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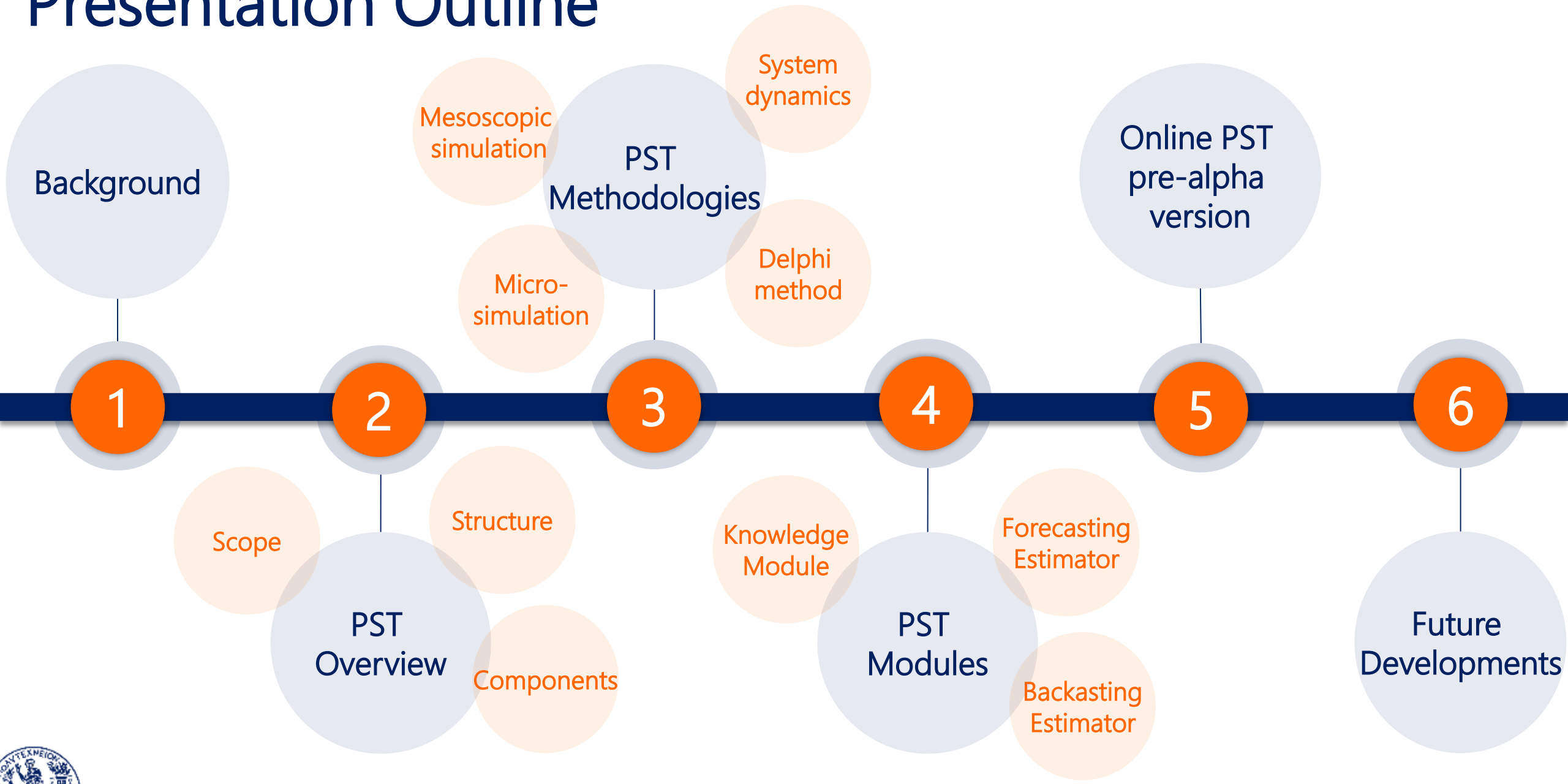
The LEVITATE Policy support tool to enhance the preparedness for a future with increasing levels of automated vehicles

Apostolos Ziakopoulos,
Maria Oikonomou,
Julia Roussou,
George Yannis

National Technical University of Athens
Department of Transportation Planning and Engineering

