Introduction to LUTI modelling –
What is it and why do we need it?

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LUTI modelling
Structure of presentation
• Introduction
• What is a LUTI modelling?
• Why do we need LUTI models?
• Conclusions

What is a LUTI model?
• combination interaction of transport and land use (local, regional, national and global level)
• overall impacts of policies
• long term impacts of policies
• using simple supply characteristics
• focus on transport demand
• support tool for decision makers

Why do we need LUTI models?
• four stage modelling is complex through detail level
• mostly focused on assignment and not on demand
• mostly focused on private car and PT
• designed to adopt the supply to the demand
• four stage modelling is too slow
• no feedback between Land use and Transport
• tells the decision maker only the half of the truth
Why do we need LUTI models?

- strategic modelling is complex through interaction between land use and transport
- is designed to estimate future demand
- includes all modes (and feedbacks between the modes)
- designed to find policies to influence future transport demand
- fast model runtimes
- designed to show decision makers a fuller picture of future developments

Questions concerning modelling

- selection of system borders
  - spatial – what should be included and on what detail level?
  - temporal – what is the forecast horizon (daily traffic, peak/off peak 10 years 30 years)?
- which modes should be included?
- feedback of transport system and land use system and vice versa?
- consideration of time lags / reaction speeds
  - short term transport system
  - long term land use changes housing, employment

What is the MARS-model?

- is a very fast land use and transport interaction model
- it works on a high spatial aggregation level (max 34 Zones! not any longer)
- it includes feedback loops between land use and transport system
- it includes all means of transport
- it is not an equilibrium model
- and it is designed to identify optimal land use and transport strategy packages
MARS-model some further details

- Two person groups (person living in household with / without a car)
- Two trip purposes (commuting / other)
- Two time periods (peak and off-peak)
- Three means of transport (Slow, PT, PC)
- NEW - includes motorcycles as 4th means of transport
- Trip generation using the constant travel time budget theory
- Adaptation speed transport system – 1 year
- land use system – 5 years
- Use of gravity model approach for transport model and land use model

MARS-model as it was: Software details

- MARS is implemented in VBA V6 (~ 10,000 lines of code – V6y)
- Front-End is Excel
  1. Control file
  2. Input files:
     - Transport System data file
     - Land Use System data file
     - Calibration data file
  3. Output
     - Evaluation file (transport indicators, LU indicators, etc)
     - Text files for every indicator for each simulation year
- Run time for a single run (30 year simulation) ~ 3 minutes

MARS-model as it is: Software details

- MARS is implemented in Vensim (System Dynamics programming environment)
  - (code is generated automatically – programming is done via a graphical editor)
- Data front-end is still Excel
  1. Data input file which contains information about
     - Transport System
     - Land Use System
     - Calibration data file
  2. Output
     - Automated graphs and table within VENSIM environment
       (transport indicators, LU indicators, etc)
     - Text files or Excel files for every indicator for each simulation year
- Run time for a single run (30 year simulation) ~ less than 1 minute
- Model can be distributed using Vensim Model Reader (runtime version)

MARS-Model description

- Demographic transition and growth model
- Car ownership model
- External scenarios
- Transport policy instruments
- Land use policy instruments
- TOD model
- Transport model
- Transport sub model
- Housing development model
- Employment location model
- Household location model
- Land use sub-model

Objective Functions:
- User benefits
- Operator benefits
- Investment costs
- Changes land use patterns

Public transport

A journey with the mode transport consists of four different parts:
- Walking from the source to the public transport stop
- Driving from the public transport stop to the destination
- Changing time
- Walking from the public transport stop to the destination
Friction factor PT

\[ f(t_{ij}) = t_{W,ij} * SV_{W,ij} + t_{P,ij} * SV_{P,ij} + \sum_{l=1}^{k} \sum_{y=1}^{c} c_{y} * SV_{C_{y},ij} + t_{R,ij} * SV_{R,ij} + R_{ij} \]

