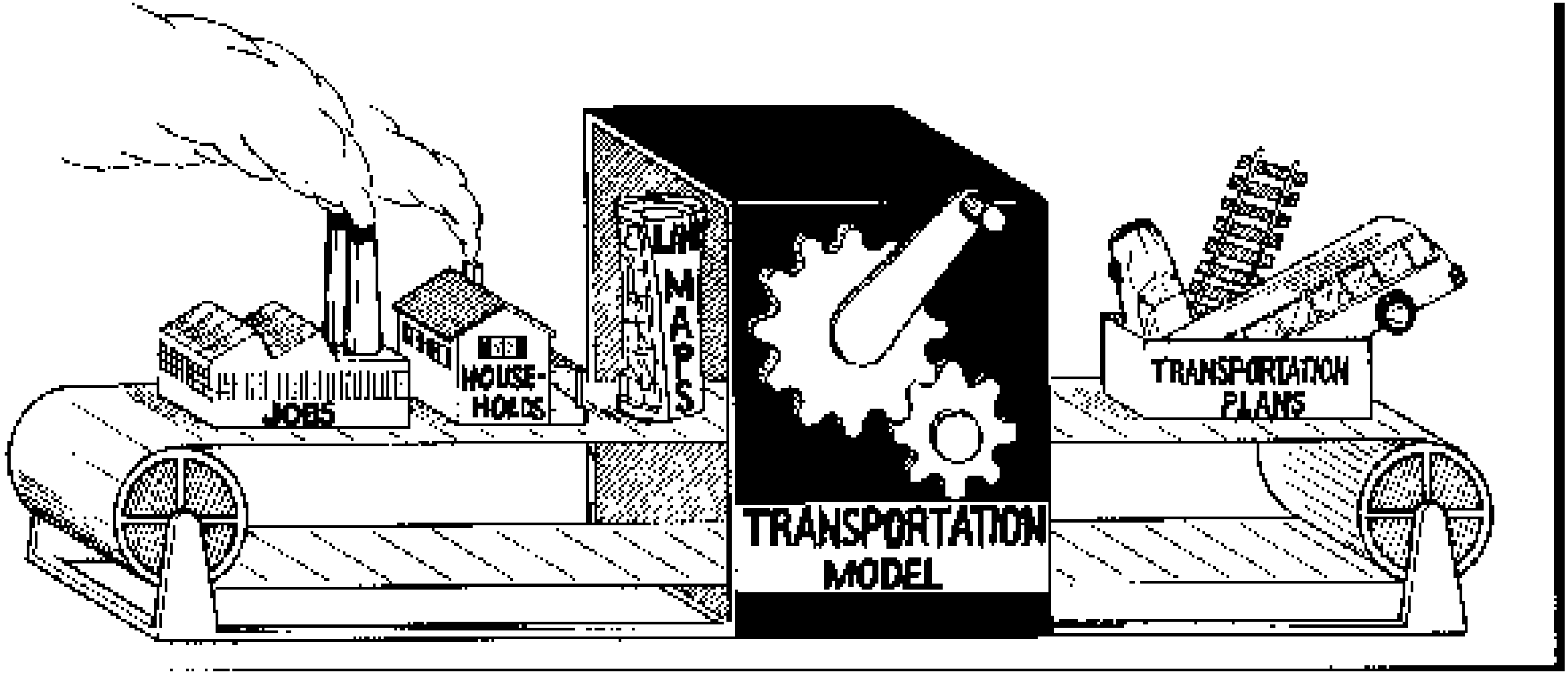
AVENSA

Issues to discuss

1. Introduction to Transport Models.
   - 1.1 What is TDM.
   - 1.2 Importance of TDM.
   - 1.3 Classical vs. Non-Classical Models.
2. Four Step Models
   - 2.1 Generation Models.
   - 2.2 Distribution Models.
   - 2.3 Mode Split Model.
   - 2.4 Assignment Model.
3. Complexity vs. Efficiency, Model Pitfalls.
4. Recommended Reading.

Part 1: Introduction to Transport Demand Models

What is a Travel Demand Model?

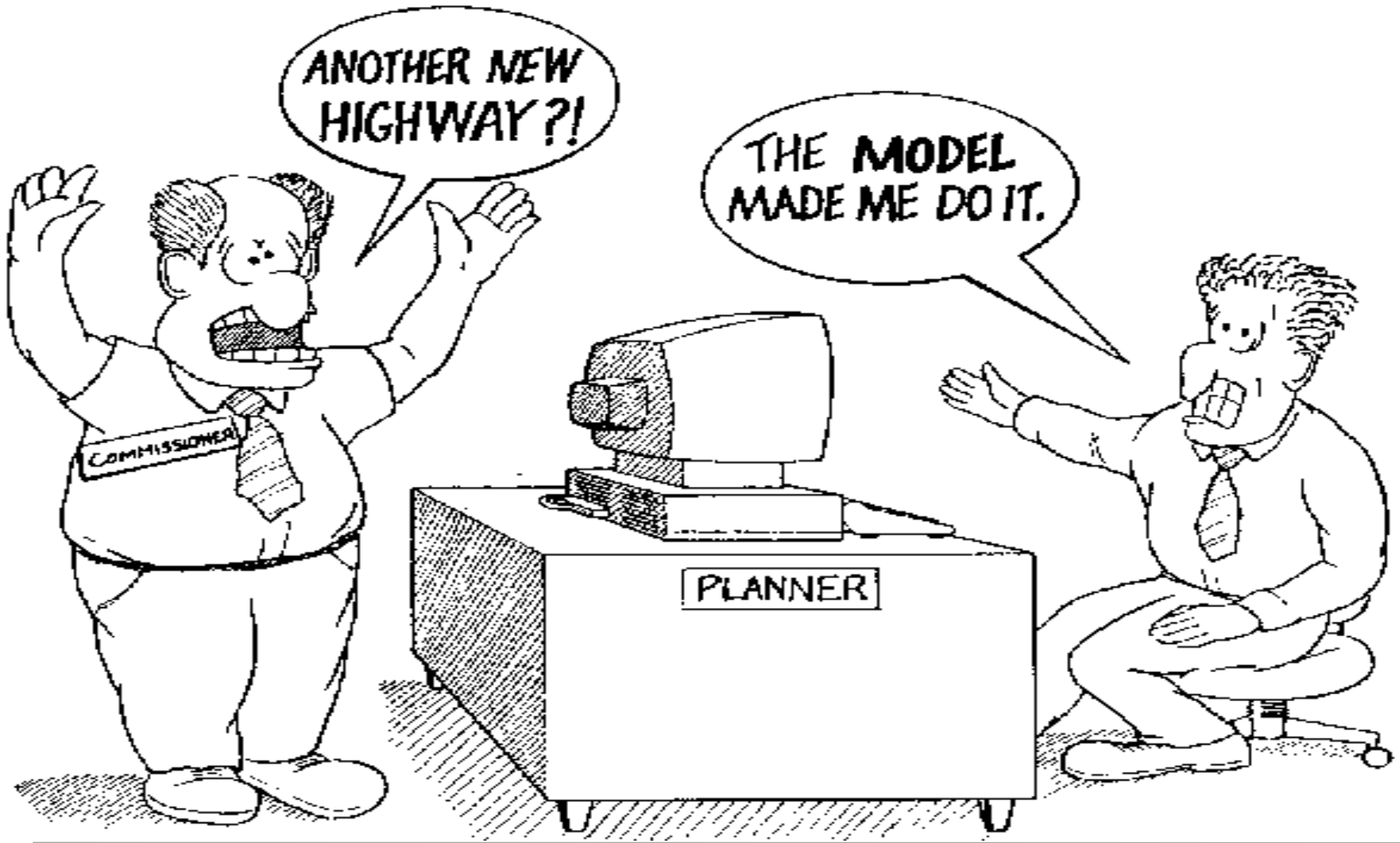


What is a Travel Demand Model?

- This term is used to refer to a series of mathematical equations that are used to represent how choices are made when people travel.

- Decisions of Travel are affected by many factors such as family situations, characteristics of the person making the trip, and the choices (destination, route and mode) available for the trip.

Importance of TDM



Importance of TDM

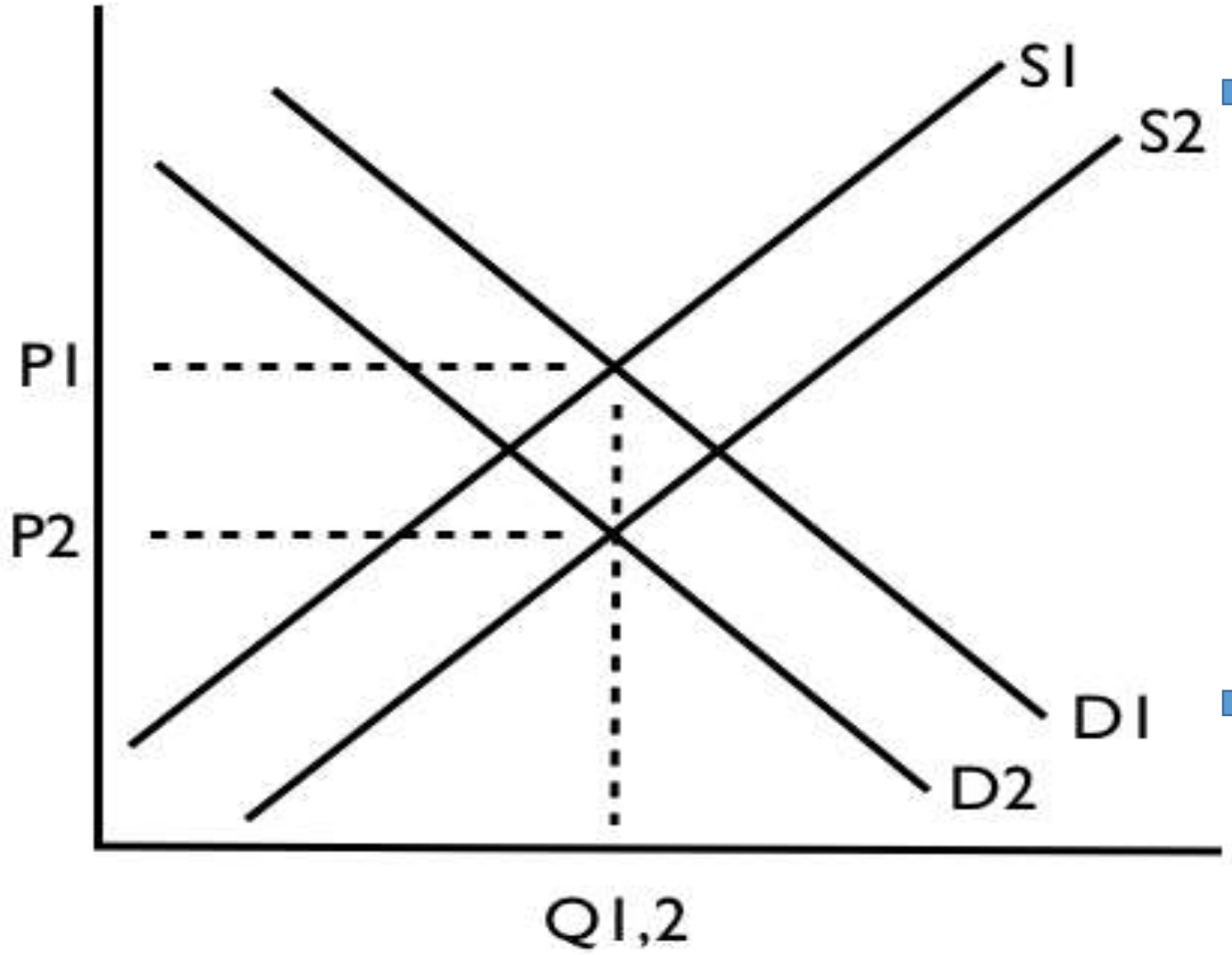
Can be Summarized in Two Points:

- Determining Future Demand for Travel: Transportation Investments, Sustainable Transport Alternatives.

- Policy Evaluation: Toll roads, Parking price, parking lots, HOV lanes, …etc.

Importance of TDM

Can be viewed as a Tool to Match Demand and Supply



Transportation Infrastructure: Roads, Transit

Change in Socio-Economic Factors, Economic Development Migration

To Summarize:

- Transport Models are Statistical and Mathematical Tools.

- Transport Demand Models are the answer to Scenarios of **“What if”**:
  - Policies: Congestion Pricing, New Transit Fares, …etc.
  - Change in Population: Migration, Increase in Population.
  - Change in Socio-Economic Variable: Income, Car Ownership.
  - Change in Employment and Land-Use: New Work Zones.

