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The role of information systems to better understand, analyse and improve urban mobility

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Safe I Secure I Green I Integrated I Resilient

AUS TÜRKİYE ITS TÜRKİYE

Session: Safe, Secure, Sustainable, Human Oriented and Accessible Transportation

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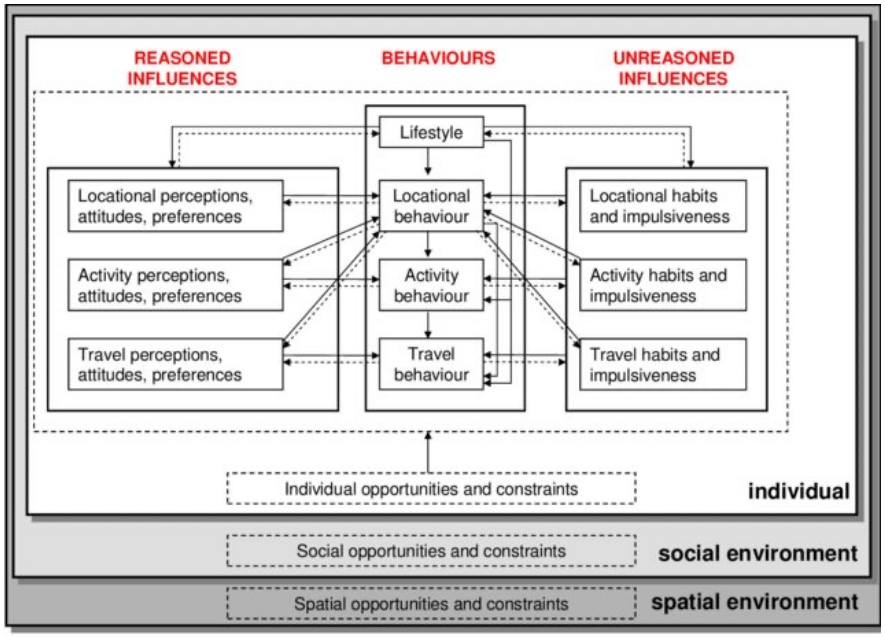
The topics covered in this presentation are discussed within the Travel Behaviour research

- Travel behaviour concerns:

"the *use of time and its allocation to activities and to travel*, methods for studying travel and time allocation in a variety of contexts and stages in person's life, and the arrangement of artifacts and use of space at multiple levels of social organisation such as the individual, household, the community, and other formal and information groups.

Travel Behaviour also includes the *movement of goods and provision of services* that strong interfaces and relationships to activities and the movement of persons.

Travel Behaviour Analysis is heavily influenced by policy needs, pragmatic considerations in data collection and analysis, and a multitude of both theoretical and computational approaches" (Goulias, 2018; Goulias, 2024)



(Van Acker et al., 2010)

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Rapid advancements in technology and information systems have facilitated innovations in urban mobility

Advancements	New private and public mobility options/solutions	We are in transitional phase and problems remain…
• Electrification • Automation • Digitalisation • …	• Electric connected, autonomous vehicles • Electric scooters • Shared mobility (e.g. car, bike) and ride hailing • Integrated ticketing and Mobility as a Service • vs. no mobility: 'teleworking', 'telemarketing'	• Poor air quality and impacts on human health • Climate change • Noise • Congestion and disruptions • …

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There is urgency to learn how and whether technology advancements and mobility options would help address urban problems