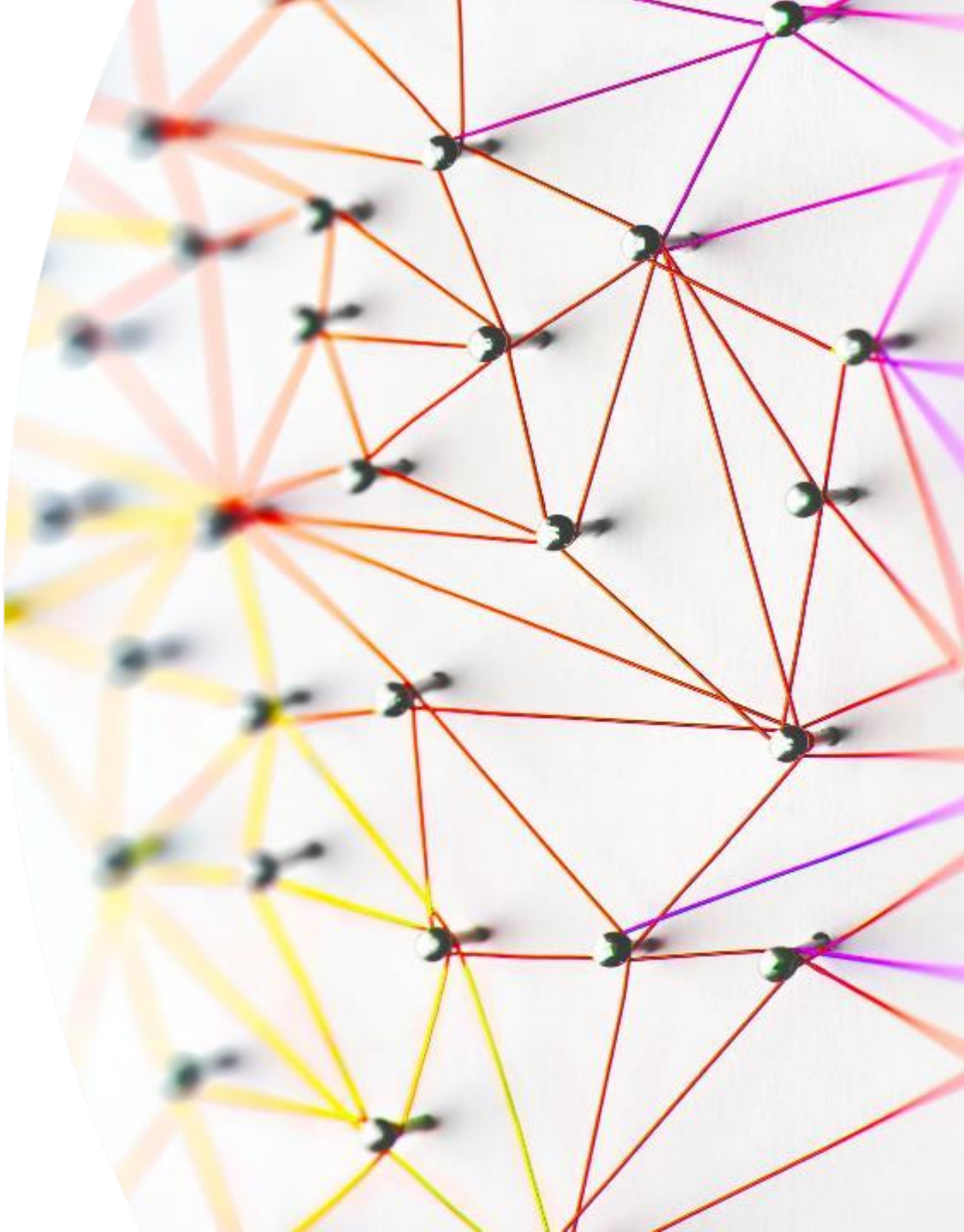
levitate

Presentation Outline



Introduction

- Rapid technological advances leave limited margins for the preparation of cities in order to receive Connected and Automated Transport Systems (CATS).
- Automation technologies are expected to roll out in a rapid pace in all transport domains, including land transport modes such as passenger cars, urban public transport and freight transport.
- The Levitate project endeavors to develop an open access web-based Policy Support Tool (PST) targeting Decision makers at all levels: Municipalities, Regional Authorities & National Governments.



The Levitate Project

- Levitate focuses on the development of a new impact assessment framework, in order to enable policymakers to manage the introduction of connected and automated transport systems, maximise the benefits and utilise the technologies to achieve societal objectives
- Project partners: LOUGH (UK), AIT (AT), AIMSUN (ES), NTUA (EL), POLIS (BE), SWOV (NL), TOI (NO), TfGM (UK), City of Vienna (AT), QUT (AU), TJU (CN), UMTRI (US)
- Duration of the project: 36 months (December 2018 - December 2021)
- Framework Program: Horizon 2020 - The EU Union Framework Programme for Research and Innovation - Mobility for Growth

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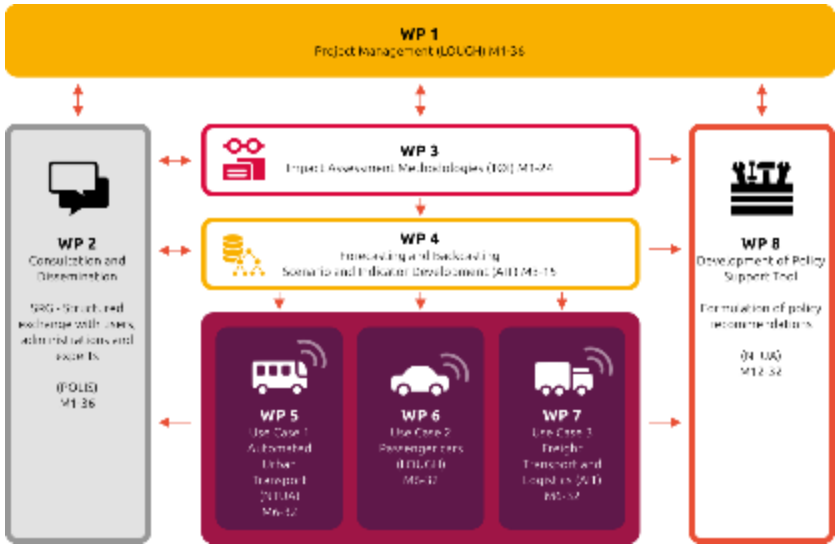


Scope

- To consolidate the outputs of different methods into an overall framework for the assessment of impacts, benefits and costs of CATS, for different automation and penetration levels and on different time horizons.
- To analyze user needs for a decision support tool aiming to assist in the analysis of urban policy scenarios and targets.
- To develop and implement a toolkit and a decision support tool, allowing the testing of various policy scenarios on the basis of the needs of relevant stakeholders, incorporating both forecasting and backcasting approach.
- To provide policy recommendations.