Classical vs. Non-Classical TDM

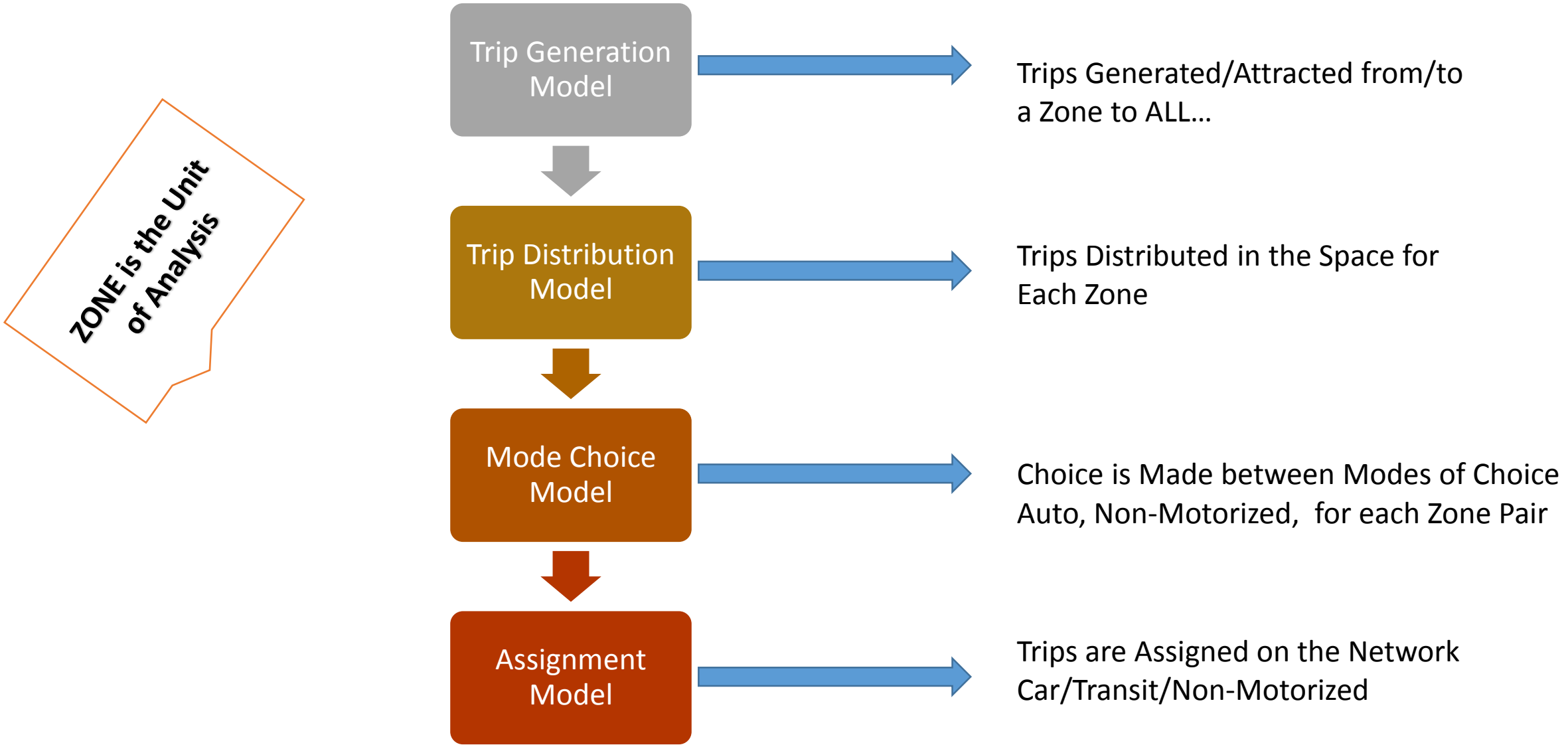
Classical Model:

- Four-Step Models.
  - Simplified Model
  - Follows a Simple Common Sense.
  - Most Widely Used.
  - Simple tools of Estimation and Maintenance of the Model.
  - Provides answers to most of Demand and Supply Questions.

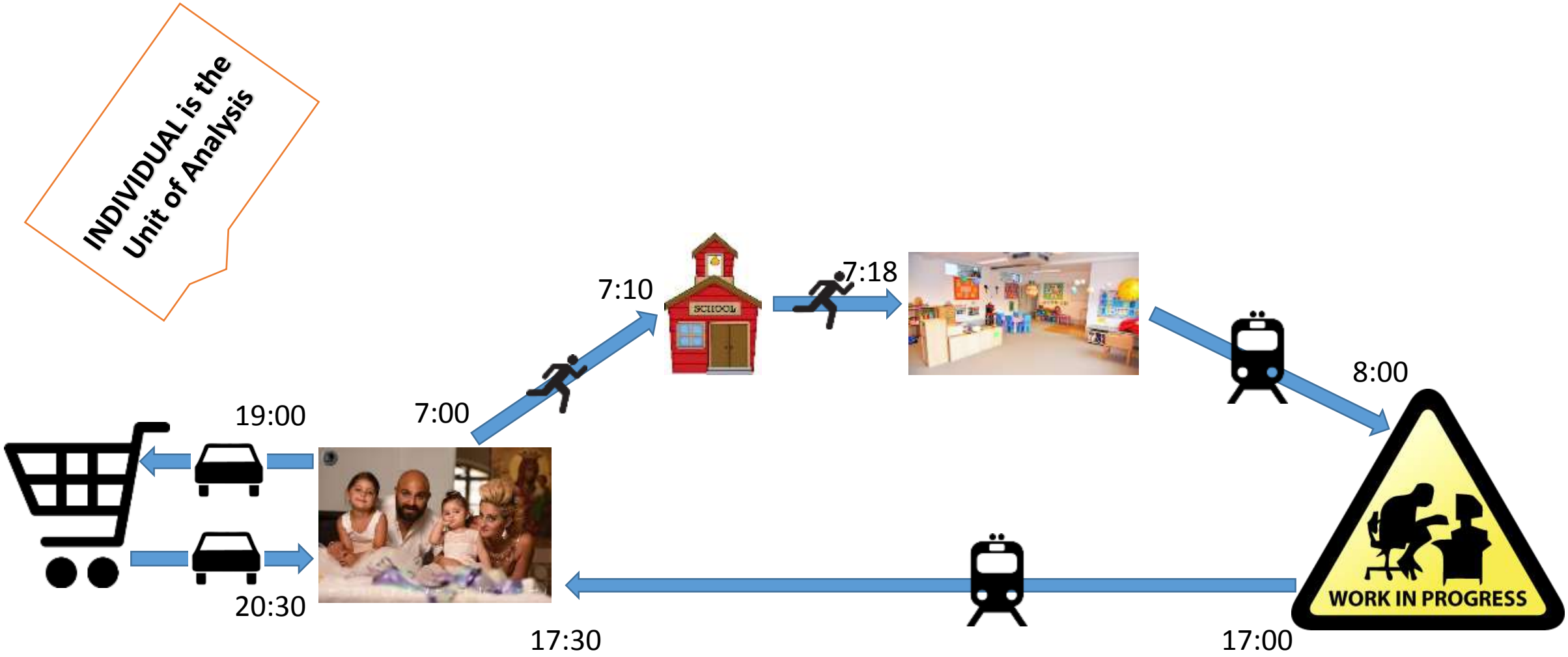
Non-Classical Model:

- Activity Based Models.
  - Complex Model
  - Behavioral Based
  - Very Sensitive to Policy
  - Less Widely Used
  - More Dynamic Demand

Classical Models 4 Step Models



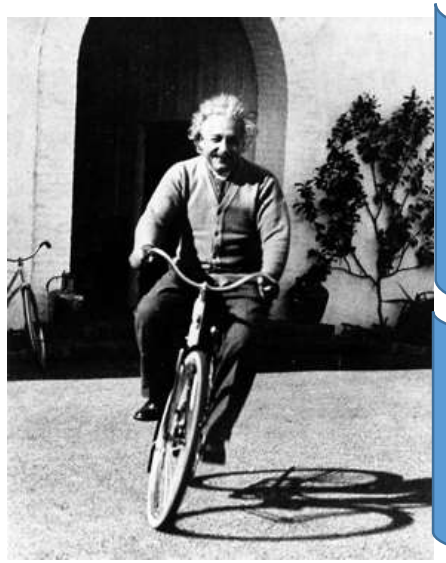
Non-Classical 4 – Activity Based



Type of Model to Choose

Complexity vs. Simplicity:

- **Simple Models are more stable.**
- **More experience in 4 Step Models.**
- **Sensitive Enough to Policy.**



Everything Should be made as simple as possible, but not simpler.

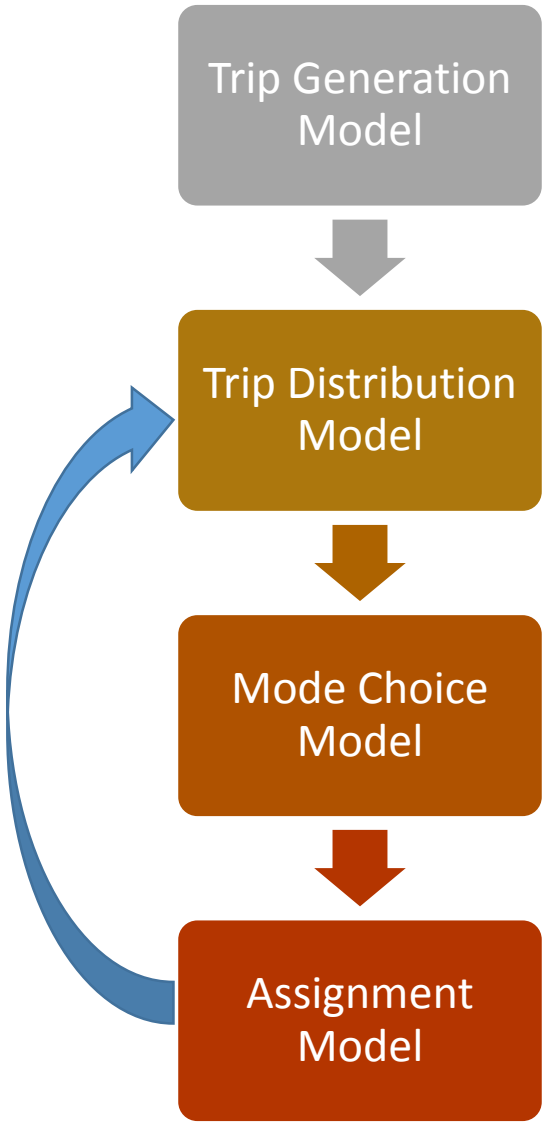
If you cannot explain it Simply, you do not understand it Well.

Practically:

- **Data Availability.**
- **Model Cost in Terms of Time and Money**

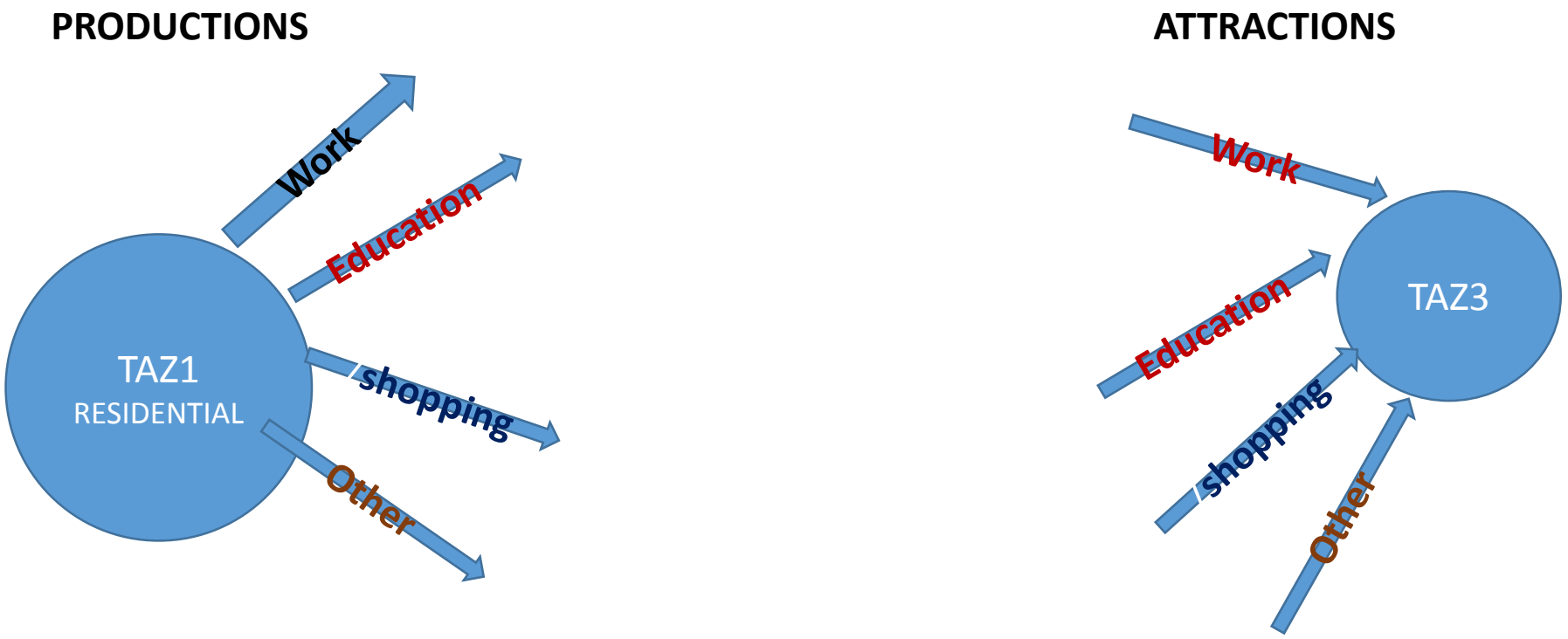
Part 2: Four Step Models •

Four Step Models



STEP 1: Trip Generation

- How Many Trips Does Each Zone Produce for EachTrip Purpose



STEP 1: Trip Generation

- Regression Models:

Productions = f (Socio-Economic Characteristics, Zonal Characteristics)

Ex. HH size, income, work status, age group, … etc.