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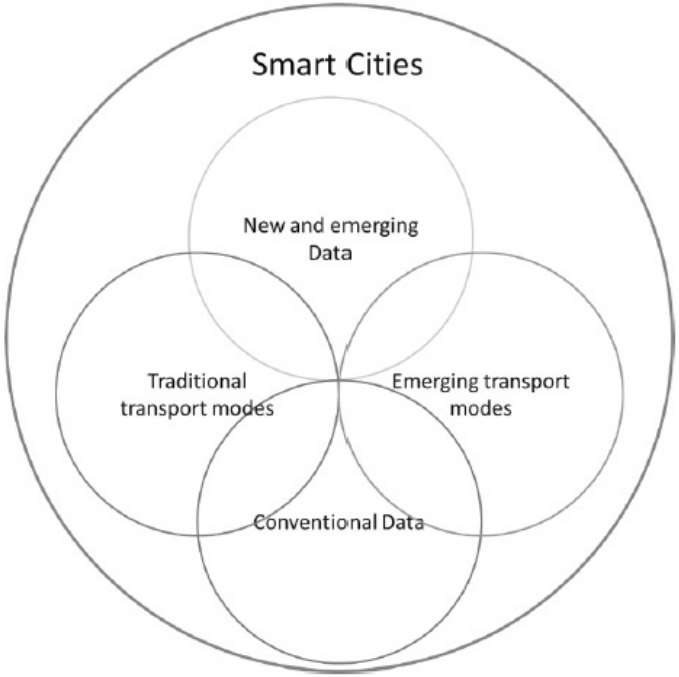
The study of human travel behaviour and user preferences are central in this exploration

- Recent advances and opportunities across:

✓ Data sources and analysis

✓ Study of (New) travel modes

✓ Behaviour change



Source: He et al. (2024)
in Handbook of Travel Behaviour

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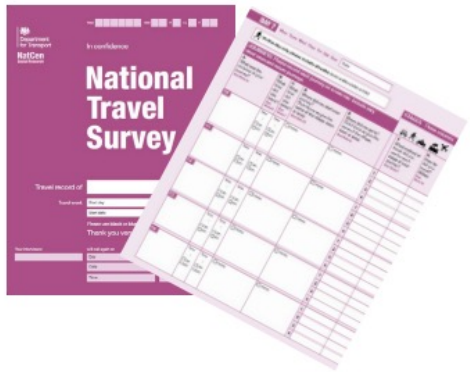
Empirical data are central to studying human mobility

Conventional



- Household travel surveys
- Cross-sectional small scale questionnaire surveys
- Questionnaires and GPS tracking
- Time use data

New, emerging and diverse data

- Large-scale and diverse sensor data by travellers and vehicles (big data) offer (Manyika et al., 2011)
  - Volume
  - Variety
  - Velocity
  - Veracity and
  - Value

Source: Wikipedia

Applications

- GPS and trajectory data
- Smart Card Data
- Mobile phone data
- Geotagged Social Media Data and Volunteer Geographic Information

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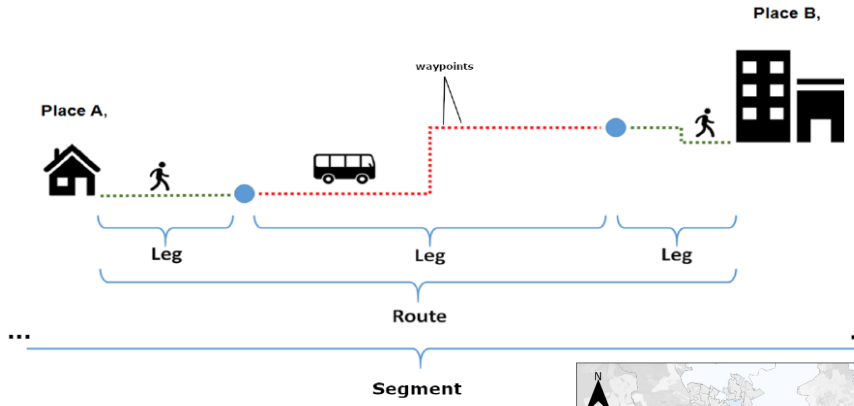
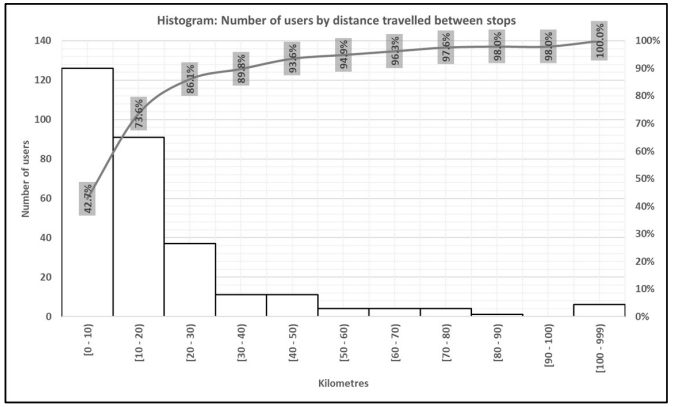
Inferring battery capacity requirements and infrastructure needs from drivers' travel patterns