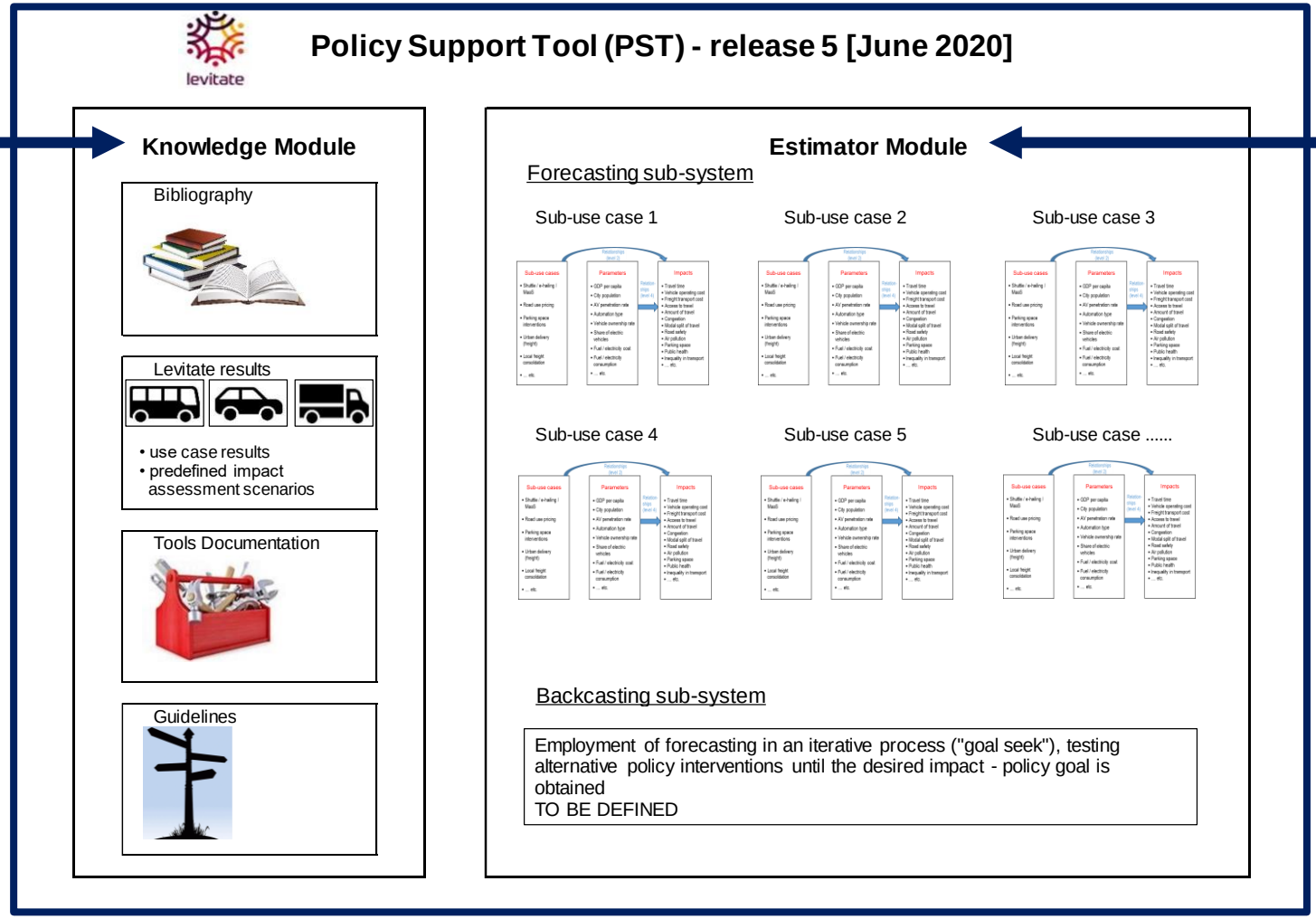
Components

- Three automation use cases are considered:
  - Passenger cars
  - Urban transport
  - Freight transport
- Twenty examined impacts are considered, classified into three distinct categories:
  - Direct impacts,
  - Systemic impacts and
  - Wider impacts

- Four scenarios of automation penetration are established:
  - No automation base scenario
  - Pessimistic base scenario
  - Neutral base scenario
  - Optimistic base scenario
- Four different methods used to provide inputs:
  - Microsimulation
  - Mesoscopic simulation
  - System dynamics
  - Delphi method

Structure

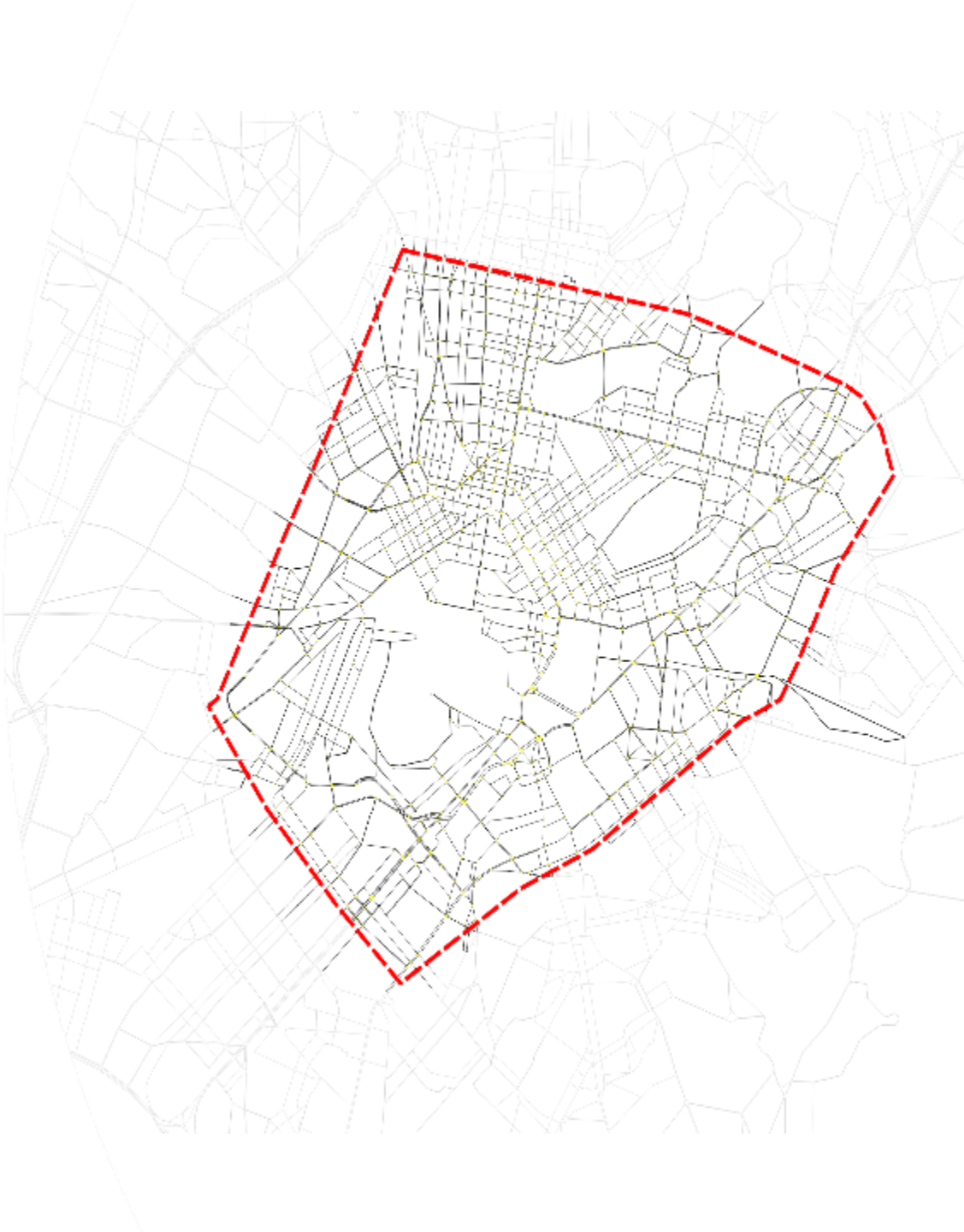
- Static
- Searchable
- Components:
  - Bibliography
  - Results
  - Tools
  - Guidelines and policy recommendations