Attractions = f(Zonal Work Activity, Land Use,…etc)

Ex. Work Space, Shopping Centers,…etc

Example: Simple Linear Regression Model for Home-Based Work Trips - Bucharest

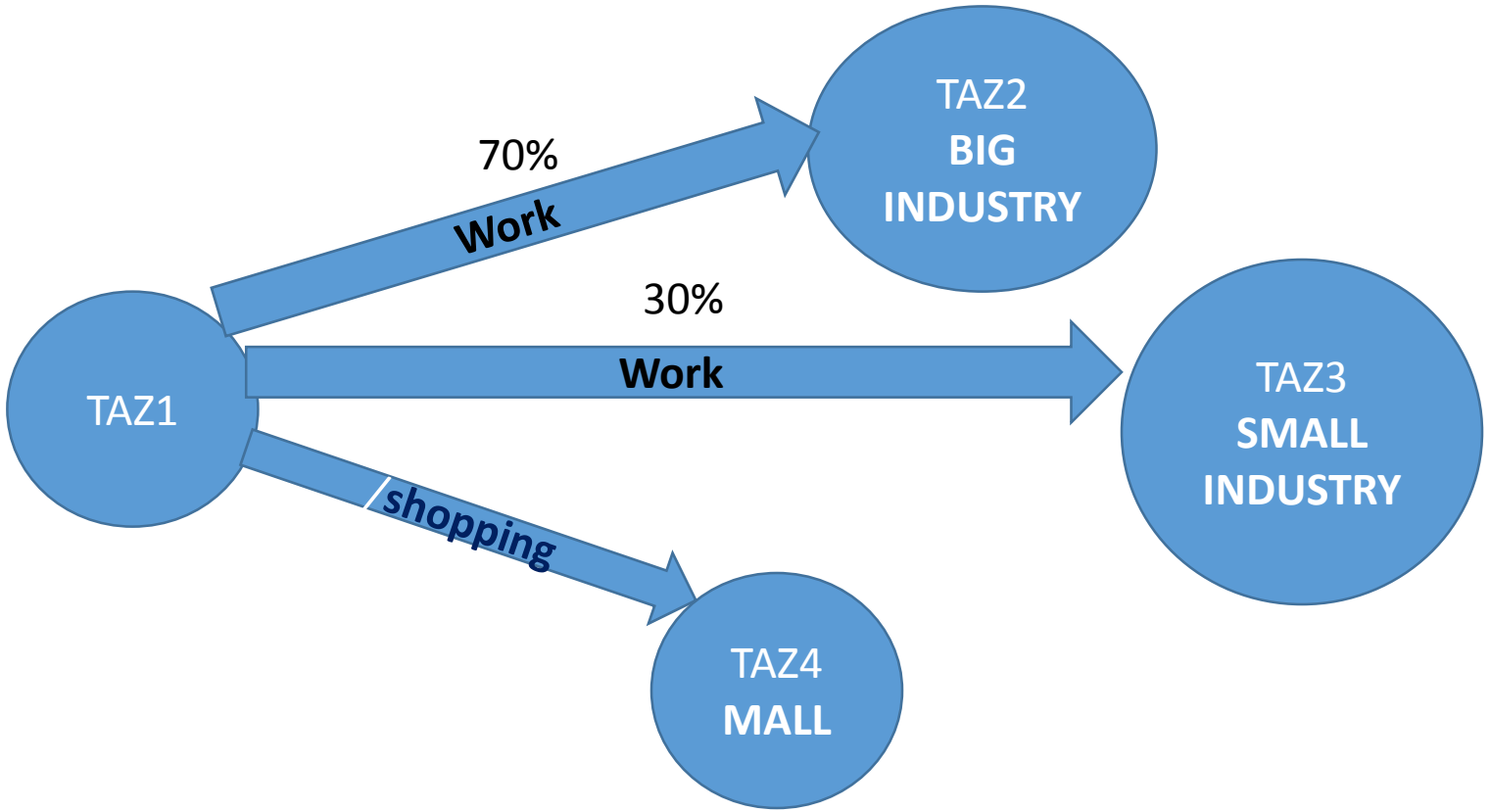
HBW - PRODUCTIONS	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Age_20-24	.271	.098	.062	2.75	.006
Work_Employed	.695	.017	.926	40.93	.000

STEP 1: Trip Generation – Result

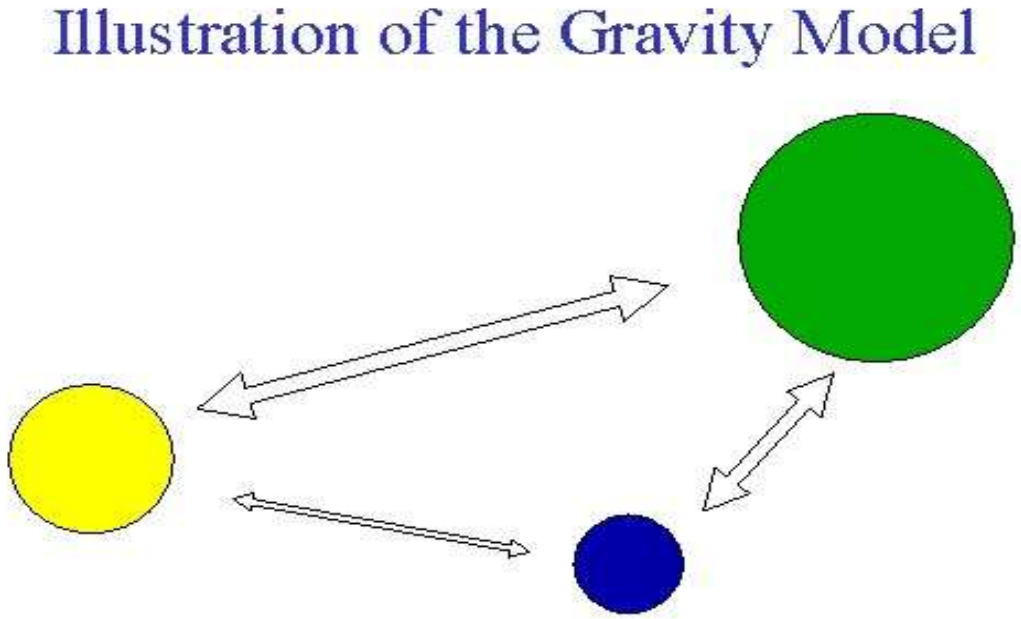
ZONE ID	PRODUCTIONS	ATTRACTIONS	
1	850	0	→ Residential Zone
2	730	530	→ Mixed Land Use
3	20	50	→ Small Zone
4	0	630	→ Industrial Zone
5	0	0	→ Empty Zone?

STEP 2: Trip Distribution

Matches origins with destinations



Most Widely Used: Gravity Model.



The shorter the distance between two objects, and the greater the mass of either (or both) objects, the greater the gravitational pull between the objects.

STEP 2: Trip Distribution

- Gravity Model
  - $T_{ij} = T_i \dfrac{A_j / C_{ij}^{\,a}}{\text{Sum}\,(A_x / C_{ix})^{a}}$

You can consider this as the probability spatial distribution P(Tj)

    - T_{ij} = trips from zone i to zone j
    - T_i = total trips originating at zone i
    - A_j = attraction factor at j
    - A_x = attraction factor at any zone x
    - C_{ij} = travel friction from i to j expressed as a generalized cost function
    - C_{ix} = travel friction from i to any zone x expressed as a generalized cost function
    - a = friction exponent or restraining influence

STEP 2: Trip Distribution

Result: A Matrix for Each Trip Purpose

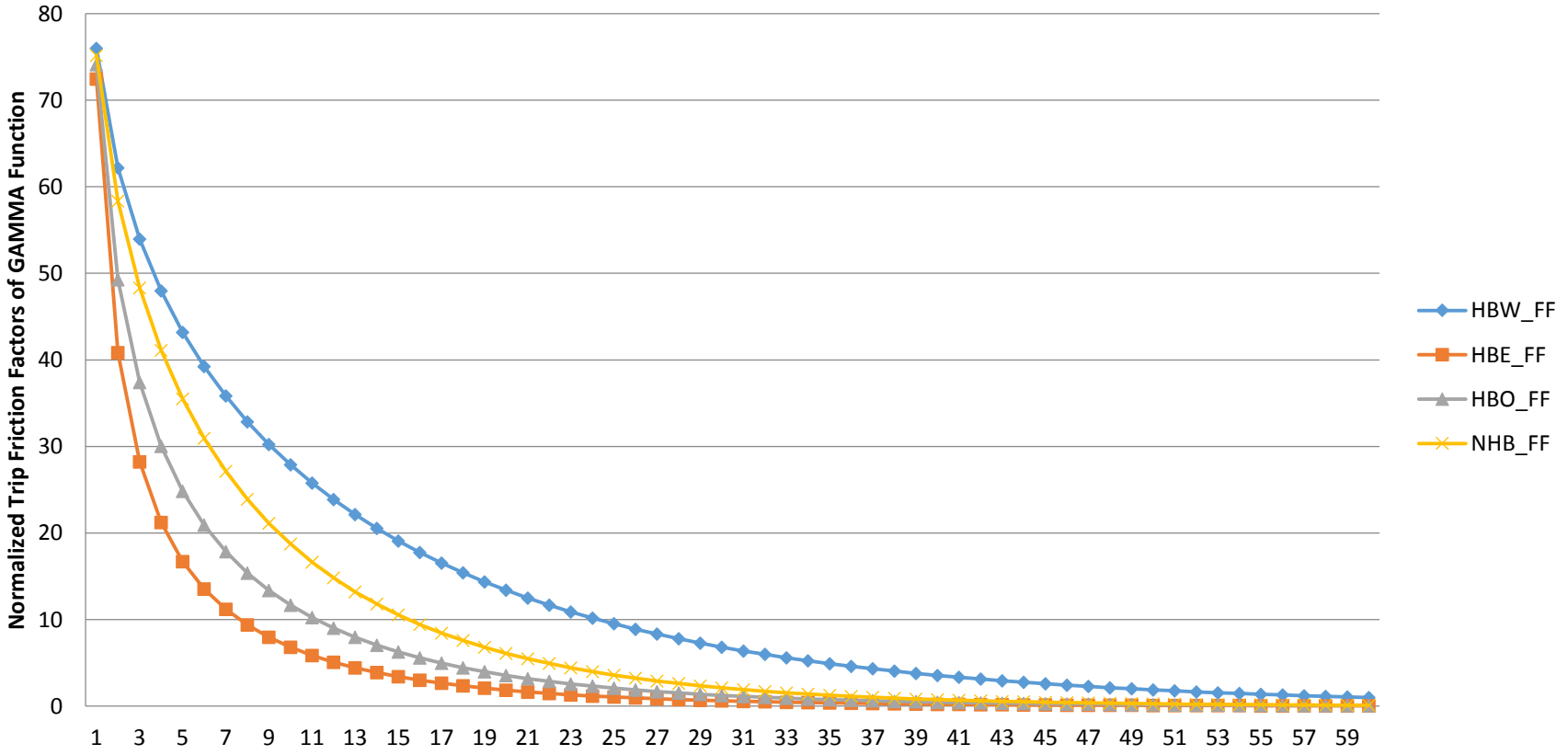
TAZ	1	2	3	4	PRODUCTIONS
1	T_{11}	T_{12}	T_{13}	T_{14}	P1
2	T_{21}	T_{22}	T_{23}	T_{24}	P2
3	T_{31}	T_{32}	T_{33}	T_{34}	P3
4	T_{41}	T_{42}	T_{43}	T_{44}	P4

ATTRACTIONS	A1	A2	A3	A4

STEP 2: Trip Distribution – Bucharest Model

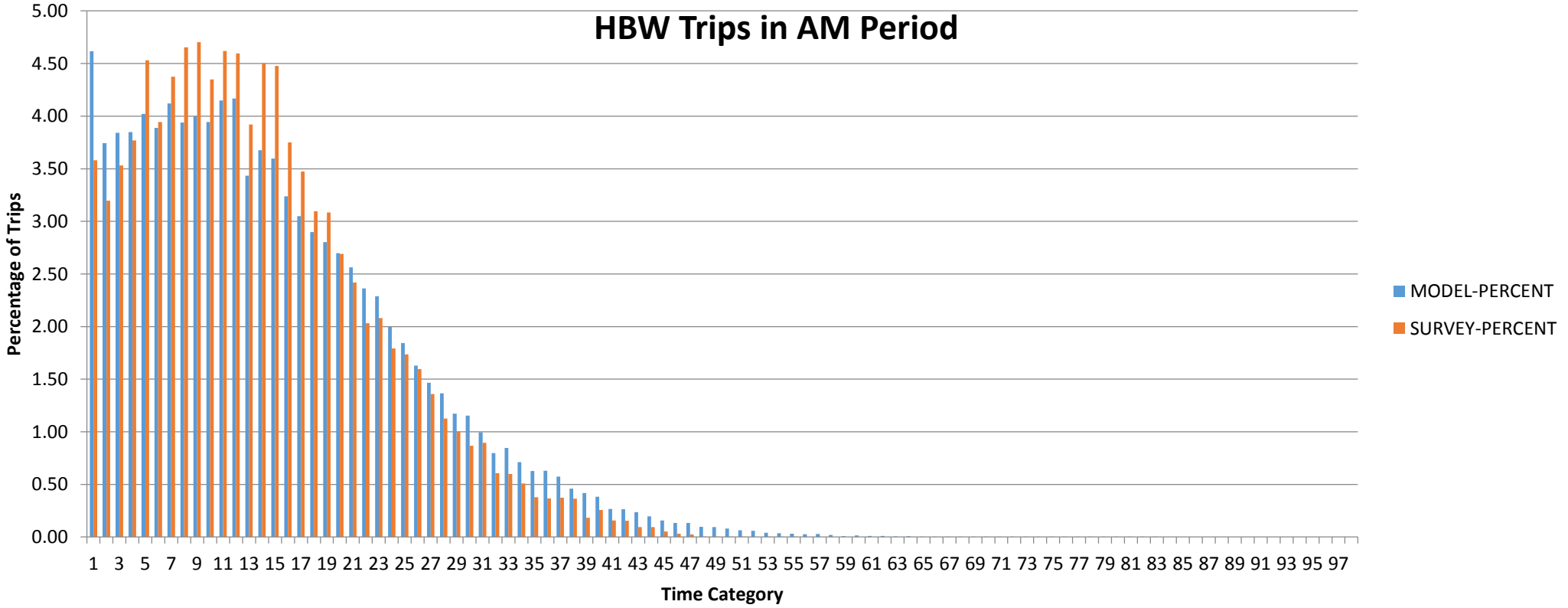
GAMMA_PARAMETERS	HBW _TIME	HBE_TIME	HBO_TIME	NHB_TIME
a	80.611972	2357.012482	1212.285659	827.753848
b	-0.203509	-0.710891	-0.464564	-0.226108
c	-0.059274	-0.080909	-0.086636	-0.096549