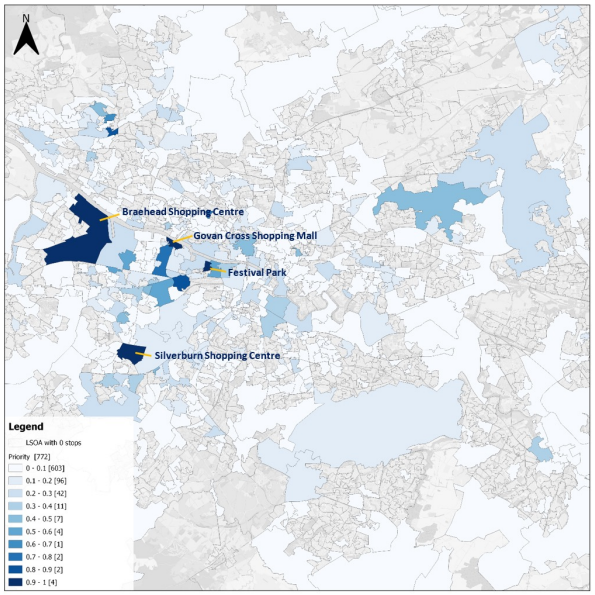


Figure 9 - Priority to allocate EV's charging infrastructure by LSOA.

- All consumers do not have the same battery needs
- Different needs mean that each vehicle does not necessarily require the same battery capacity
- How much batter capacity do private-car users need?

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Travelai

Passively generated large-scale data and computational power enabled analyses of travel behaviour and modelling using machine-learning approaches

- Unlike previous approached driven by theories of economics and psychology, machine-learning approaches are data driven as they ‘learn patterns from the data’ (Kalatian and Choundry, 2024)

Machine Learning

Inferring travel behaviour related variables

- Mode
- Route
- Activity type and purpose
- Public transport itinerary and route inference
- Mobility patterns and activity detection
- Attitude perception and sentiment analysis

Modelling Travel Behaviour (as an alternative to choice modelling)

- Route choice modelling
- Pedestrian behaviour
- Traffic flow or demand modelling
- Vehicle-ownership
- Accident prediction

