

# Introduction to Transportation Planning

## Demand Model, Four Step Demand Model

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# Demand Model



# Demand Model

## Demand

Number of trips  $q$  that travellers **demand** to make between origin  $o$  and destination  $d$ .

$$q_{od} \quad (1)$$

## Demand model

Estimate the demand

$$q_{od} = f(o, d, X_o, X_d, c_{od}, \dots) \quad (2)$$

to determine expected/mean/average demand expressed as a function of known variables  $X_o$  and parameters  $\beta$  estimated to match the observed demand.



## Travel survey



# Travel survey

## Demand model input

### Personal Travel diary

Chain of trips executed by an individual during the day

- ① activity 1: type, location, start time
- ② trip 1: type, location, start time, mode, route
- ③ activity 2: type, location, start time
- ④ trip 2: type, location, start time, mode, route
- ⑤ activity 3: type, location, start time



# Travel survey

reason

## Survey

We cannot know diaries of all individuals (cost, time, organization, privacy, ...).

We need to sample the population.

## Sampling and extrapolation

The sample is representative if the key statistics of the population are the same as for the sample.



# Travel survey

sample sizes

## Małopolska 2013

12 000 individuals

## Kraków 2014

18 000 individuals

## Warszawa 2016

24 000 individuals

## Wrocław 2018

300 000 individuals - GSM traces



# Travel survey

## methods

### Paper

fill the form

### Tablet

fill the form online

### Census

officially fill the form

### App based

install the tracing (GPS) App on your cell phone

### BigData

record anonimized traces - GSM, bluetooth, instargam, etc.



# Travel survey

## results

### Survey results

- 1 average number of trips (per purpose, per person group, per zone)
- 2 temporal distribution of trips
- 3 trip distance profile/ destination choices
- 4 mode shares/mode choices
- 5 route choices
- 6 vehicle occupancy



# Four step demand model

FSM

## Survey results

Reproduce (model) the behaviour read (understood) from survey.

Model shall be calibrated, i.e. modelled values shall match the observed (empirical ones)



## Four step demand model



# Four step demand model

## Wprowadzenie

- analytical
- built on and to reproduce the survey
- interpretable
- algorithmic
- probabilistic (expected demand)
- trip based (not chains)



# Four step model

FSM

## Four step demand model

- ① Trip Generation
- ② \* Time Choice
- ③ Destination Choice
- ④ Mode Choice
- ⑤ Path/Route Choice



# Four step model

FSM

|   |                       |                             |            |                           |
|---|-----------------------|-----------------------------|------------|---------------------------|
| 1 | <b>do?/how often?</b> | zone production /attraction | $q_o, q_d$ | <b>Trip Generation</b>    |
| 2 | <b>where?</b>         | od matrix                   | $q_{od}$   | <b>Destination Choice</b> |
| 3 | <b>how?</b>           | mode shares                 | $p_{od}$   | <b>Mode Choice</b>        |
| 4 | <b>which way?</b>     | network loads               | $q_a$      | <b>Route/Path Choice</b>  |



# Summary

Thanks for attention

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