# ROUNDTABLE ON SOCIAL IMPACTS OF TIME AND SPACE-BASED ROAD PRICING

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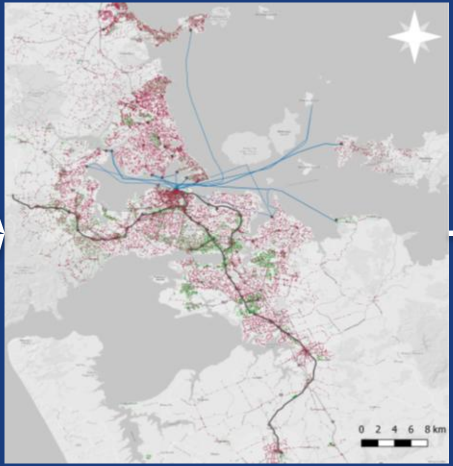
# Objective and approach (I)

- Create a detailed representation of the Auckland region mobility and sociodemographic composition to assess road pricing policies
- Develop a synthetic mobility dataset, with all users represented, their household and their mobility to be able to assess in the detail the potential social impacts of road pricing

Synthetic mobility dataset

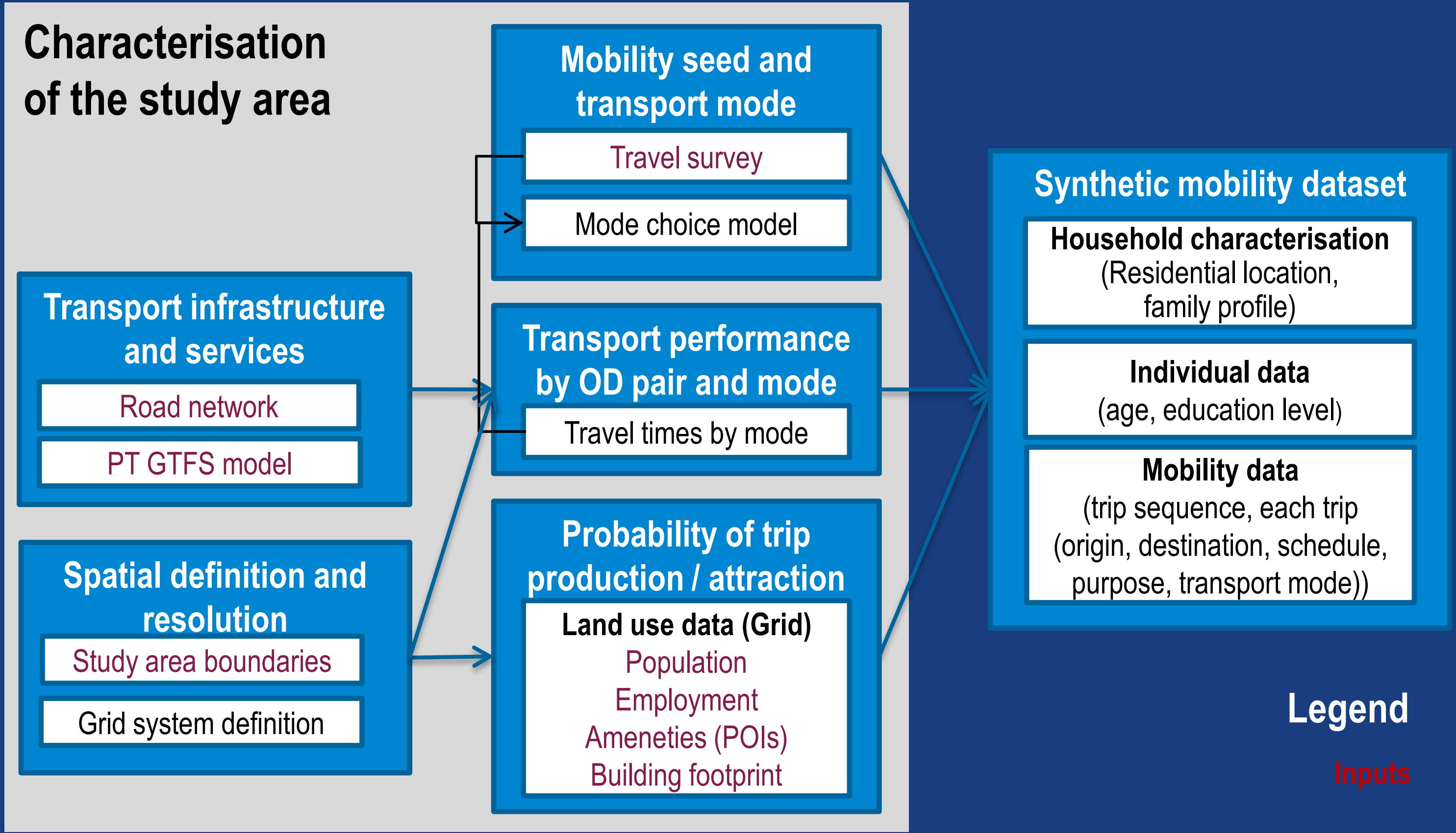
Road pricing policies




Social impacts by income strata or geographical location

- How the synthetic mobility dataset is developed?

# Objective and approach (II)



# Synthetic mobility dataset generation

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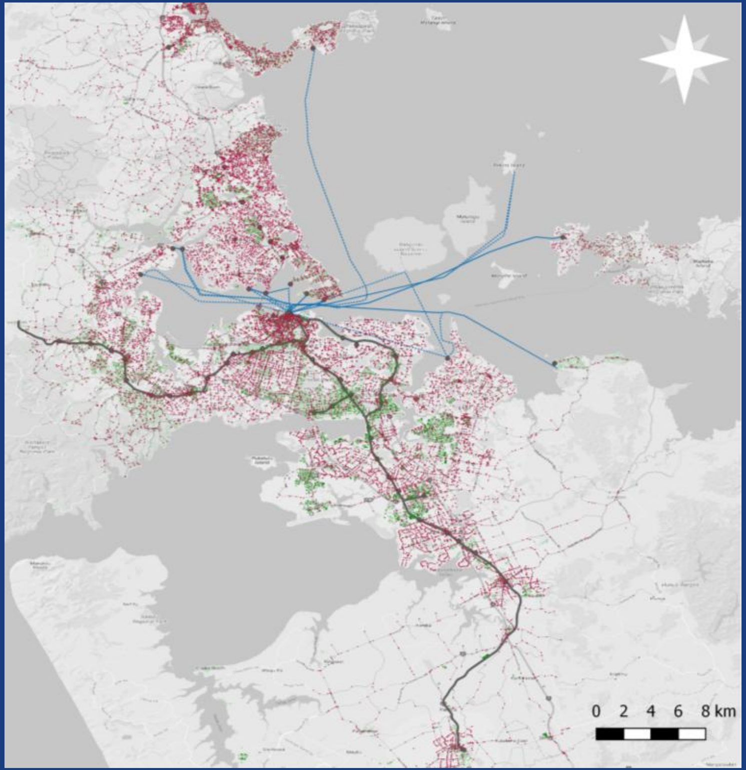


# Synthetic mobility dataset generation

## Introduction

- The model uses information from each respondent of the Household Travel survey to:
  - ✓ Generate a set of persons similar to the respondent (depending on the survey expansion multiplicative coefficient of the person)
  - ✓ Model the trip chain of each new "virtual person" – preserving the array of trip purposes stated on the survey
  - ✓ Introduce (relatively small) variations in time and in space distance of each trip (keeping all the other attributes of that trip) – which depend of the origin and destination, the trip purpose and mode used for each trip
- The model uses statistical data from the survey to establish constraints and membership fuzzy functions to determine "virtual origin and destination", attached to the land uses associated with the trip generation of each census track