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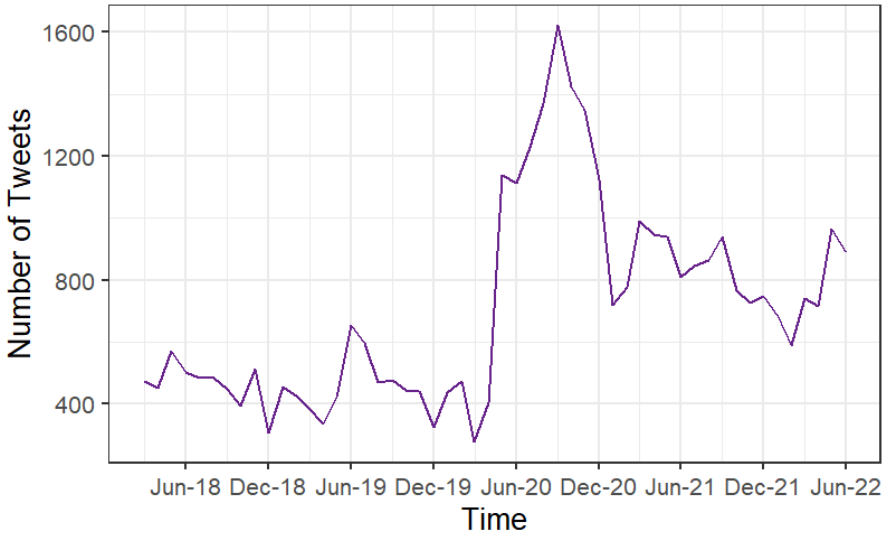
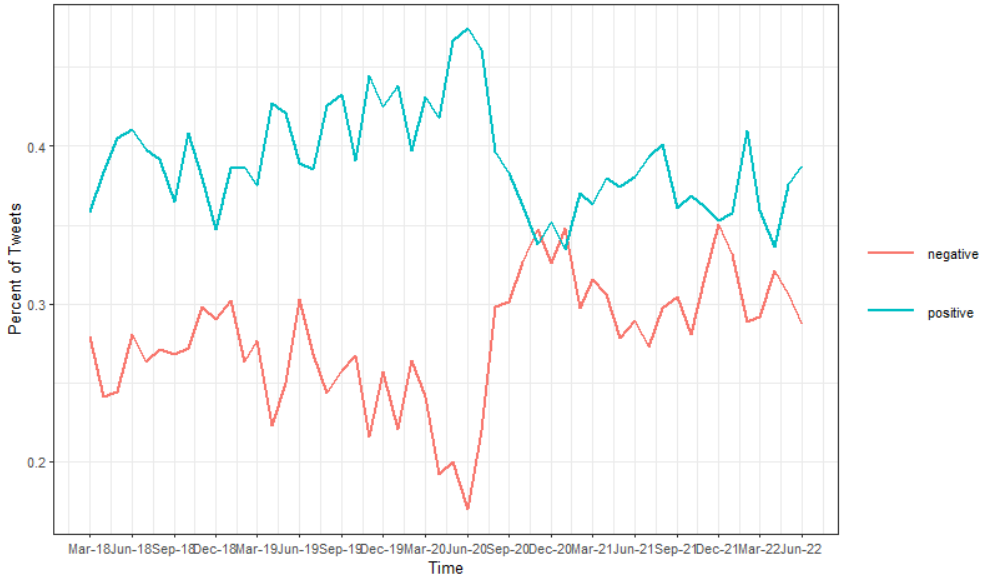
Sentiment analysis on cycle lanes and low-traffic neighbourhoods in the UK





Malet-Lambert et al. (2024)

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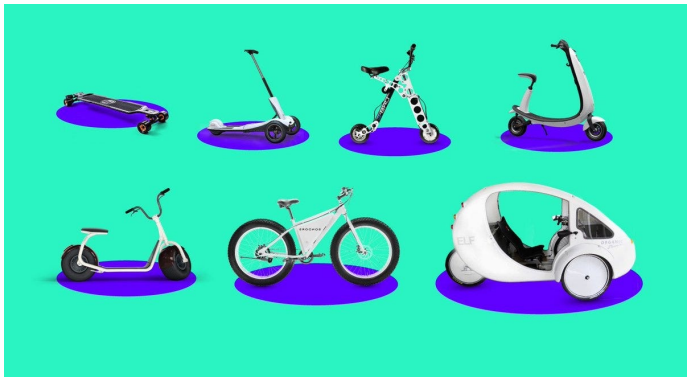
New and alternative mobility technologies have already enhanced the possible ways to travel

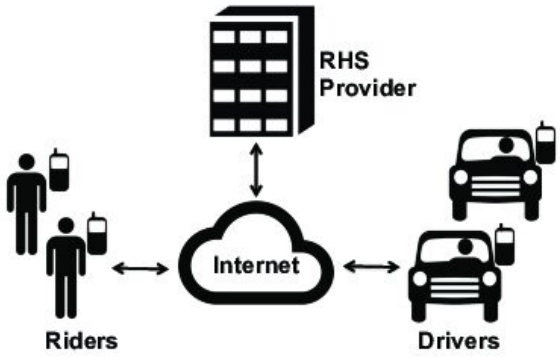
Micromobility



Source: Have a Go

Facilitate short, inner-city trips. Recent advances in offering these mobility solutions are due to rapid advances in wireless communications, real-time information, secure online payments, and online subscription systems (Nikitas et al., 2024).

Ride-hailing



Source: https://doi.org/10.1515/popets-2017-0015

Travellers 'purchase mobility' instead of owning a car via online platforms and associated vehicles thanks to advancements in ICT systems and related platforms (Mondal et al., 2024).

Car-sharing

Source: STARS project

'Short-term, on demand access to a fleet of shared vehicles so that users benefit from vehicle use without owning one thus avoiding all related costs and responsibilities' (Shaheen and Pan, 2024).