Friction Factos vs. Impedence for Trip Purpose

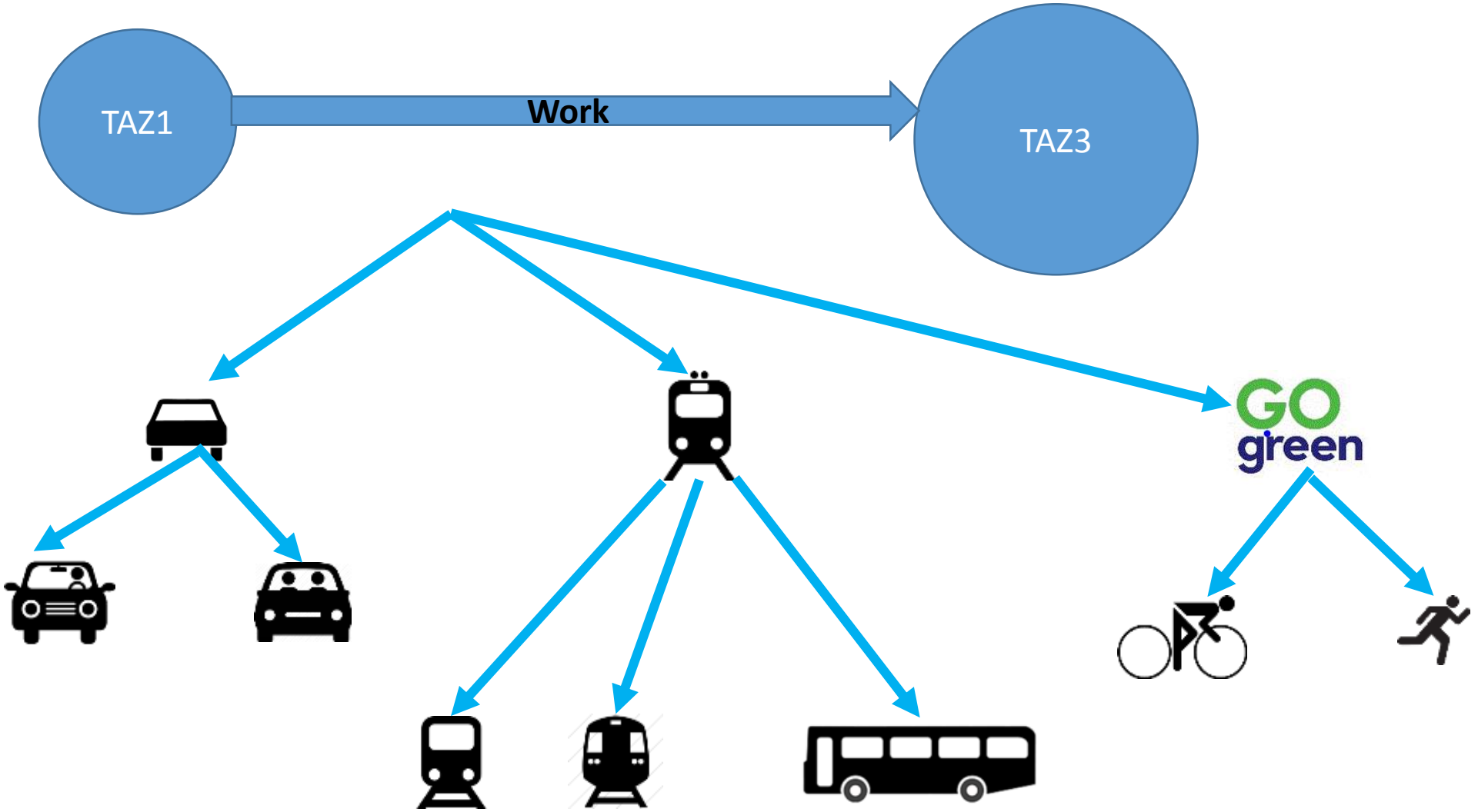


Trip Length Distribution

Purpose of Trip	Trip Time (Minutes) Model	Trip Time (Minutes) Survey
HBW	14.8	13.9
HBE	10.5	10.01
HBO	10.7	9.2
NHB	12.8	10.2



STEP 3: Mode Split



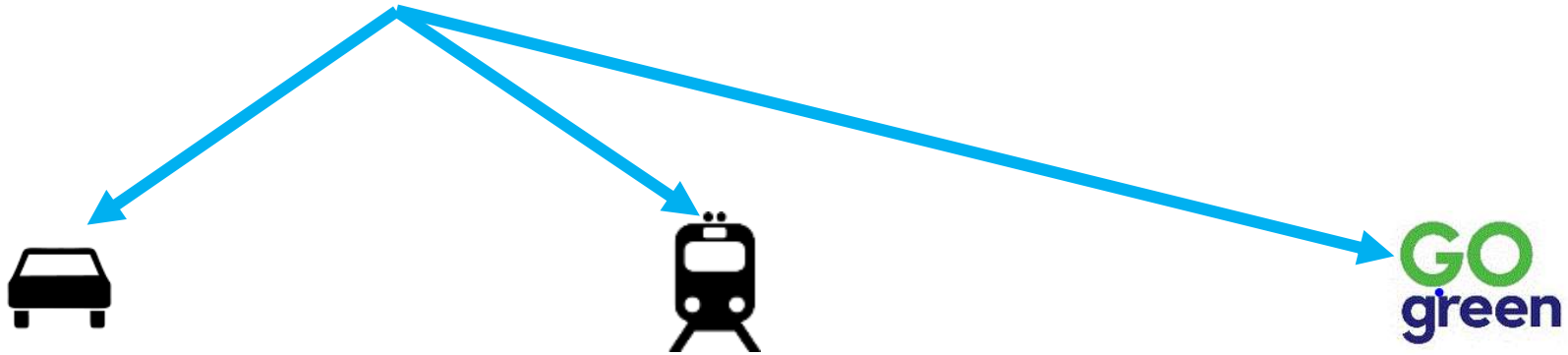
STEP 3: Mode Split

- **Depends on:**
  - Purpose of Trip: Work, Education,…etc.
  - Socio-Economic Factors: Income, Age,…etc.
  - Zonal Factors: Accessibility of Mode, Availability of Mode,…etc.

- **Estimation:**

Multinomial or Nested Logit

STEP 3: Mode Split – Logit Model



U_{CAR} $U_{PUBLIC\ TRANSIT}$ $U_{non\text{-}Motorized}$

$$U_{CAR} = a_0 + a_1 * \text{Travel Time} + a_2 * \text{Fuel Cost} + \ldots$$

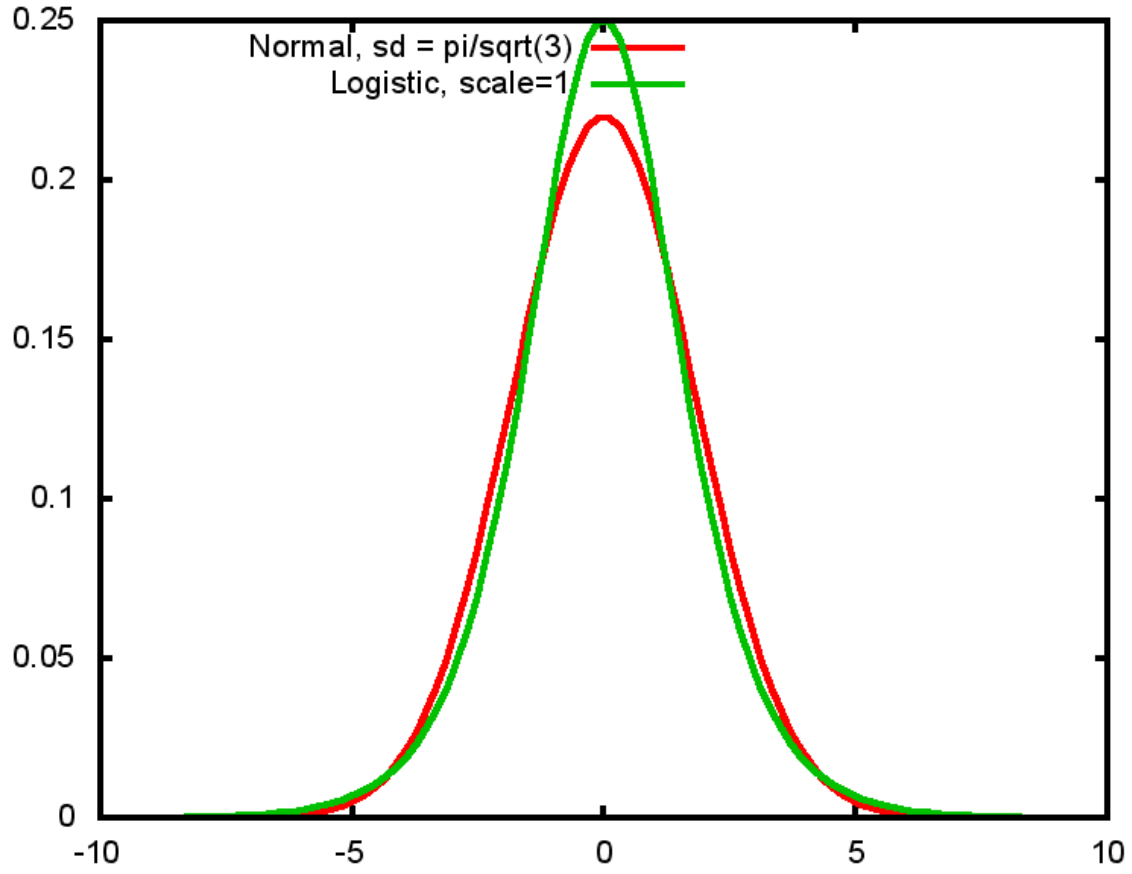
$$U_{PUBLIC\ TRANSIT} = a_0 + a_1 * \text{Transit Time} + a_2 * \text{Transit Fare} + \ldots$$

$$U_{non\text{-}Motorized} = a_1 * \text{Walk Time}$$

STEP 3: Mode Split – Logit Model

- **Estimation:**

Why Logit Model?