- Dynamic
- Interactive
- R-Studio Design
- Sub-systems:
  - Forecasting
  - Backcasting

Microsimulation

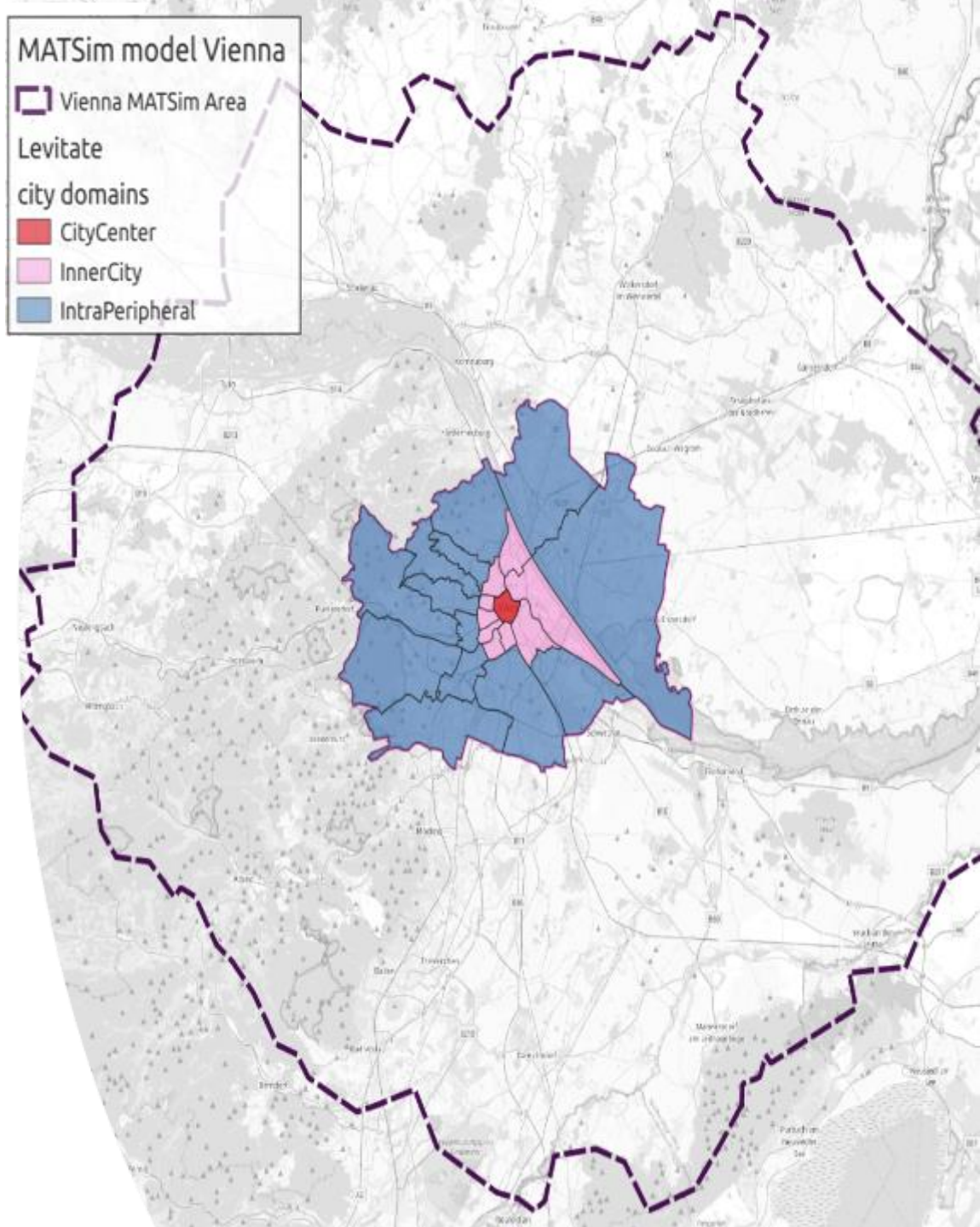
- Impacts of CATS on traffic: travel times, flows, traffic emissions and road safety under several simulation scenarios.
- Influence of different CAV penetration rates on a microscopic level.
- AIMSUN software is used within Levitate, with inputs including road geometry and design, traffic volume, modal split, O-D matrices etc.