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The role of public transport in the 'information age'

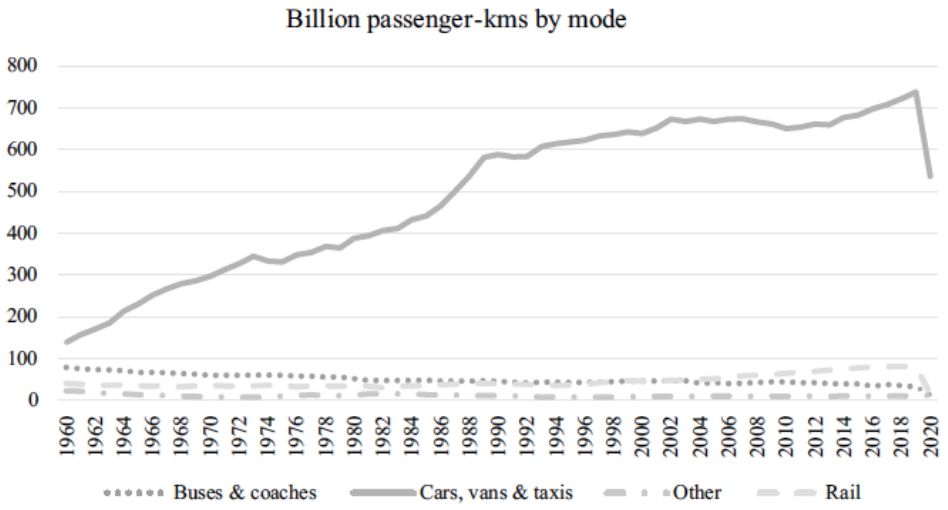
- Public transport (mainly train and buses) struggles to retain market share and patronage due to its competition with the private car and shared mobility services

This trend exacerbated with the COVID-19 pandemic

  - Although public transport is recovering 60-70% of its pre-COVID-19 levels across many areas (Nelson, 2024; Goodland and Potoglou, 2023)

- Information – personalised, accurate, timely, readily available – is critical to the prospect of public transport in terms of (Nelson, 2024):
  - Promoting safety
  - Ease of use
  - Passenger confidence

- Challenges:
  - Technology and older people
  - Wider challenges in accessing information (e.g. disabled individuals)



Source: Transport Statistics Great Britain, 2021 (https://www.gov.uk/government/statistics/transport-statistics-great-britain-2021/transport-statistics-great-britain-2021).

Source: Transport Statistics Great Britain

Source: Intelligent Transport

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The nature of public transport is changing but its role remains crucial, especially for low-income and disadvantaged groups

- Fixed-route, fixed-schedule, heavily subsidised bus and rail services are central in most countries
- However, competition emerges from shared transport solutions (e.g. pre-arranged, on-demand services by connecting travellers to drivers via an online digital application or platform)
- MaaS may help in shaping the future landscape for public transport and present both challenges and opportunities for 'traditional' public transport services
- Continuing to understand the needs of the traveller is key to the success of public transport

The 'three revolutions' (3R) in urban transportation

Business-As-Usual (BAU) Scenario (20th-century technology)	*2 Revolutions Scenario* (electrification + automation)	*3 Revolutions Scenario* (electrification + automation + sharing)
Internal combustion engine vehicles used at an increased rate, and PT and shared transport at current rate Population and income grow over time	EVs commonplace by 2030 and automated EVs dominant by 2040 Single-occupancy car travel exceeds even BAU	Embrace the 2Rs technology and maximise use of shared vehicle trips Widespread ridesharing by 2030 Increased PT performance (including on demand) and improved infrastructure for active travel Maximum energy efficiency

Source: Institute for Transportation & Development Policy (adapted from https://www.itdp.org/2017/05/03/3rs-in-urban-transport/).

Cited in Nelson (2024)

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Travel Behaviour Change

- Associations across commuting, subjective well-being, and mental health
- Response to automated technologies
- Behaviours of millennials and order people (Musselwhite and Murray, 2024)
- The effects of COVID-19 on commuting (Angell and Potoglou, 2022)

- With regard to urban mobility:
  - Travel behaviour changes over time (short-, long-term)
  - Observing changes might be challenging

There is great interest in finding out (Avineri (2024):

(a) what are the drivers of behaviour change?