# Synthetic mobility dataset generation

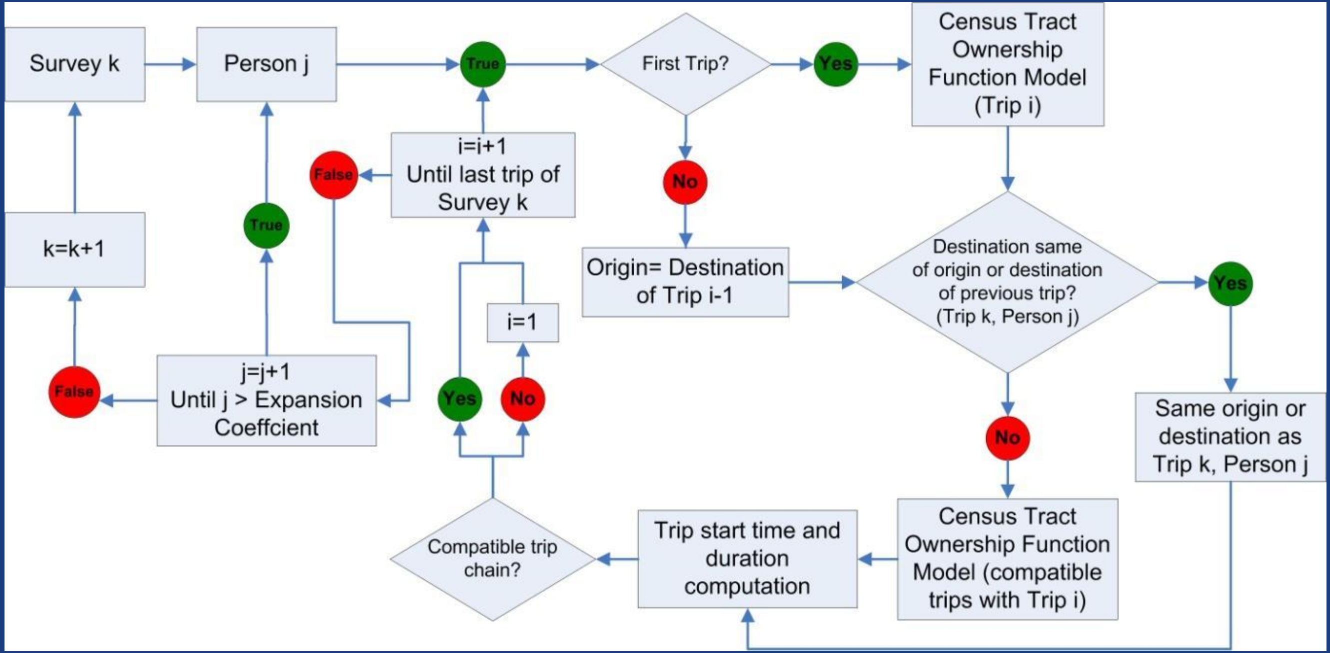
## Model Inputs

- The Household Travel Survey with geocoded trip ends and characterization of the respondents and each trip that they perform (if possible also including trip purpose) with sample coefficients (sampling rate >0.5%)
- A detailed land use database used as seed for trip generation/attraction functions
- A characterization of the trip generation/attraction rates of land use activities for different times of the day and relation with the purpose of the trip (worker, visitor or other)
- A characterization of the travel times in different transport modes and the number of transfers required in public transport between all the census tracts of the study area

# Synthetic mobility dataset generation

## Model workflow

- For each trip end location the model calls a membership fuzzy function, which determines the trip end location using a Monte Carlo simulation procedure