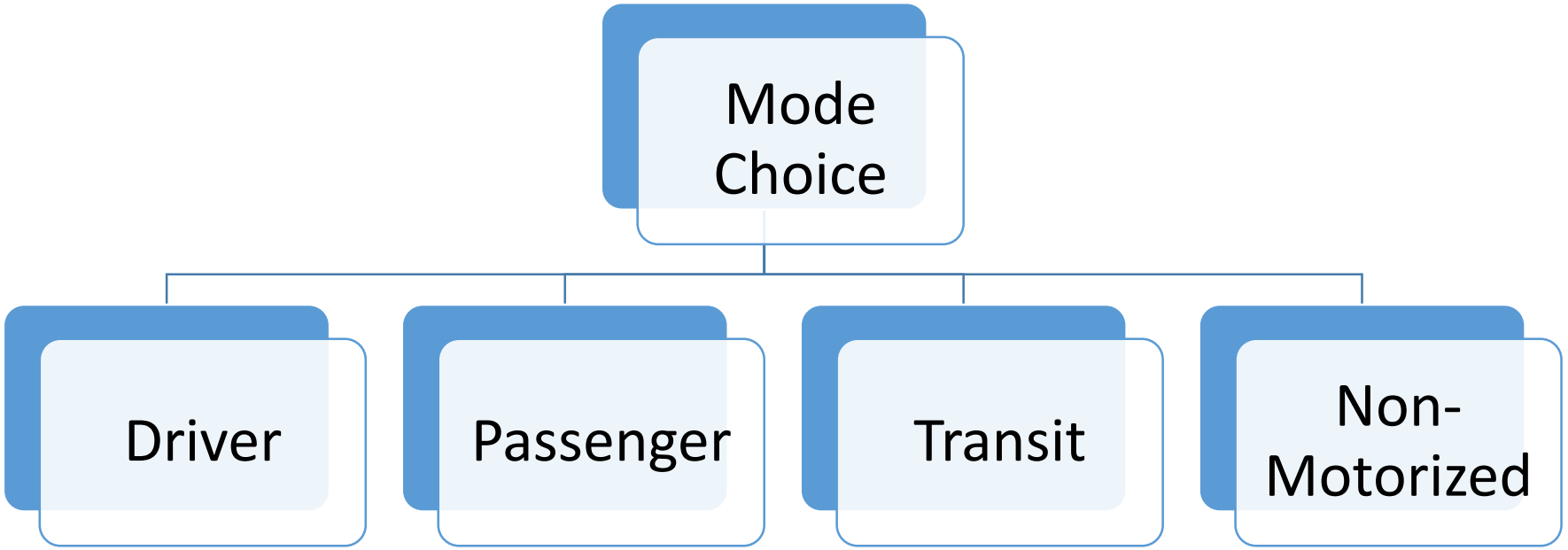
- **Probability Calculation:**

$$\text{Probability(a)} = \frac{\exp(U^a)}{\sum_i^{all} \exp(U)}$$

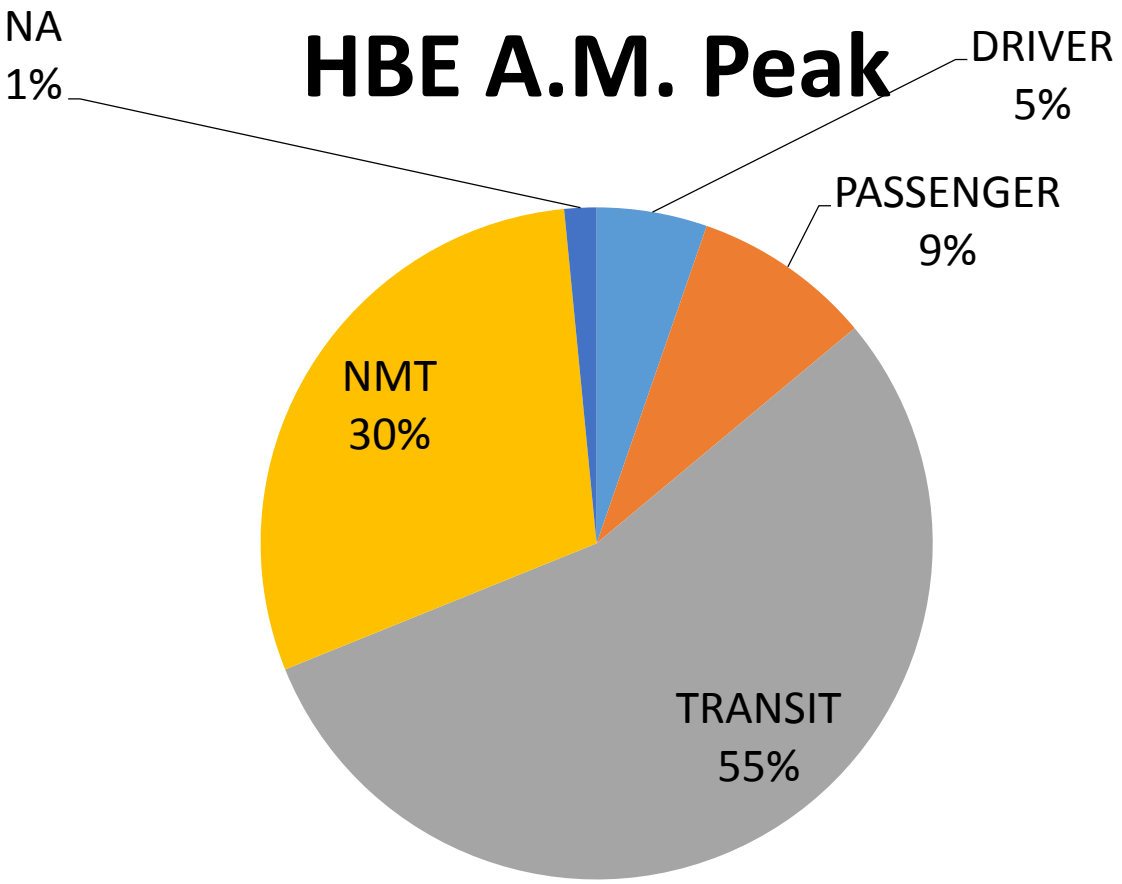
- **Ex.:**

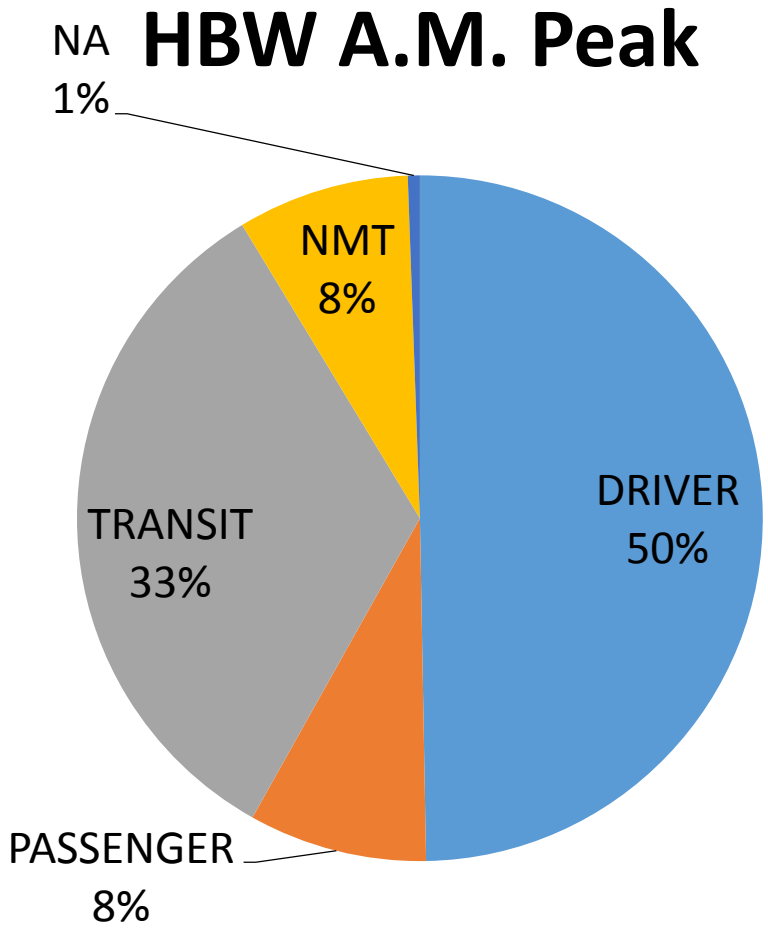
$$P(\text{Car}) = \frac{\exp(U^{Car})}{\exp(U^{Car}) + \exp(U^{Transit}) + \exp(U^{Non-Motorized})}$$

Model Structure: Multinomial Logit Model



STEP 3: Mode Split – Bucharest Model





Utility Parameters of Bucharest Model (A.M. Peak. Work Purpose)

PARAMETERS				
PARAMETER	DRIVER	PASSENGER	TRANSIT	NMT
B_CarTime	-0.547			
B_PassengerTime		-0.477		
B_PT_Time			-0.25	
B_WalkTime				-0.532
B_FuelCost	-1.352			
B_Pass_FuelCost		-0.72		
B_Fare			-1.284	
B_IZ_Driver	-5			
B_IZ_PASS		-5		
DRIVER_CONST	2.69382			
PASSENG_CONST		-3.1		
TRANSIT_CONST			2.08	

STEP 4: Assignment

- Assignment is the Route of Choice from each zone per Model.

- Input:
  - ***DEMAND:*** Origin-Destination Trips Per Mode of Trip.
  - **SUPPLY:** Auto and Transit Network.

STEP 4: Assignment – Auto Assignment

- **Auto Assignment:**
  - Auto Demand.
  - Auto Network.
  - Capacity and Free Flow Time Calculation.

  - **Incalculable Number of Routes.**

STEP 4: Assignment – Auto Assignment

Auto Assignment Algorithm:

USER EQUILIBRUIM

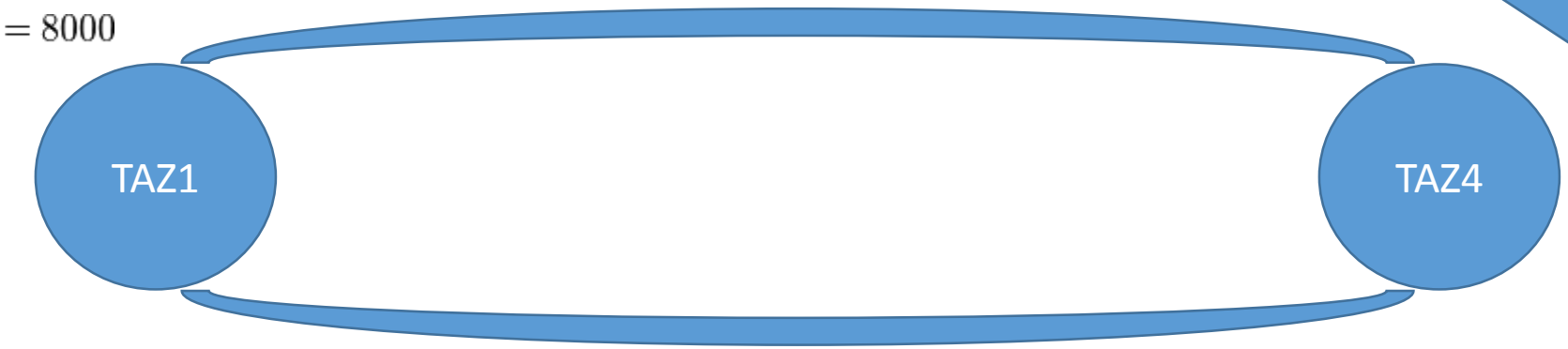
Equilibrium is Reached When Traveling from Each Route between Origin and Destination has the Same Time