(b) What are the effective measures and how these should be implemented to enable change?

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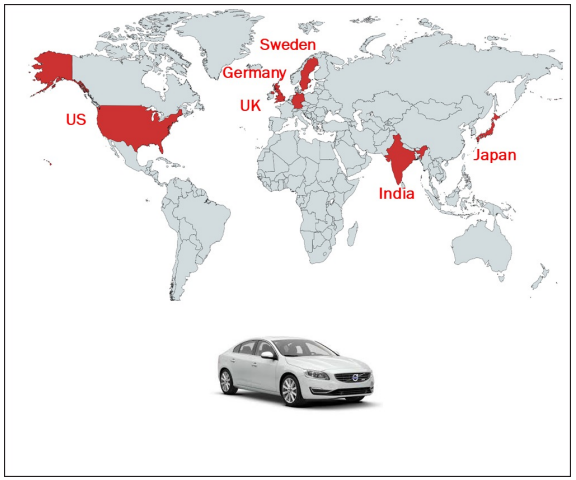
Behaviour change: an example of vehicle-technology stated choices across six countries



Car options by fuel type

Car features

	Petrol	Electric	Biofuel	Hybrid
Price ($)	35,000	49,000	45,500	35,000
Size	Large	Mid-size	Mid-size	Large
Autonomous driving	Driver assistance	High automation	Driver assistance	Partial Automation
Annual running cost ($)	985.00	788.00	886.50	886.50
Availability of fuel at existing petrol stations (%)	100	60	60	100
Materials	Conventional materials	Conventional materials which are climate neutral	Conventional materials, which are climate neutral	Organic materials
Design	Conventional design	Conventional design	Conventional design	Conventional design
Acceleration (0-60 mph in seconds)	8	12	12	6

Potoglou et al. (2020a, 2020b); Song and Potoglou (2019)

This type of research focuses on the behavioural, psychological and societal factors affecting potential demand for cleaner vehicles, a possibly important aspect towards sustainable transport in urban areas and beyond

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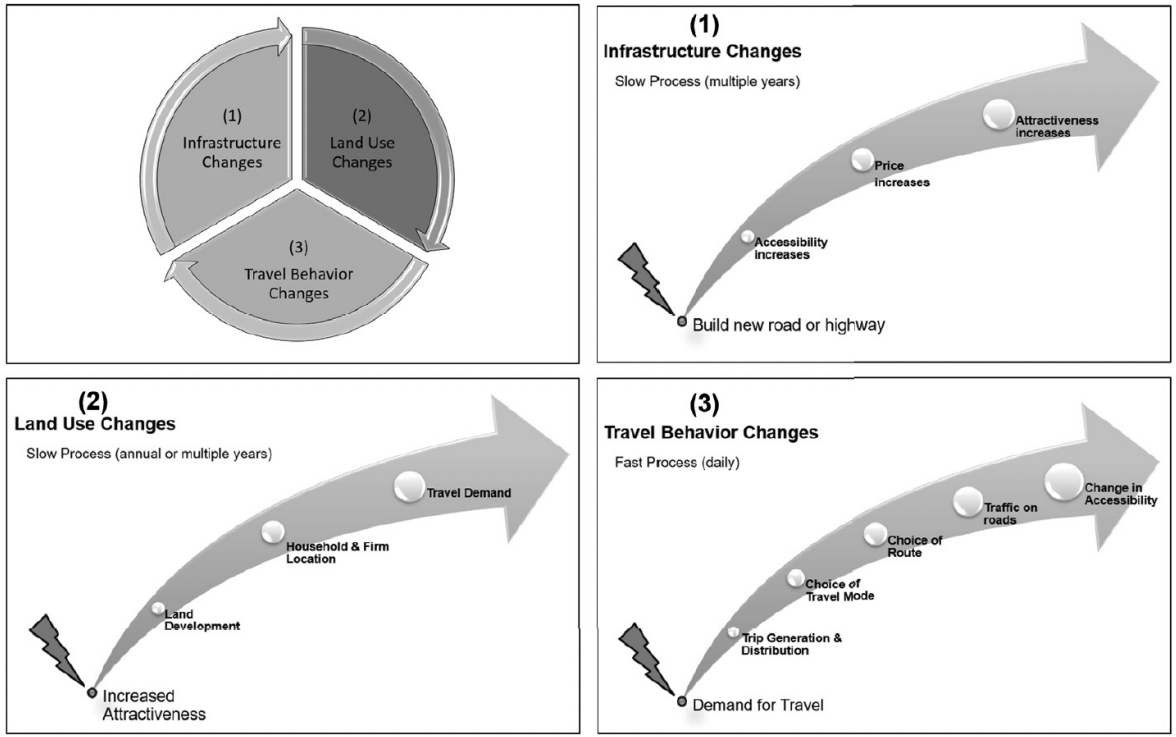
Simulation-type modelling systems are key in testing ‘what-if’ scenarios and their impacts