Mesoscopic simulation

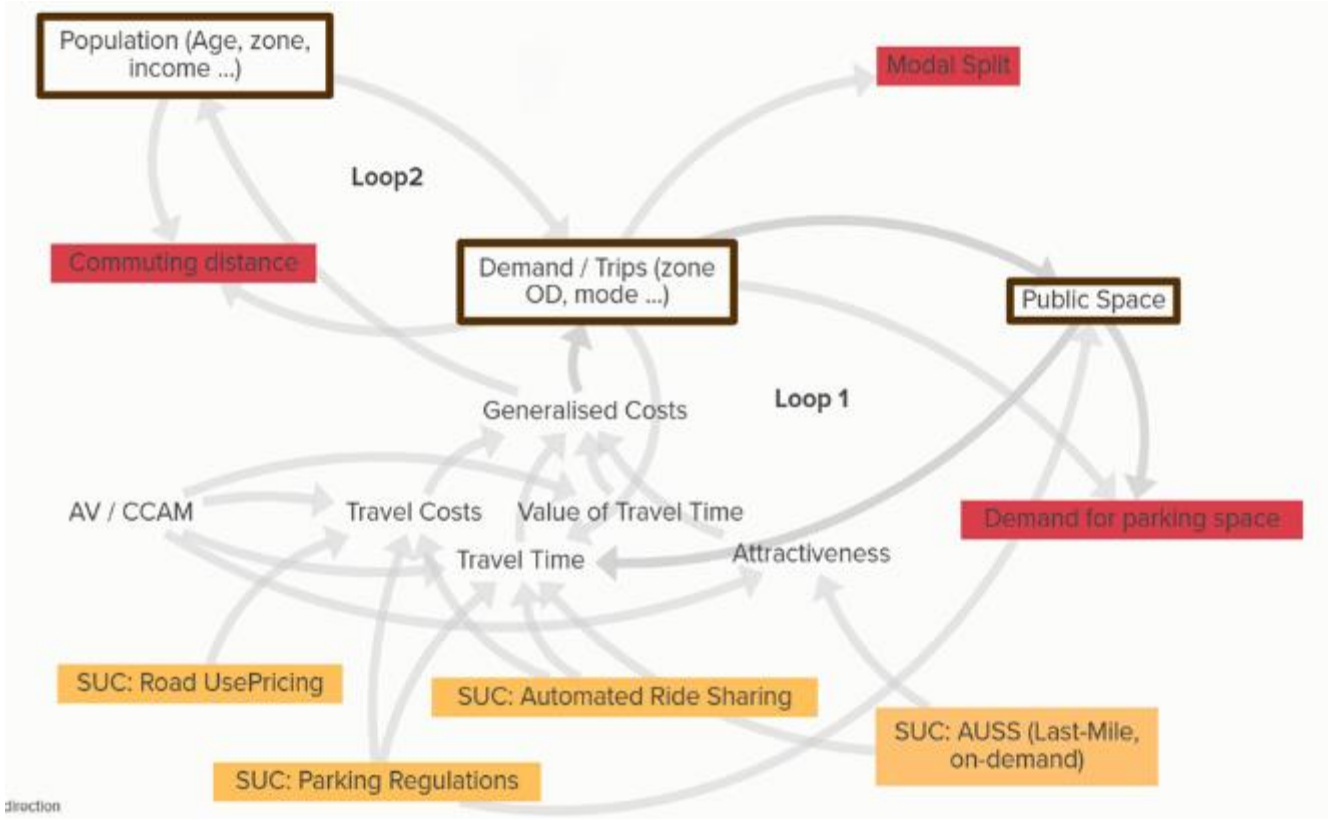
The mesoscopic mobility simulation of agents and their plans of activities is used as a method to estimate:

- Travel time of an average 5 km trip within the inner city.
- Modal splits and modal shifts (i.e. changes in modal split) of active (walking or cycling) and public transport modes of travel.
- Total distance traveled within the inner city.



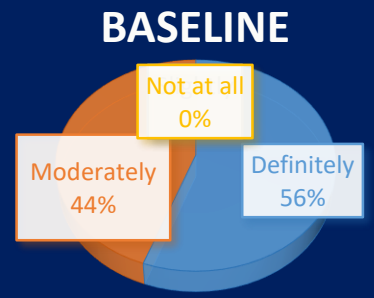
System dynamics

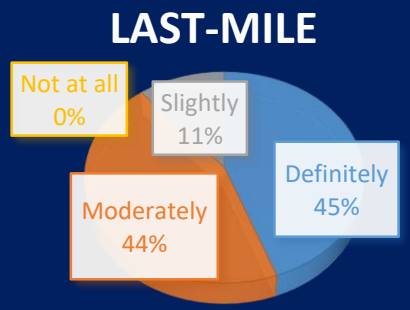
- Transportation systems that are undergoing transformation are considered.
- Assess impacts of policy interventions (e.g., road use pricing/last-mile shuttles) during a transition period of increasing AV percentage.
- Impacts are typically commuting distances, modal split and parking space as a function of MPR per scenario.