i.e. ta = tb

$$S_a = 15\left(1 + 0.15\left(\frac{v_a}{1000}\right)^4\right)$$

ROUTE a

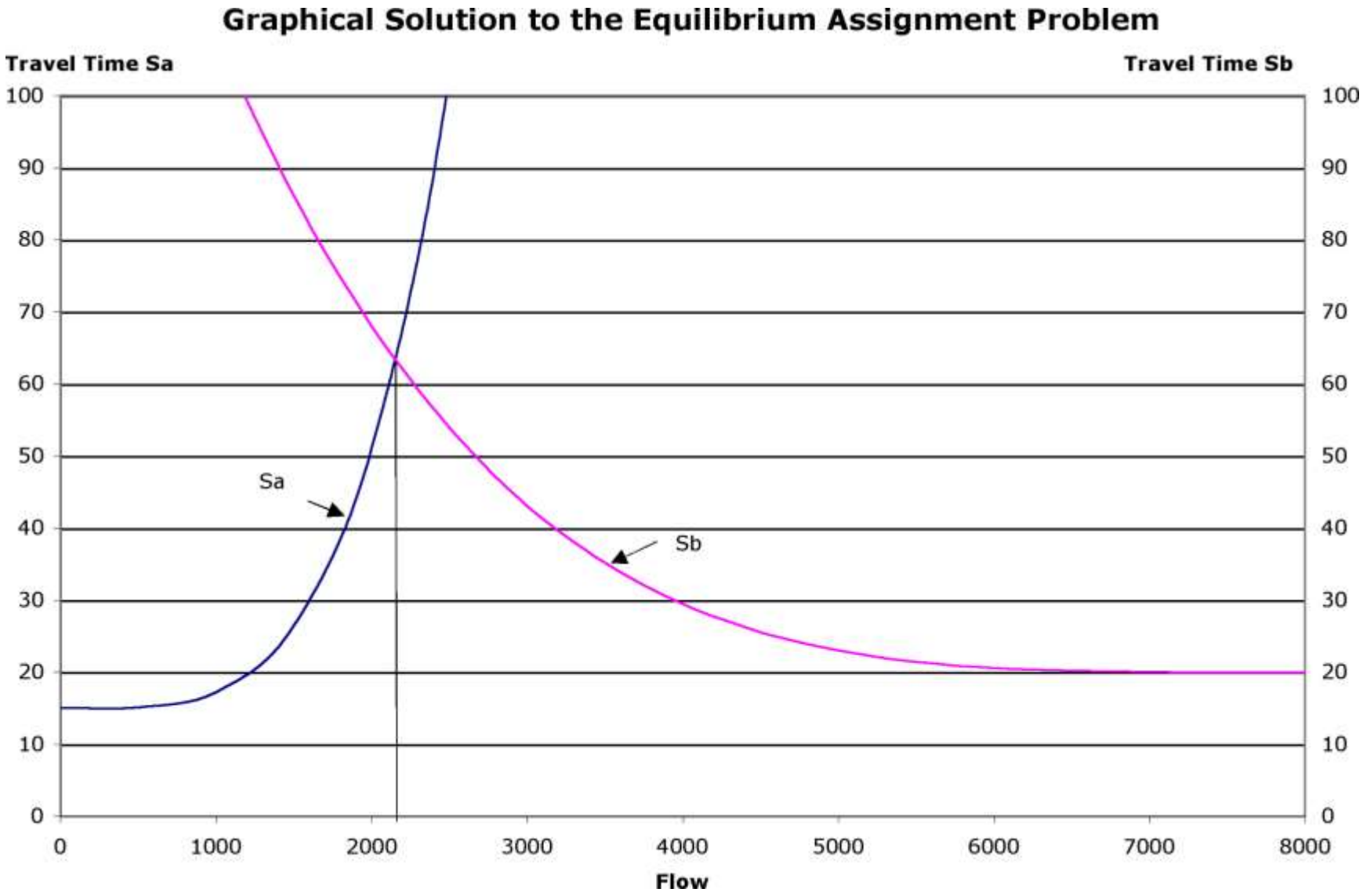
$v_a + v_b = 8000$



ROUTE b

$$S_b = 20\left(1 + 0.15\left(\frac{v_b}{3000}\right)^4\right)$$

STEP 4: Assignment – Auto Assignment

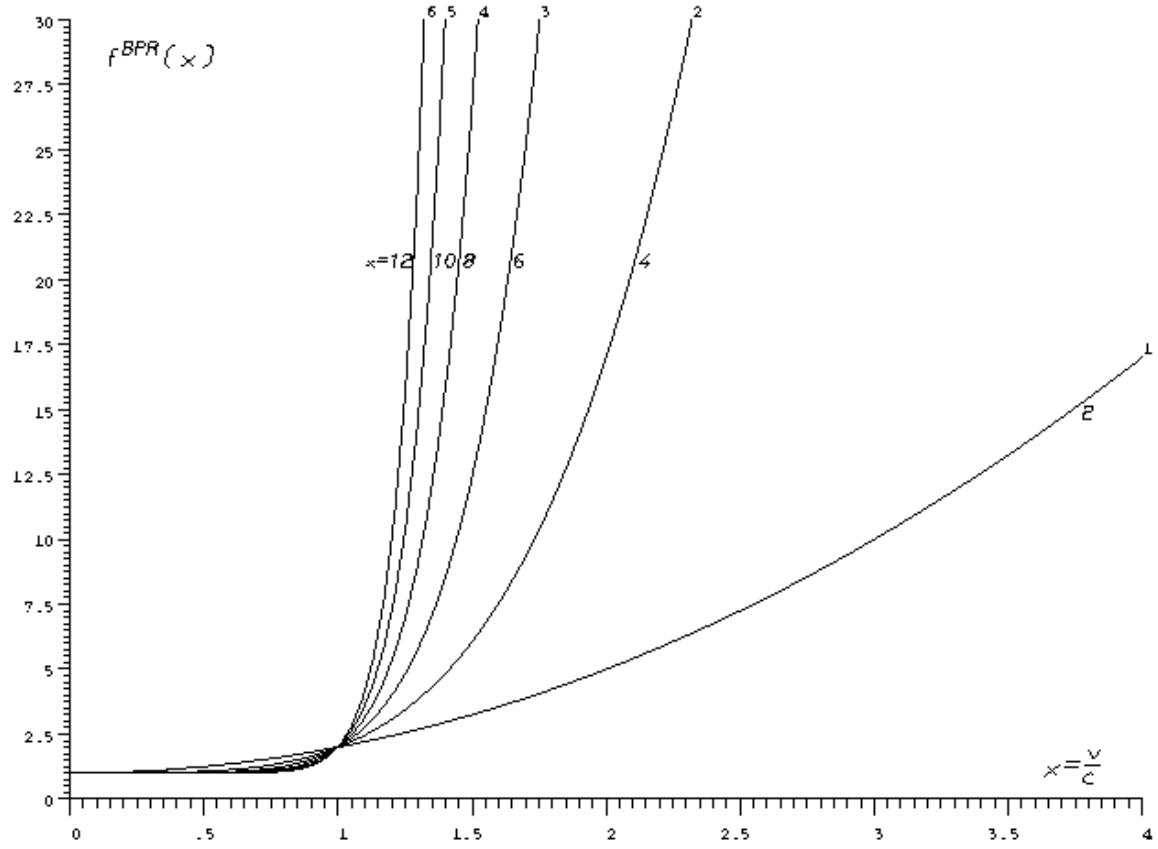


STEP 4: Assignment – Auto Assignment

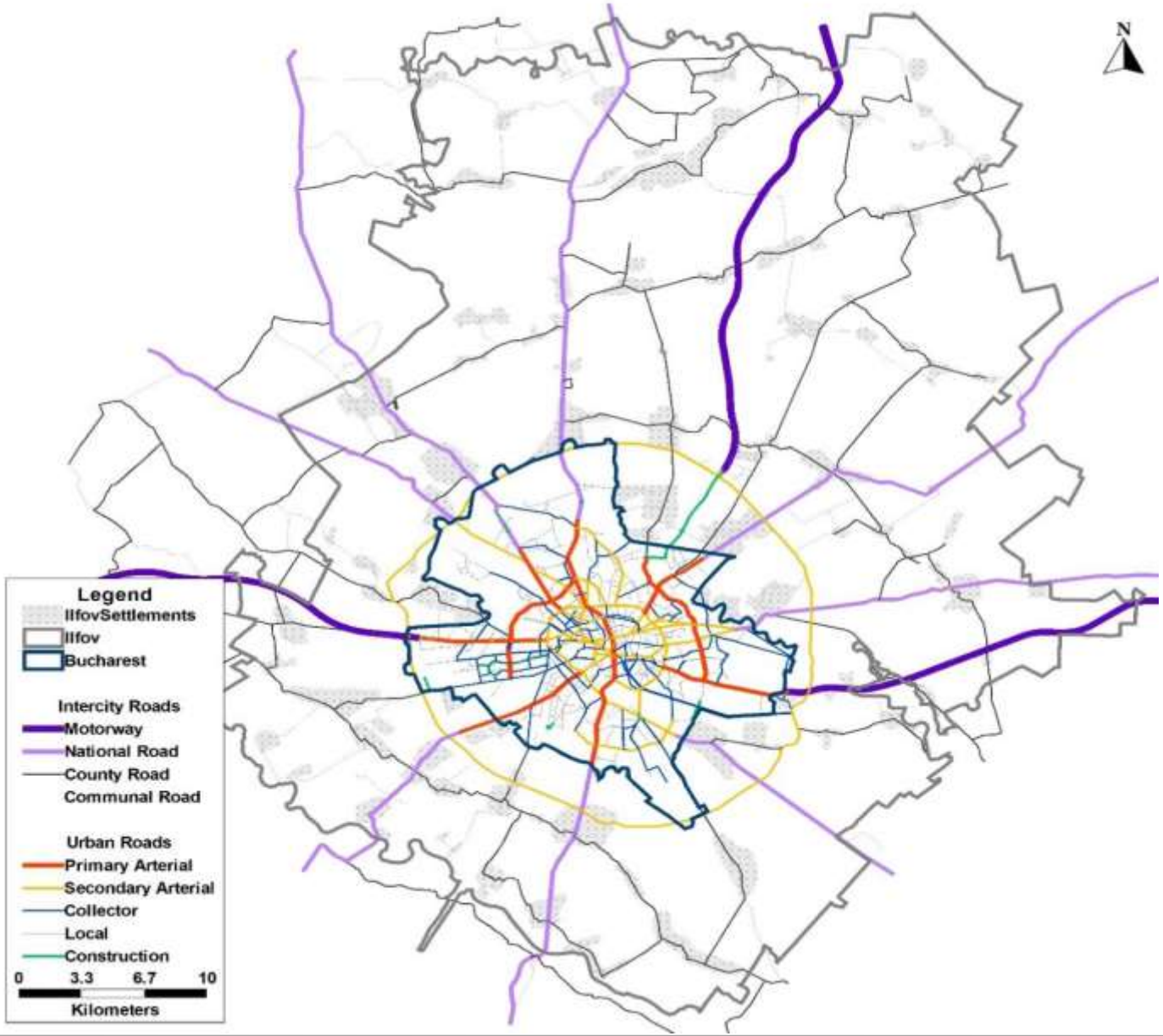
Bureau of Public Roads Function of Travel Time

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

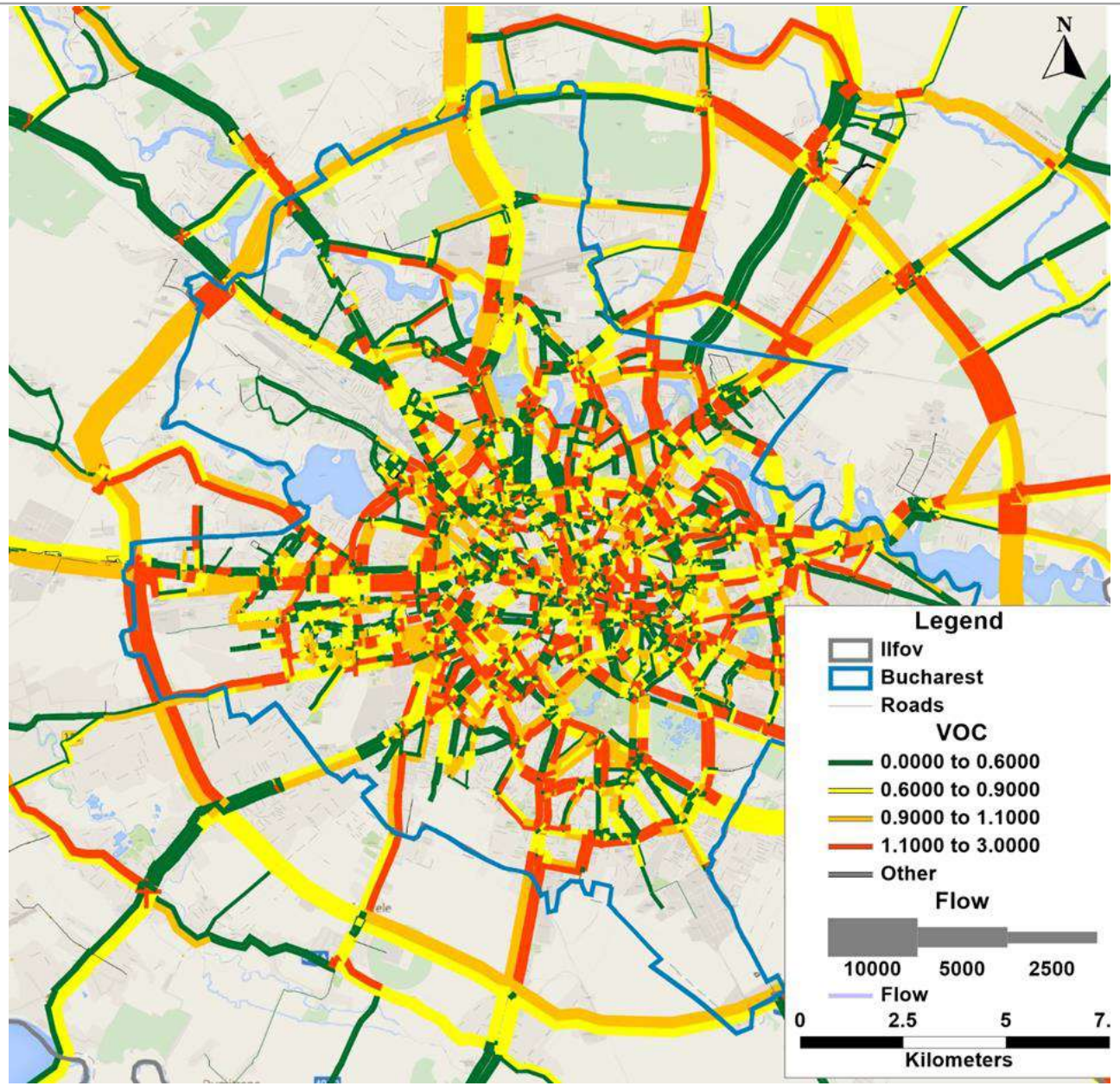
T = travel time (minute)
T_0 = free flow travel time (minute)
v = traffic volume (passenger car unit/hour)
c = practical capacity (passenger car unit/hour)
α, β = parameters