Maoh and Habib (2024)

- There is a continues feedback loop between land-use and transport systems:
  - Infrastructure changes
  - Land-use changes
  - Travel behaviour changes
- Increased accessibility will affect land prices and makes locations for attractive for development
- New buildings, households and firms moving in
- Such location choices would trigger changes in travel behaviour

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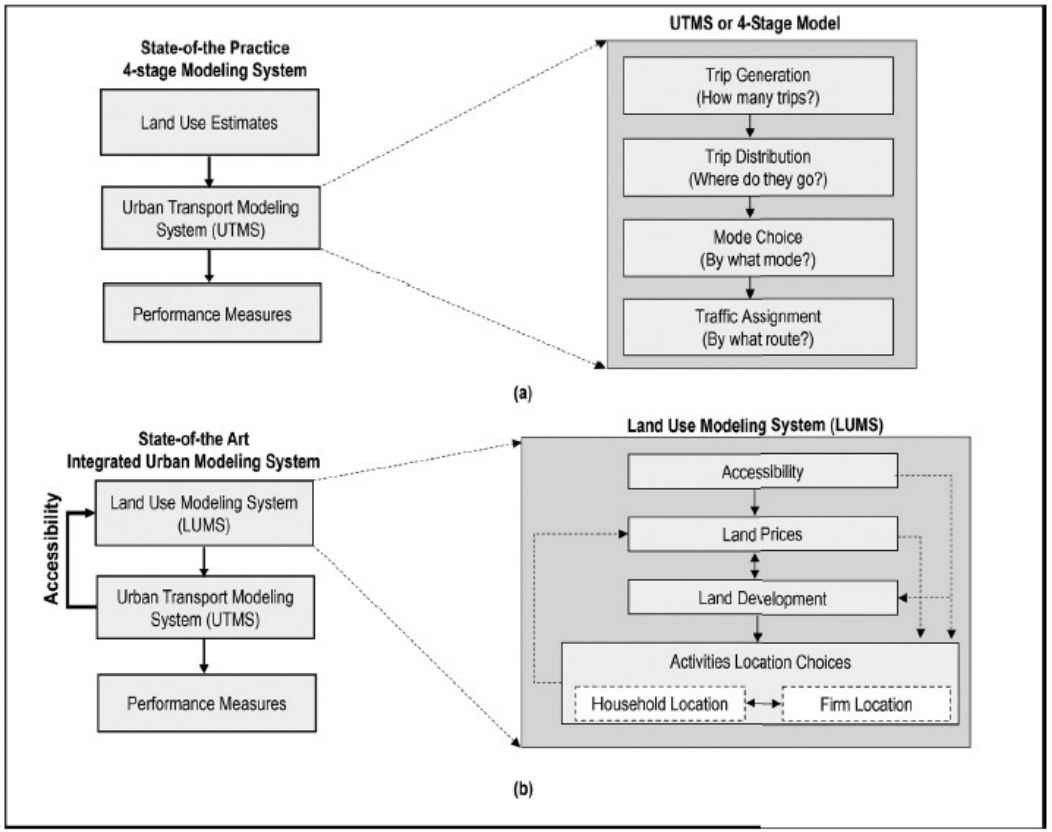
Modelling systems for transportation and land-use and their future



Maoh and Habib (2024)

Three main areas to be developed:

- Agent based microsimulation to better represent the physical urban system, decision makers and decision processes
- Data, computation needs and software platforms to facilitate implementation of future systems
- Extension of modelling systems to capture future mobility solutions and problems (connected and autonomous vehicles, pandemics and other disruptions)

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Thank you!