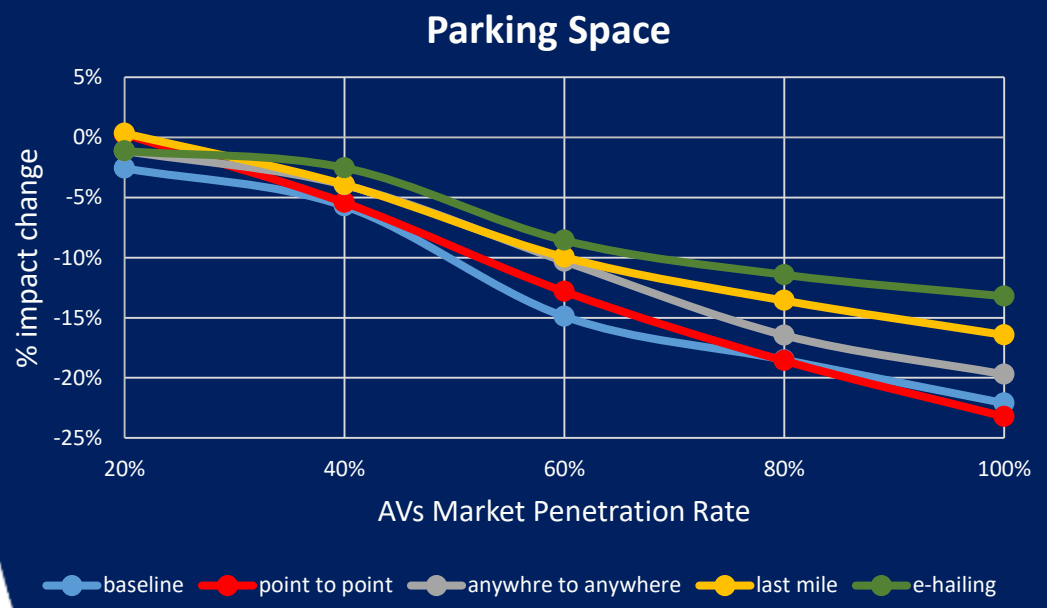


Delphi method

- A process used to arrive at a collective, aggregate group opinion through an expert panel.
- Used to obtain impacts that cannot be calculated by other quantitative methods.
- Two-round 45-min questionnaires, regarding 2 to 4 automation interventions based on expertise.
- Answers were aggregated as percentage change coefficients.







Knowledge Module

- **Bibliography:** Relevant literature concerning impact assessments of CATS
  - Systematic literature review across the project and one per use case
  - The documentation of each sub-use case
  - Short synopsis summarizing each use-case/sub use-case

- **Project results:** Case studies, impact assessments

  For each case study:
  - Information regarding the scenarios and baseline conditions
  - Assumptions and limitations relevant to each case study
  - Showcasing of case study results

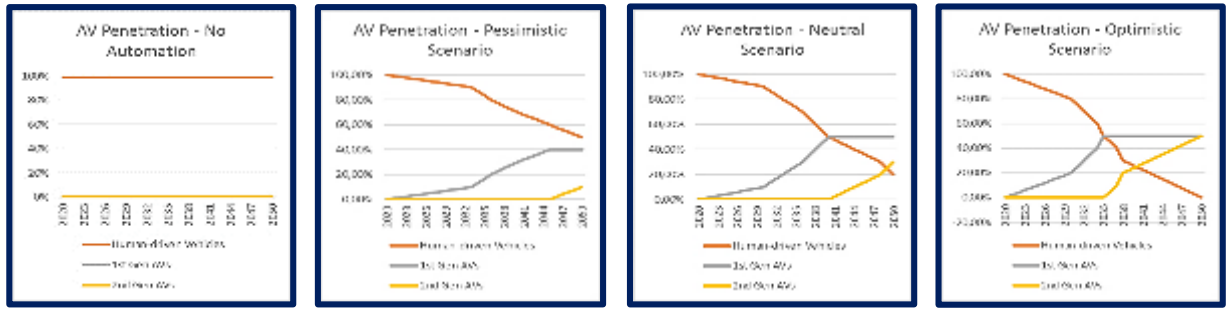
- **Documentation of tools:** Toolbox of methods

  For each methodology:
  - Information regarding the methodological background
  - Assumptions and limitations relevant to each methodology

- **Guideline excerpts:** Guidelines and policy recommendations regarding CATS
  - Explanations and tutorials on the use of the PST Estimator modules
  - Overall recommendations to cities from project results
  - Additional recommendations from literature or other inputs

Forecasting Estimator

- **Step 1:** Selection of Use Case:
- **Step 2:** Definition of initial values
- **Step 3:** Definition of base scenario:
- **Step 4:** Details of sub use-case and policy intervention
- **Step 5:** Details of sub use-case implementation
- **Step 6:** Details of economic situation of agents
- **Step 7:** SUC impact estimation – presentation of results



User interface: Inputs

Step 1: Selection of use case — **PASSENGER CARS**

Step 2: Definition of initial values

	no.	Description	Unit of Measurement	Default Initial Value (can be changed by user)
PARAMETERS	1	GDP per capita	€	17,000
	2	Annual GDP per capita change	%	1.50%
	3	Inflation	%	1.00%
	4	City Population	million persons	3.000
	5	Annual City Population change	%	0.50%
	6	Urban shuttle fleet size	no. of vehicles	~~300~~
	7	Freight vehicles fleet size	no. of vehicles	~~100~~
	8	Average load per freight vehicle	tones	~~3~~
	9	Average annual freight transport demand	million tones	~~1.5~~
	10	Human-driven Vehicles	%	100%
	11	1st Gen - Cautious AVs	%	0%
	12	2nd Gen - Aggressive AVs	%	0%
	13	Fuel cost	€ / lt	1.50
	14	Electricity cost	€ / KWh	0.10
	15	Fuel consumption	lt / 100Km	8.00
	16	Electricity consumption	KWh / 100Km	13.00
	17	VRU Reference Speed (Typical on Urban Road)	km/h	40.00
	18	VRU at-Fault accident share	%	30.00