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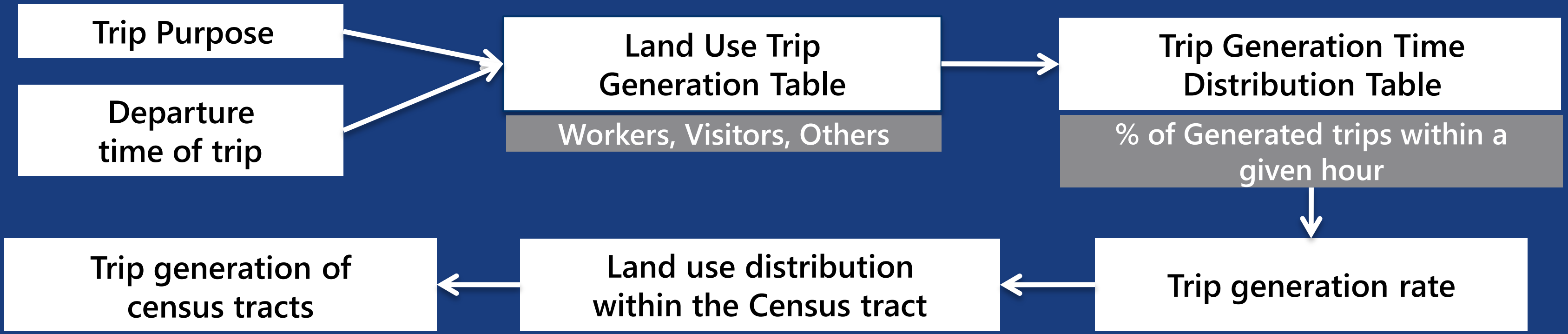
# Synthetic mobility dataset generation

## Generation of individuals mobility (I)

### Land use “mass” of trip origin or destination

- The membership fuzzy function is computed for each census tract of the modelling area for each trip. This model is based on a trip generation rate for each type of land use, linked to the trip purpose and the trip departure time
- Based on the land use distribution of each census tract, the model computes a trip generation rate. These generation rates are then corrected by model correction factors and constraints



# Synthetic mobility dataset generation

## Generation of individuals mobility (II)

### Transportation probability

- A logistic function (S curve) is calibrated to assess the deviation of travel time for every potential OD pair when compared to the original reported travel time and the number of transfers
  - ✓ The number of transfers is set by a rule based approach where the "virtual person" presents a similar mobility by having either the same number of transfers or a maximum variation of 1
  - ✓ The probability of travel time similarity is obtained through an S curve where same travel time has higher probability and 15 minutes travel time variation has 0 probability
- The total membership fuzzy function is generated as a product of the land use "mass" and the transportation probability

# Synthetic mobility dataset generation

## Generation of individuals mobility (III)

### Transportation probability

- The total mass is converted into a probability density function and a random number is generated to choose the destination of the “virtual user” for the reported trip and a given trip purpose
- The probability density function when generating an empty set of options restart the Monte Carlo simulation for the “virtual person” mobility
- In case of constrained mobility to previous members, previous generation is preserved and ensured that other trips respect the fixed term introduced

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# Synthetic mobility dataset generation

## Generation of individuals mobility (IM)

### Compatibility analysis of generated journeys and trip chain

- Structural compatibility:
  - ✓ Same trip purpose, trip mode (walking/biking, private car or public transport), trip home based (yes/no), alone (yes/no)
- Time compatibility:
  - ✓ Trip starting time interval, trip duration ratio (max 25% difference)
- Space compatibility:
  - ✓ Distance between origins and destinations (depends of the trip purpose), trip length ratio (max 25% difference)

- The probability of choice of a given census track as destination of a trip is a function of the similarity of distance to origin (in comparison with that reported in the survey), of the distribution of functional areas aligned with the stated trip purpose along with the distance-compatible census track and of the mode-compatibility

# Synthetic mobility dataset generation

## Outputs of the model

- The model generates a database with a code for each household, person and trip recording the following information:
  - ✓ Trip ID ([T_ID])
  - ✓ Grid origin, destination, coordinates ([Grid_o], [Grid_d], [Grid200_o], [Grid200_d], [X_o], [Y_o], [X_d], [Y_d])
  - ✓ Seed respondent code ([samno]), Household code ([household_code]), person ([person]) and virtual person ID ([Clone_ID])
  - ✓ Trip order ([trip]), Seed journey ID ([journey_ID])
  - ✓ Trip purpose ([purpose])
  - ✓ Code of the person in which the trip was performed in company of ([company])
  - ✓ Original transport mode ([mode]) and transport mode estimated ([mode_est])
  - ✓ Departure time ([start_time]), duration ([duration]) and day of the week of trip ([day_of_week])