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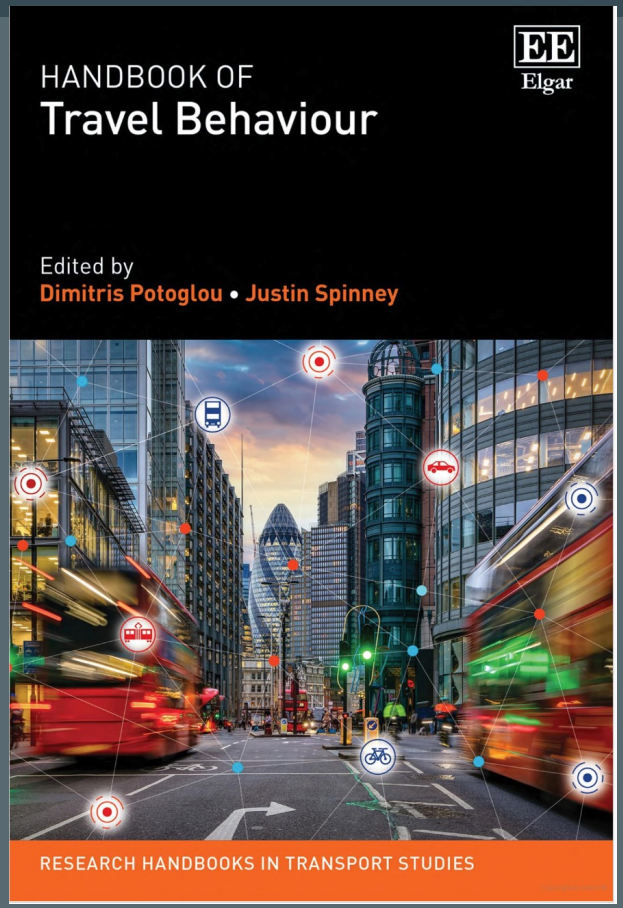

https://t.ly/e_F9r

References

- Angell and Potoglou (2022): https://doi.org/10.1016/j.cities.2022.103602
- Avineri (2024): https://doi.org/10.4337/9781839105746.00012
- Garus et al. (2022): https://doi.org/10.1155/2022/7293909
- Goodland and Potoglou (2024): https://doi.org/10.1016/j.cstp.2023.101088
- Goulias (2018): https://doi.org/10.4337/9781784717544.00010
- Goulias (2024): https://doi.org/10.4337/9781839105746.00008
- He et al. (2024): https://doi.org/10.4337/9781839105746.00018
- Kalatian and Choudhury (2024): https://doi.org/10.4337/9781839105746.00020
- Malet-Lambert, I., Poortinga, W., Potoglou, D. & Xenias, D. “Understanding public attitudes to new cycling infrastructure and low-traffic neighbourhoods (LTNs) using Twitter data”. 55th Conference of the Universities' Transport Study Group, 10-12 July, 2023, Cardiff, UK (peer-reviewed extended abstract)
- Manyika et al. (2011)
- Maoh and Habib (2024): https://doi.org/10.4337/9781839105746.00011
- Mondal et al. (2024): https://doi.org/10.4337/9781839105746.00016
- Musselwhite and Murray (2024): https://doi.org/10.4337/9781839105746.00030
- Nelson (2024): https://doi.org/10.4337/9781839105746.00024
- Nikitas (2024): https://doi.org/10.4337/9781839105746.00025
- Potoglou et al. (2020a): https://doi.org/10.1016/j.jclepro.2019.118957
- Potoglou et al. (2020b): https://doi.org/10.1016/j.trd.2020.102243
- Shaheen and Pan (2024): https://doi.org/10.4337/9781839105746.00026
- Song and Potoglou (2020): https://doi.org/10.3390/su12166494
- Spinney and Potoglou (2024): https://doi.org/10.4337/9781839105746.00034
- Van Acker et al. (2010) : https://doi.org/10.1080/01441640902943453