	no.	Impact	Description / measurement	Unit of Measurement	Initial Value
Direct impacts	1	Travel time	*Average duration of a 5Km trip inside the city centre*	*min*	*15.0*
	2	Vehicle operating cost	*Direct outlays for operating a vehicle per kilometre of travel*	*€/Km*	*0.3*
	3	Freight transport cost	*Direct outlays for transporting a tonne of goods per kilometre of travel*	*€/tonne.Km*	*0.3*
	4	Access to travel	*The opportunity of taking a trip whenever and wherever wanted (10 points Likert scale)*	-	*5*
Systemic impacts	5	Amount of travel	*Person kilometres of travel per year in an area*	*person-km*	*19165.40*
	6	Congestion	*Average delays to traffic (seconds per vehicle-kilometer) as a result of high traffic volume*	*s/veh-km*	*197.4*
	7	Modal split of travel using public transport	*% of trip distance made using public transportation*	*%*	*0.4*
	8	Modal split of travel using active travel	*% of trip distance made using active transportation (walking, cycling)*	*%*	*3%*
	9	Shared mobility rate	*% of trips made sharing a vehicle with others*	*%*	*4%*
	10	Vehicle utilisation rate	*% of time a vehicle is in motion (not parked)*	*%*	*8%*
	11	Vehicle occupancy	*average % of seats in use (pass. cars feature 5 seats)*	*%*	*25%*
Wider impacts	12	Parking space	*Required parking space in the city centre per person*	*m2/person*	0.9
	13	Energy efficiency	*Average rate (over the vehicle fleet) at which propulsion energy is converted to movement*	*%*	*0.25*
	14	NO_x due to vehicles	*Concentration of NO_x pollutants as grams per vehicle-kilometer (due to road transport only)*	*g/veh-km*	*1.80*
	15	CO_2 due to vehicles	*Concentration of CO_2 pollutantsas grams per vehicle-kilometer (due to road transport only)*	*g/veh-km*	*2500.00*
	16	PM_{10} due to vehicles	*Concentration of PM_{10} pollutantsas grams per vehicle-kilometer (due to road transport only)*	*g/veh-km*	*0.20*
	17	Public health	*Subjective rating of public health state, related to transport (10 points Likert scale)*	-	*5*
	18	Inequality in transport	*To which degree are transport services used by socially disadvantaged and vulnerable groups, including people with disabilities (10 points Likert scale)*	-	*5*
	19	Commuting distances	*Average length of trips to and from work (added together)*	*Km*	*20.00*
	20	Unmotorized VRU crash rates	*injury crashes with unmotorized VRUs per vehicle-kilometer driven*	*injury-crashes/veh-km*	*2.20*
	21	Road safety motorized	*Number of crashes per vehicle-kilometer driven*	*crashes/veh-km*	*1.40*
	22	Road safety total effect	*Road safety effects when accounting for VRU and modal split*	*crashes/veh-km*	~~0.86~~

Step 3: Definition of base scenario — **SCENARIO 2 - PESSIMISTIC**

Step 4: Selection of sub-use case — **Dynamic city toll**

Step 5a: Enter the policy implementation year — **2021**

Introduction lag: 1

Step 5b: Selection of policy intensity/magnitude for each year (controlled by authorities)

Policy intensity/magnitude	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Step 5c: Selection of policy effectiveness (not controlled by authorities)

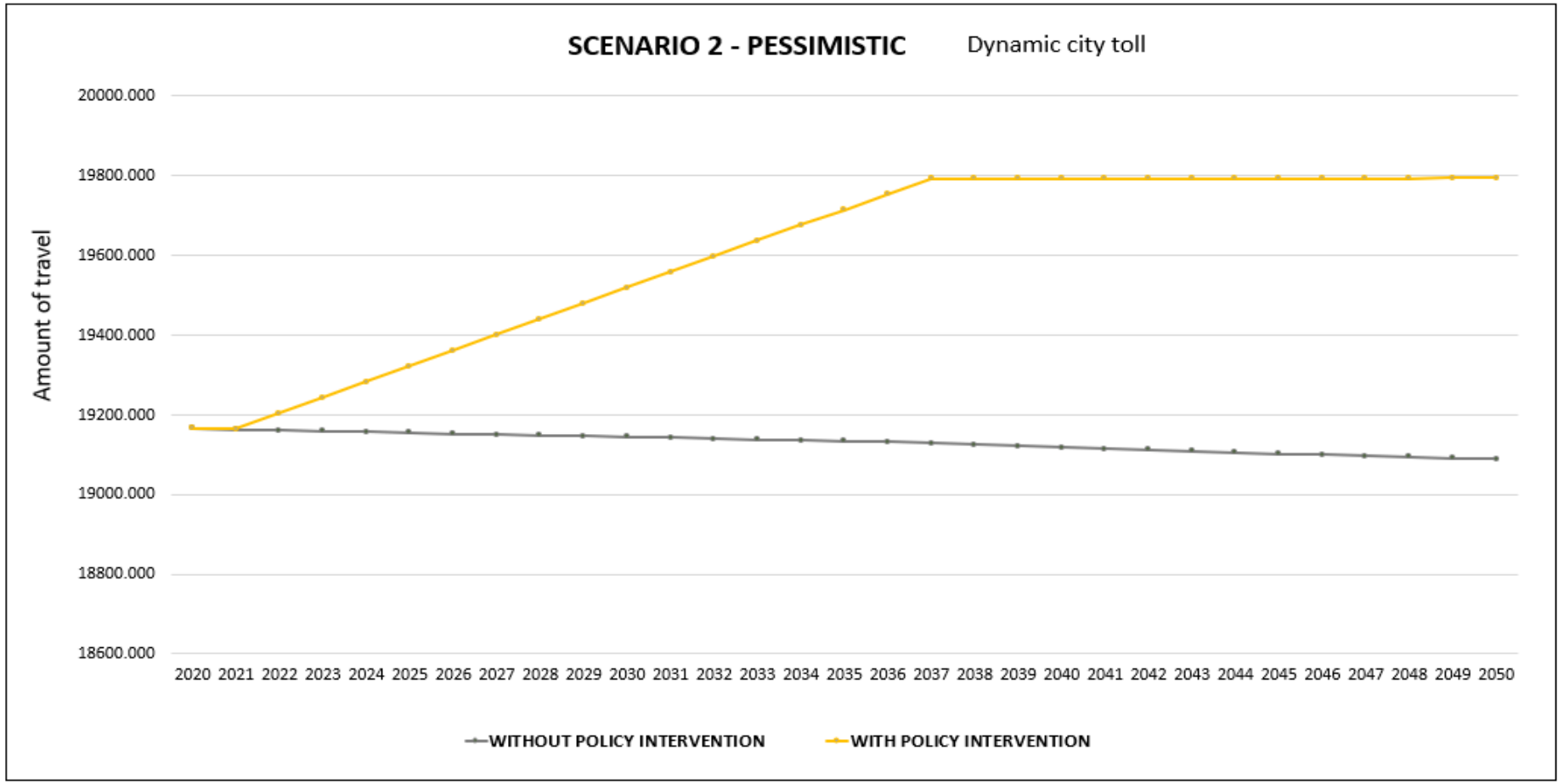
Policy effectiveness	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%