# Focus group and stated preference survey

## Design of the focus group meetings

- The focus group is a commonly applied qualitative research method which fits well for the purpose of the study
- Focus groups can provide more personal disclosure and allow more topics to emerge (due to the larger number of participants discussing the matter) compared with individual interviews
- Also, focus groups can mimic better, real decision making environments where people are exposed to peer opinions and, possibly, are influenced by them
- The ITF shared mobility focus group was designed for groups between seven and 20 people, with sessions lasting between 90 to 120 minutes
- All the focus group materials and terminology were adapted to the local language and local, most widespread nomenclature to aid the understanding of the participants

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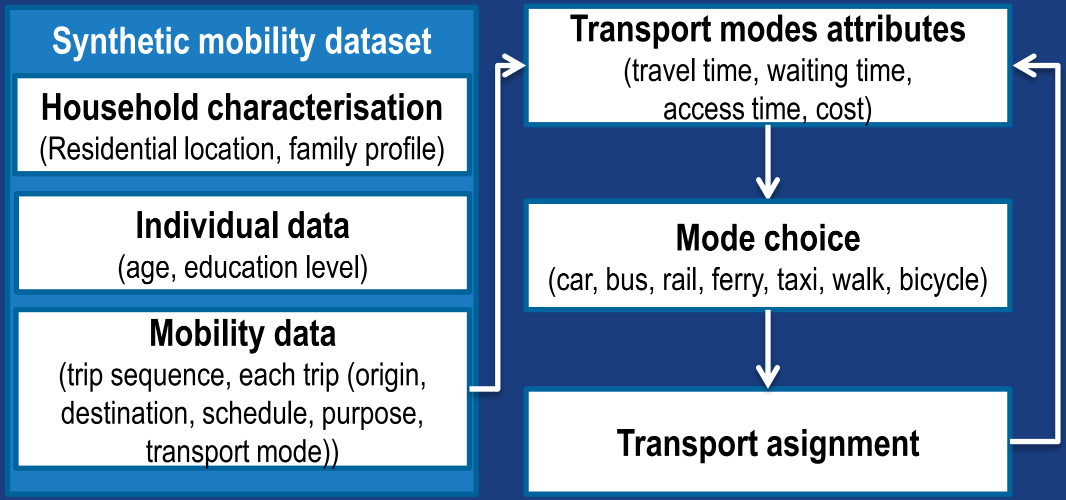
# Policy use of the dataset

## Measuring social impacts

- The synthetic population of trips and persons allows estimating the sociodemographic characteristics of residents for each trip




- At equlibrium the logsum variation of every trip is measured
- This allows measuring the consumer surplus resultant from a variation in the costs of using private car

$$CS_{os}^{u} = \tau_{os}^{1} \cdot \left( \ln \cdot \sum_{n} \exp(V_{ons}^{1}) - \ln \cdot \sum_{n} \exp(V_{ons}^{0}) \right)$$

$$CS_{os}^{m} = \left( \frac{CS_{os}^{u}}{\alpha_t} \right) \cdot VOT$$

- The results can be assesed by geographical location or socioeconomic group

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# Policy use of the dataset

## Targeting policies to minimise inequalities

- Having this detailed analysis of the consumer surplus variation for each trip performed in the region and their inhabitants, policies can be targeted to assess and minimise the asymmetries in the congestion charging benefits.
- These policies may change:
  - ✓ The geographical boundary of congestion charging
  - ✓ The payment policy and development reductions or exemptions in highly penalised cases
  - ✓ How the revenue collected is used to improve the travel experiences in the modal choice for the users that stopped using their cars (financing public transport either by quality improvement or fare reduction)

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# Thank you!

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