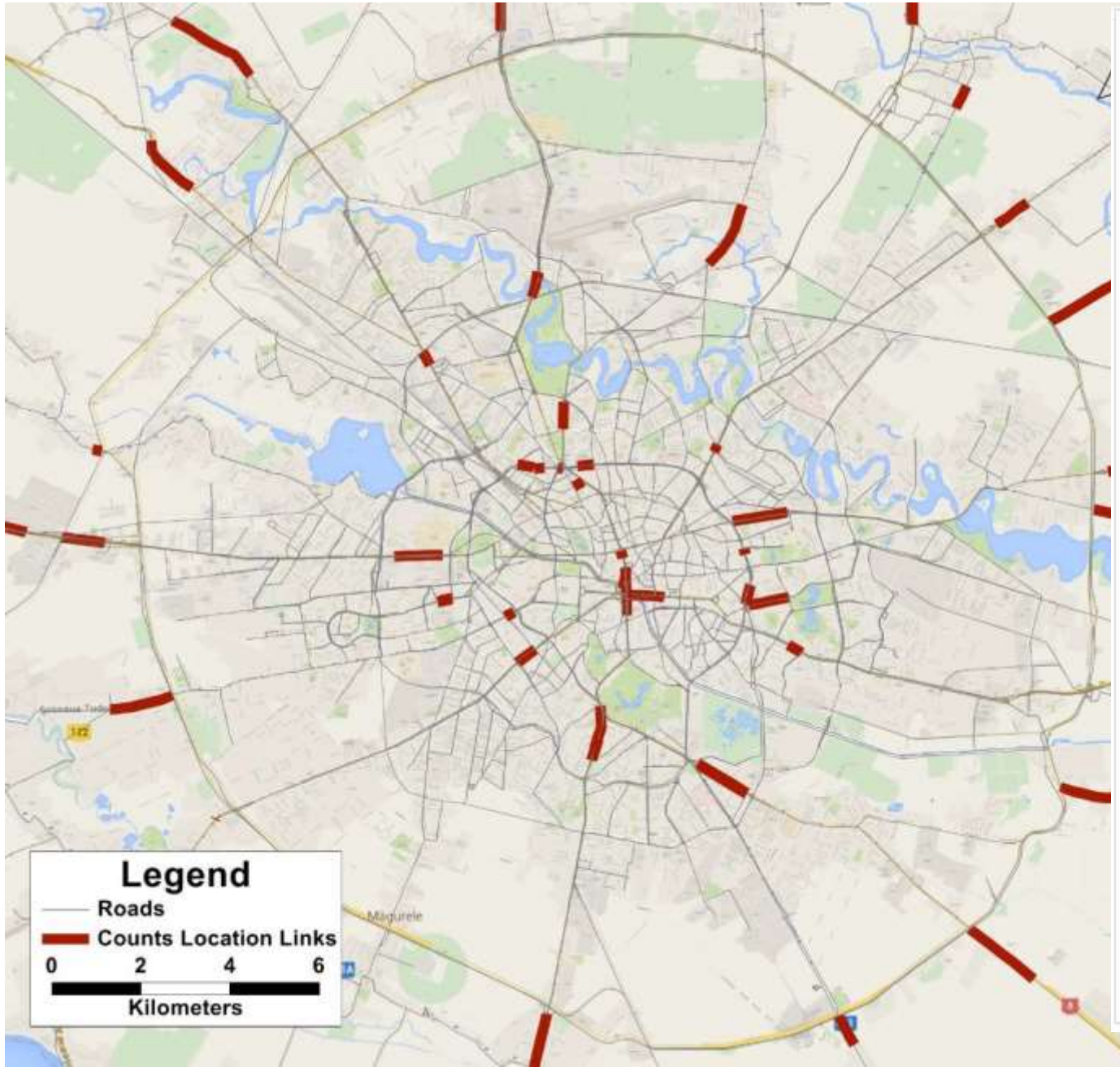
STEP 4: Assignment – Road Network

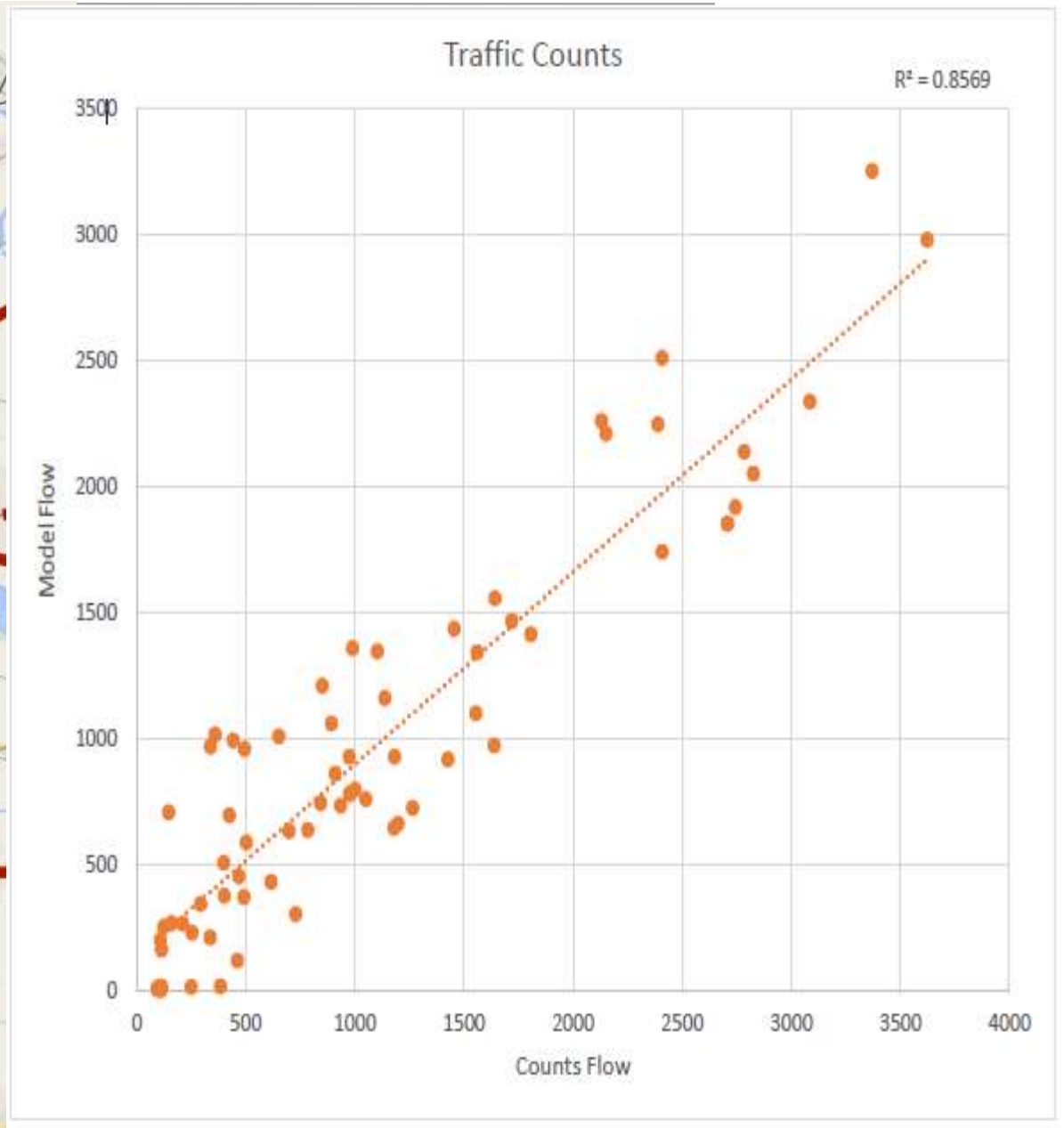


STEP 4: Assignment – Assignment Result 2030 AM



STEP 4: Assignment – Bucharest Validation



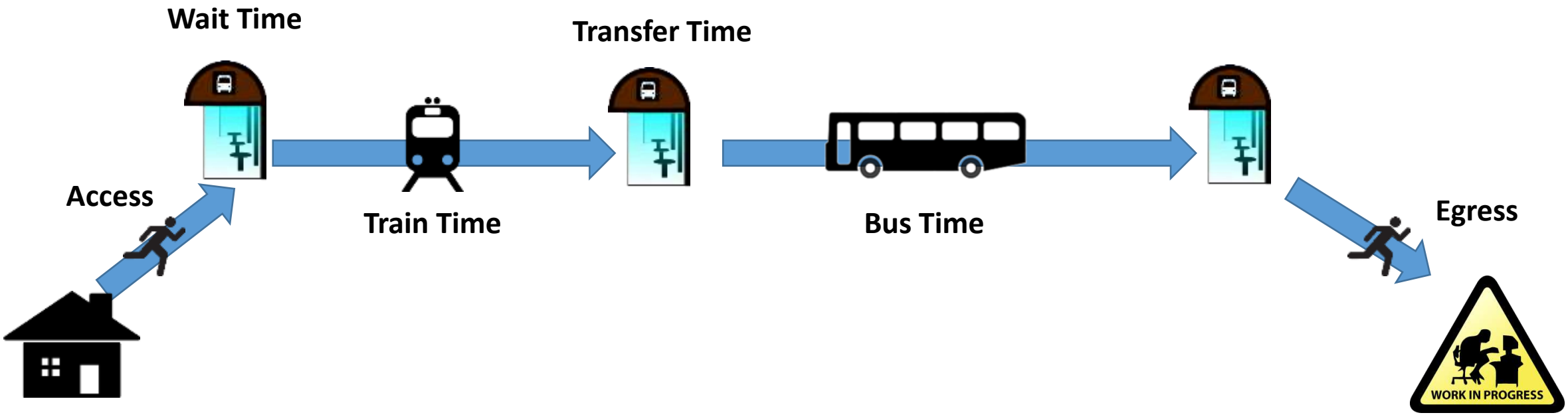


STEP 4: Transit Assignment

- Transit Assignment:
  - Transit Mode.
  - Transit Network.
  - Transit Routes (Lines)
  - Transit Stops.
  - Transit Boarding and Alighting Weights.
  - Transit Demand by Mode.
  - Fares Matrix.

  - ***Previously Determined Number of Alternative Routes.***

Time Components of Transit Skims



Path Finder Algorithm:

ASSUMPTIONS:

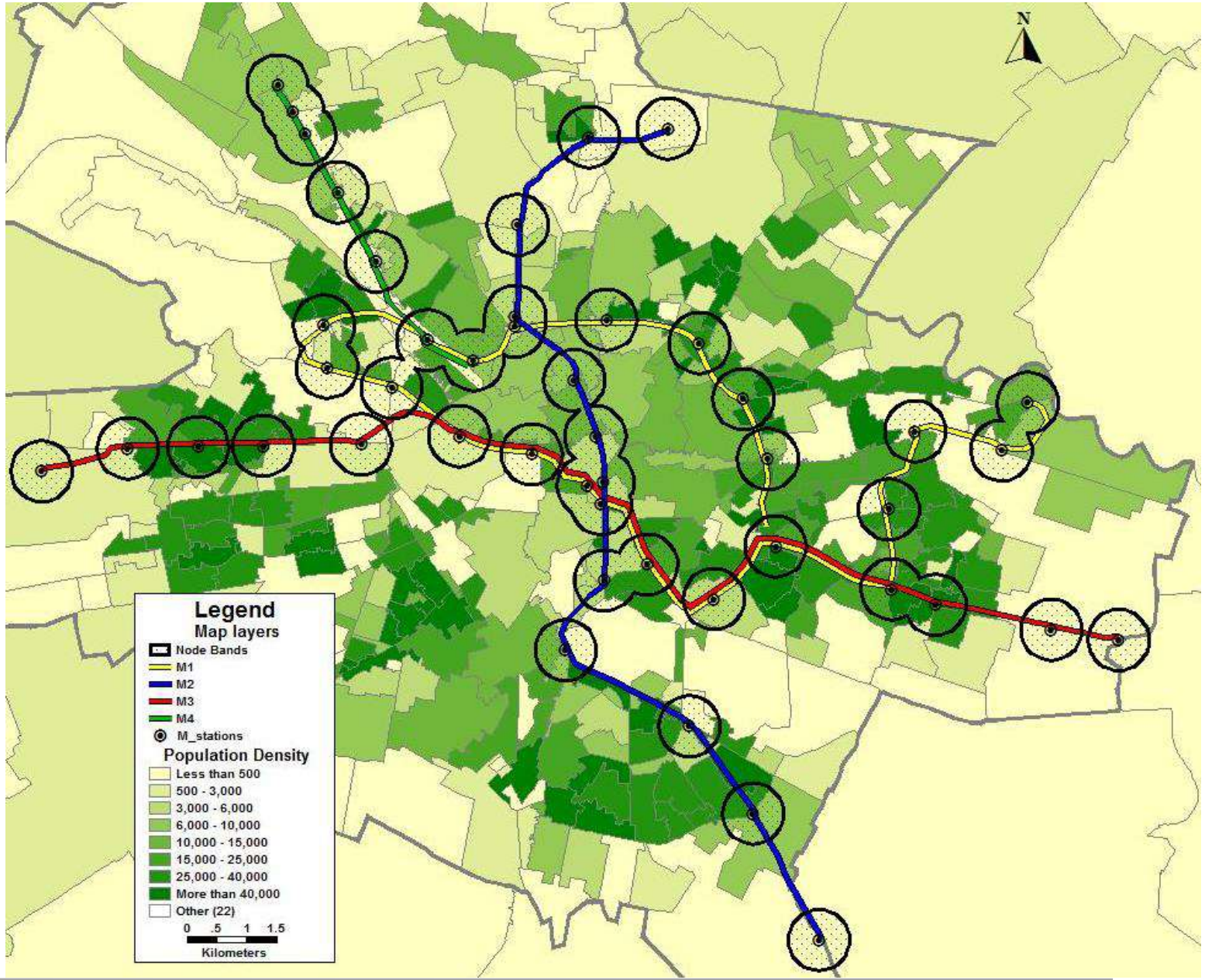
- One Path Method.
- Similar to Optimal Strategies Method.
- Passenger will take first transit line which will get them to their destination in a reasonable amount of
- Transfers will be used if and only if the transfer will reduce the Total Trip Time.

- HyptherPaths: A set of all the Lines that will be used.

- Addition: Fares are taken into consideration.