Step 6a: Selection of the pricing level (€) — **1.42857142**

Step 6b: Selection of Marginal utility of money — **0.95**

User interface: Results

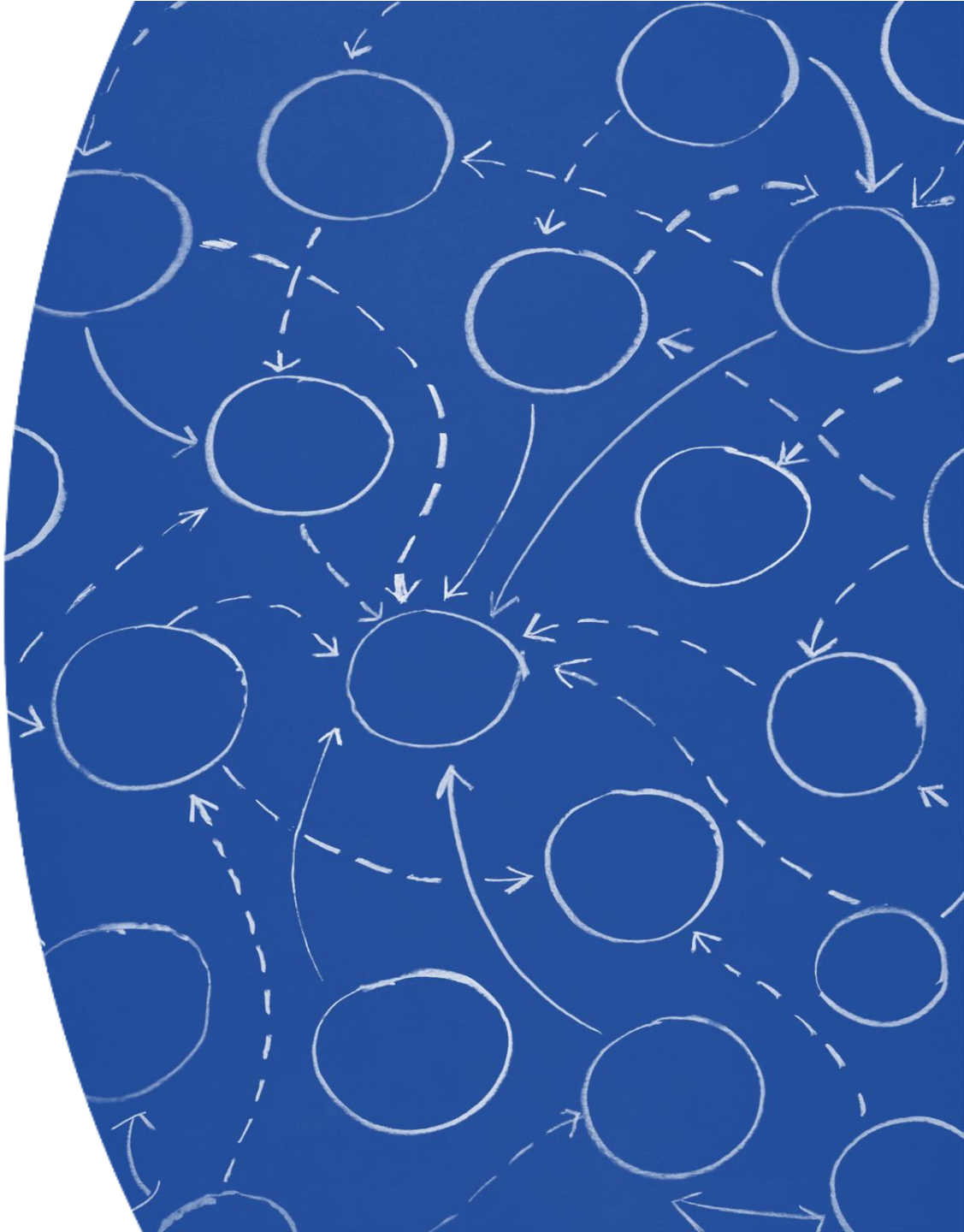
RESULTS
Enter Impact no: 5



Policy Intervention Combination

The creation of Impact Modification Factors (IMFs) and their combinations in pairs drawing from the US FHWA HSM philosophy for CMFs

- **Additive method:**
  $IMFc = 1-[(1-IMF_1) + (1-IMF_2)]$
- **Multiplicative method:**
  $IMFc = IMF_1 * IMF_2$
- **Dominant effect method:**
  $IMFc = \min(IMF_1, IMF_2)$
- **Dominant common residuals method:**
  $IMFc = (IMF_1 * IMF_2)^{\min(IMF1, IMF2)}$
- **Amplificatory method (not existing in FWHA):**
  $IMFc = [IMF_1 * IMF_2]^2$



Backasting Estimator

- **Functionality:** The backcasting process is envisioned to be the inverse of forecasting, i.e.: Set a vision, investigate how it can be reached.
- **Projection:** Are the selected measures enough or not?
- If not, define **best possible** attainable outcome.
- **Measure combination:** Using combined Impact Modification Factors (IMFs).
- **Measure change:** Option to substitute a measure for another midway once in the PST (e.g. Measure 1 performs better in low MPR, and Measure 2 performs better in high MPR).

Future Developments

- As the Levitate project moves forward, additional results and functionalities will be available for the PST user.
- CBA capabilities are already being examined as an extension of the forecasting module database in order to monetize costs and benefits induced from the overall transformation of the transport networks.
- Overall, the Levitate PST aspires to become the go-to, one-stop-shop tool for the calculation of societal impacts of automation by experts, authorities, stakeholders and any other interested party.

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