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Data Utilization in Digital Twin for Sustainable Transportation Planning

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2024 Reflection

- Understanding context:
  - **Challenge of Zero-Goal-Growth:**
    - How to assess & monitor that the city meet the target?
    - Data quality & representativeness
    - Including other data sources, but how?
  - **Answer-wanted questions, i.e.:**
    - How worth is the bike lane? To which extent it is shifting % private car to % bike?
    - If we implement X, how will the car trips decrease? When, where, for which purpose?

      X: parking policy, car restriction, bus frequency increase, etc

Data	**Data Collection**	**Data Integration & Processing**	**Formalization to Acquire Data**
	• Bike & pedestrian • Traffic count data in city level • Queuing & delay • Parking • Quality travel survey	• PT data • Travel survey data (timely processing) • Automatic update	• Micromobility • Car sharing data • Toll payment system • Freight data
Model	**Interaction between different models**	**Network resolution**	**Development of methods**
	• Interaction between : ○ LUTI, ○ Demand model ○ Operational model • Seamless flow of output	• Spatial & temporally more granular • Consider intervention → level for impact measurement	• Trip chaining & muti-modal • Active mobility • Freight • Involve element of intervention ○ Parking ○ Lane priority ○ Bike lane

Tool	Data & Information coordination & collaboration	Dynamic visualization	User-friendly Scenario building	Tools & Models Integration

Category	Sub-category	Needs	State-level authority	Municipal and city-level authority	Transit operator
Data					
	Data collection	Pedestrian counting	✓✓	✓	✓
		Bike counting	✓✓	✓	✓
		Parking cost & capacity	✓		
		First mile last mile data	✓		✓
		Data on queueing		✓	
	Data quality	National travel survey data	✓	✓	
		PT passenger traffic			✓
		Bike counting data (from sensor)		✓	
	Data processing	Timely processed national travel survey	✓		✓
		Clean PT network data	✓		
		Automatic update on road network data	✓		
		PT trips behavior			✓
	Data Integration	PT data	✓	✓	✓✓✓
		Traffic counting		✓	
		GPS-based tracking data	✓	✓	✓
		Project-based transport data	✓	✓	
		Historical data and (near) real-time data		✓	
		Targeted demographics survey (children & senior)		✓	
		Updated spatial data			✓
	Formalization to acquire data	Freight data	✓		
		Counting from toll payment system	✓		
		Micromobility			✓
		Car sharing			✓

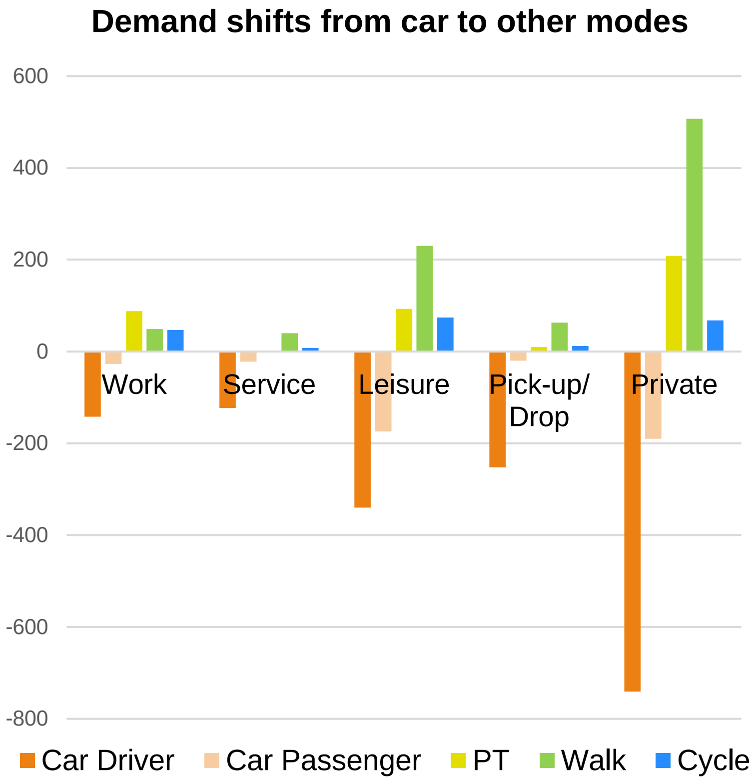
Model					
	Development of model	Active transport modelling	✓✓✓	✓	
		Public transport modelling	✓✓	✓	✓✓✓
		Freight modelling	✓		✓
		Involve element of intervention (parking, car restriction, dynamic road pricing)	✓✓	✓✓	✓
		Changes of travel habit (home office)	✓	✓	
		Sharing economy (car sharing, carpooling, bike sharing)		✓	✓
		Future mobility options	✓	✓✓	
	Finer network resolution	Spatial resolution	✓✓✓	✓	✓
		Temporal resolution	✓✓		
		Involve quality factors in network	✓	✓	
	Interaction between models	Transport micro and macro model	✓✓		✓
		LUTI and transport model	✓	✓	✓
		Elasticity-based model and transport model			✓
		Operational model and transport demand			✓✓
	Model output validation	Standardized uncertainty measurement based on matched trip data	✓✓		
		Validating delay in intersection model	✓	✓	
		Sensitivity analysis for different scenario			✓
		Incorporating different data sources	✓		
		Before and after planned transportation			✓

Tools					
	Scenario building	Incorporating non-infra variable	✓✓	✓✓	✓
		Incorporating space optimization			✓
		Resulting cost comparison		✓	✓
		Resulting alternatives with different measures		✓	✓
		Resulting informed prioritization		✓	
		Less processing time			✓
	Visualization	Adjustable level of details	✓		✓✓
		Incorporate live-dynamic visualization	✓✓	✓	
		Geospatial visualization	✓		✓
		Easy to interpret & understandable with relevant context	✓✓✓		✓
	Supporting Integration	Data sharing and integration	✓✓	✓✓	✓
		Tools interaction and integration	✓	✓	✓✓

On-going and 2025 Planning

- **Using Tomtom data in transport model**
  - A more realistic speed in the model
  - A more realistic travel demand estimation
  - Result still inconsistent, research to be continued…

- **Assessing GPS-based data quality for urban transport**
  - How GPS-based data can be used for observing travel behavior in finer resolution?
  - How is the quality of GPS-based prediction from different sources?
  - Will it impact to uncertainty in transport model?



Result of mode choice estimation after using tomtom speed data in the model

On-going and 2025 Planning

- **Using smartphone data**
  - Other study finding: less reliable for studying transport patterns in finer resolution, shorter trips within city center area and between neighboring areas (Dypvik Landmark et al., 2021)
  - Then, how to use it in urban transport system context?

- **Using LIDAR data**
  - How to use it in transport model?
  - In what way it will be beneficial for the modelling (for instance, answering the stakeholder' need)
    - Can it enrich pedestrian & counting data?
    - Can it enrich traffic counting data in terms of more detail vehicle type data?
    - What insight on pedestrian-vehicle interaction it can give? → then what?
    - Or, integrate the car traffic data for observing queueing/ speed dynamics?
    - Is it more useful to micro & meso modelling than the macro model?