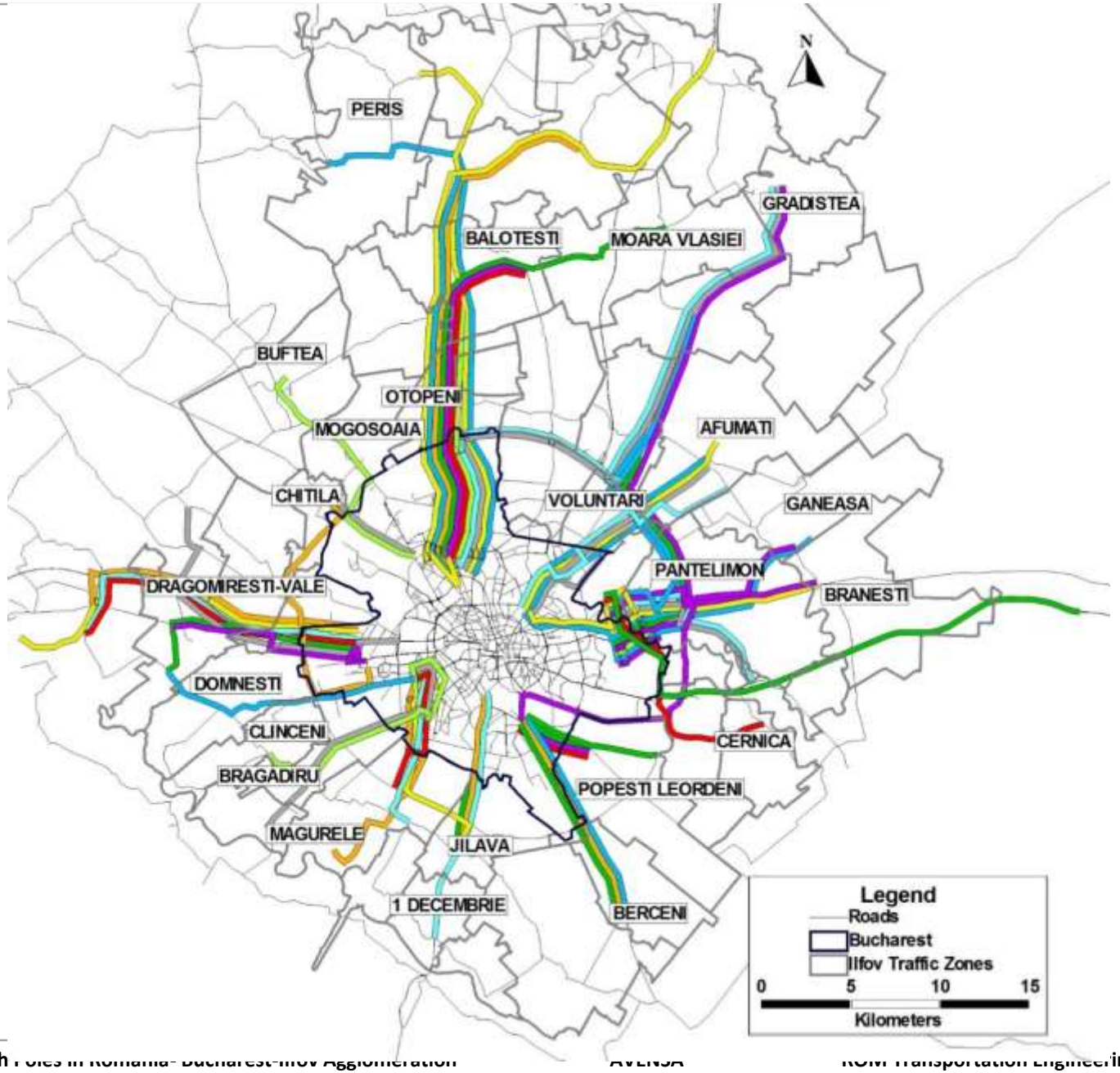
STEP 4: Transit Assignment

Metro Stations And Coverage according To Population



STEP 4: Transit Assignment

Bucharest – Ilfov Bus Lines



Part 3: Model Usage, Complexity, Pitfalls and Recommended Readings

Model Pitfalls

1. Model are Just Tools, a means to an End, and not the End.

2. Scenarios Should be Compared to Each Other, not Used Alone:

Policy vs. Do nothing

ex. Rail vs. Keeping Busses

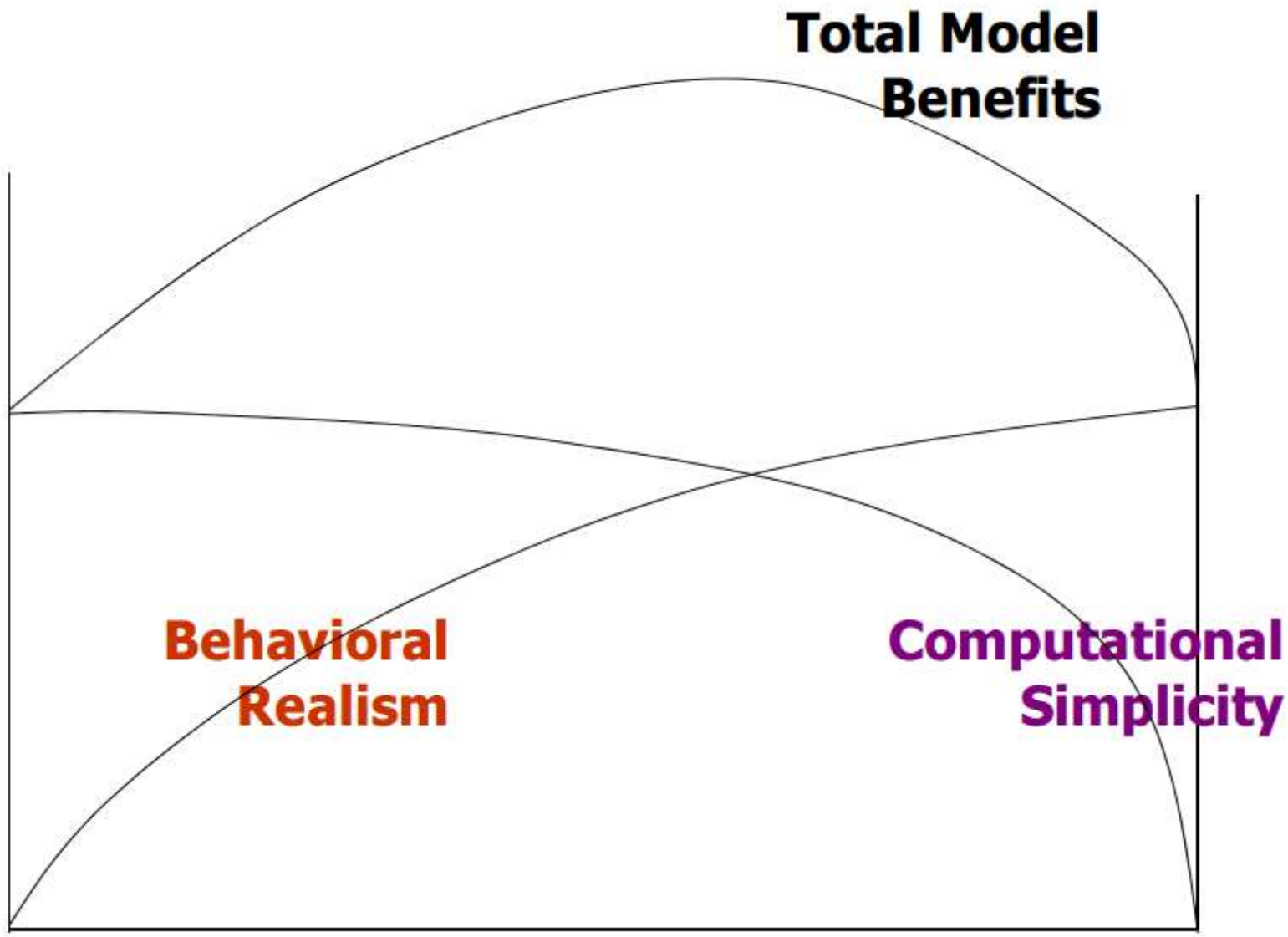
Using Congestion Pricing vs. Null

Light Rail vs. Busses

3. Documentation:

- Assumptions, *SHOULD* be documented.

Complexity vs. Efficiency



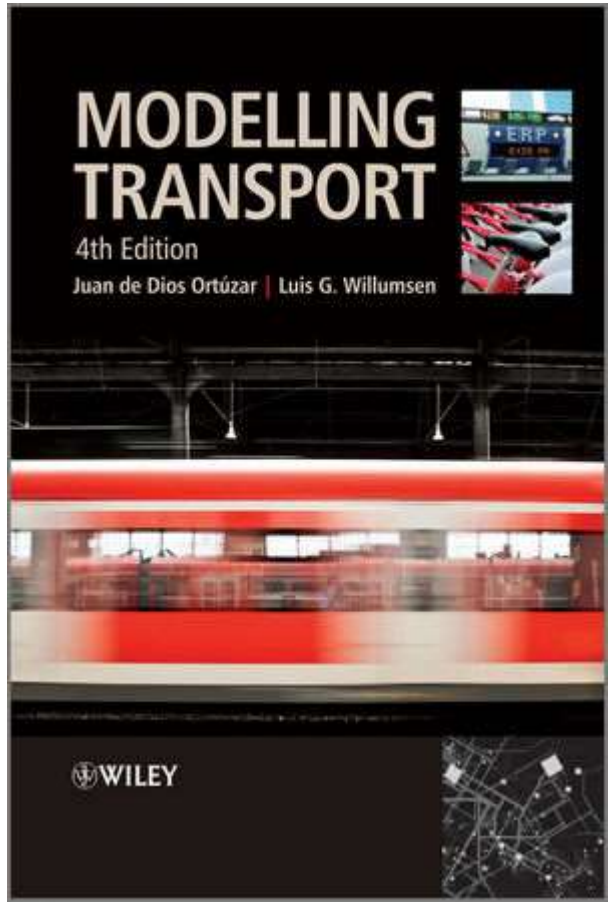
Complexity vs. Efficiency

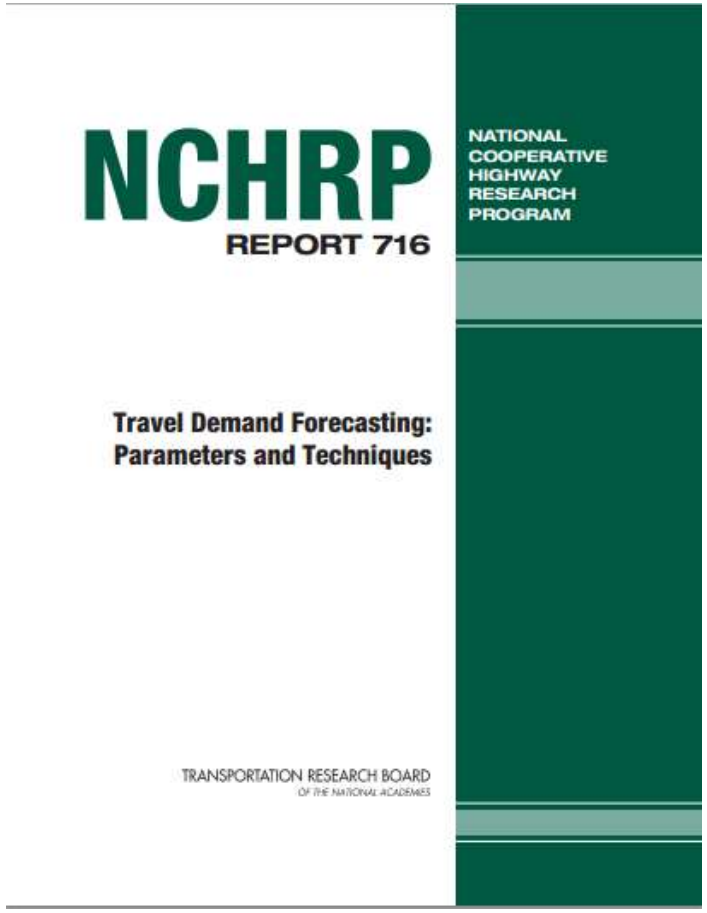
Models Should be Consistent and Efficient

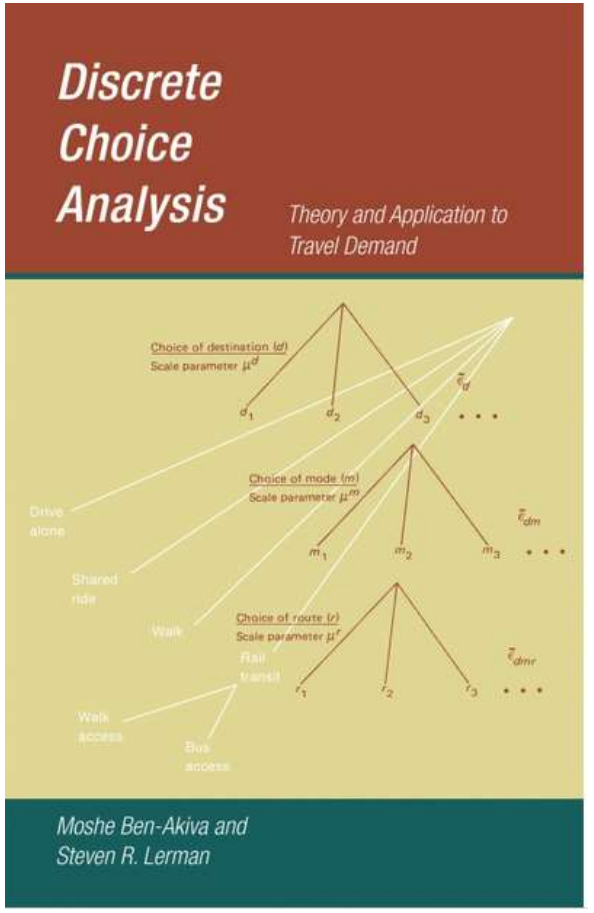
An Explicable Model is far Better than a Complex one

Models Should be Simple, Explicable and Easy to Use to Evaluate Policies

Recommended Readings





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