- \( t_{W,ij} \): Walking time from source \( i \) to public transport stop (1)
- \( SV_{W,ij} \): Subjective valuation factor walking time from source to public transport stop
- \( t_{P,ij} \): Walking time at public transport stop
- \( SV_{P,ij} \): Subjective valuation factor waiting time at public transport stop
- \( t_{R,ij} \): Total changing time from source \( i \) to destination \( j \)
- \( SV_{R,ij} \): Subjective valuation factor changing time
- \( t_{W,from,j} \): Walking time from public transport stop to destination (4)
- \( SV_{W,from} \): Subjective valuation factor walking time from public transport stop to destination
- \( R_{ij} \): Impedance from costs travelling from \( i \) to \( j \)
- \( \alpha \): Factor for willingness to pay (0.17)
- \( Inc_{HH} \): Household income per minute

Current capabilities

Within the MARS model we can evaluate the impacts of combinations of the following policy packages:

<table>
<thead>
<tr>
<th>Pedestrians</th>
<th>Pedestrianization</th>
<th>spatial(S) / temporal(T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Transport</td>
<td>New PT-infrastructure</td>
<td>S/T</td>
</tr>
<tr>
<td>Private Car</td>
<td>New Roads, Road Pricing, Road capacity increase/decrease</td>
<td>S/T</td>
</tr>
<tr>
<td>Land use measures</td>
<td>Controls on development, Land use charges</td>
<td>S, S</td>
</tr>
</tbody>
</table>

Data requirements

Transport model
- Average trip distance between and within the zones
- Average travel speed for all modes (pedestrian, bike, bus, tramway, metro and private car)
- Average distance between a parking space and source/destination for each zone
- Average time to find a parking space for each zone
- Average distance between a public transport stop and source/destination for each zone
- Average public transport waiting and change time for each source – destination combination
- Fuel costs per vehicle kilometre private car
- Other costs per vehicle kilometre private car
- Average occupancy private car
- Parking costs private car
- Costs per trip public transport

Vienna MARS-model

- 23 Zones
- 4 external Regions
- 455 sqkm
- 1.6 Mio. Inhabitants
- PT System:
  - Tram (233 km)
  - Underground (62km)
  - Bus network (623 km)
- Cars per 1000 inh: 354
- Modal Split: 27.6% Slow modes, 27.2% PT, 45.3% car
Objective function

- User benefits
- Operator benefits
- Investment costs
- Changes in Land-use
- Environmental costs

over a period of 30 years discounted to net present value
SPARKLE – Training course

Appraisal framework

CBA - Objective Function
weighted sum of
• User benefits
• Operator benefits
• Investment costs
• Changes in Land-use
• Environmental costs
over a period of 30 years
discounted to net present value
We are looking for the maximum OF value!

Objectives for sustainability

• Protection of the environment
• Accident reduction Safety
• Economic efficiency
• Equity and social inclusion
• Economic growth
• Liveable streets and neighbourhoods

Indicator/Target (I/T) approach
weighted sum of target fulfilment

• Nox [tons/day], CO [tons/day], VOC [tons/day], Noise [Euro/year] -5%
• Accident costs [Euro/year] -5%
• Journey times per mode (per mode in min) -1%, -5%, -1%
• Accessibility for those with/without car 1%, 5%, 1%
• CO2 [tons/day] -3.5%

We are looking for the highest target fulfilment

Summary

• Strategic modelling was proved to be useful
• System borders are crucial (temporal and spatial)
• Be aware that models always cover just a part of reality
• Don’t interpret sth. into model results what is not in the model
• Try to see the forest and the trees at the same time

For what we have used MARS so far

• Identification of optimal policy combinations (mostly Cordon charge, PT-frequency and PT fare level)
• Identification of elasticities of individual instruments
• Comparison of same set of instruments on different cities – using the same model
  – using different models
• Identification of impacts of used appraisal framework onto optimal strategies (CBA vs Indicator based approach)
• Identification of feasible targets (e.g. a 20% CO2 reduction cannot achieved within the tested instrument ranges)
• Identification of barriers (technically, politically)
• Training purposes

Model

Thank you for Your attention!

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