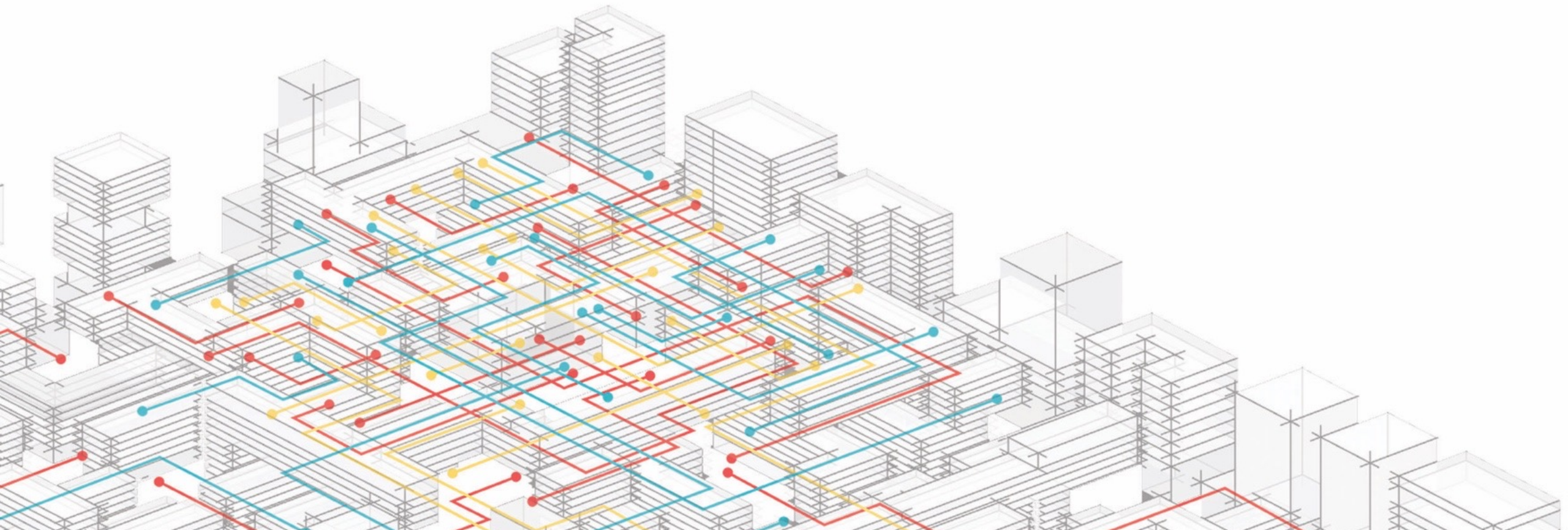


DESIGNING OUR CITIES FOR THE AUTOMATED ELECTRIC VEHICLE TRANSITION

Findings from iterative urban design and agent based simulation experiments in Singapore

Tanvi Maheshwari | 6 December 2023



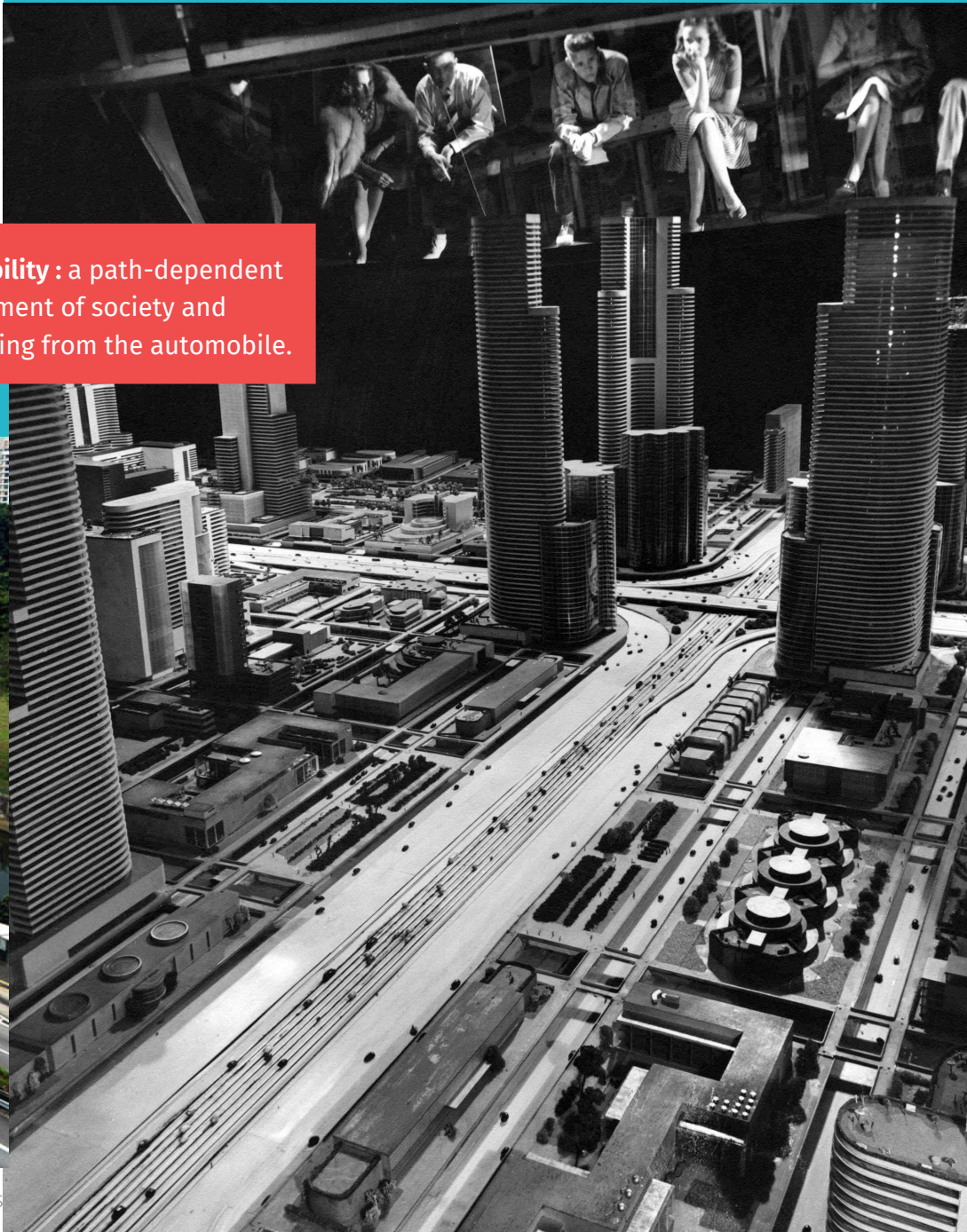
URBAN DESIGN AND TRANSPORT

System of Automobility : a path-dependent pattern of development of society and urban form, stemming from the automobile.

View of a highway in Singapore



(Urry, 2004)

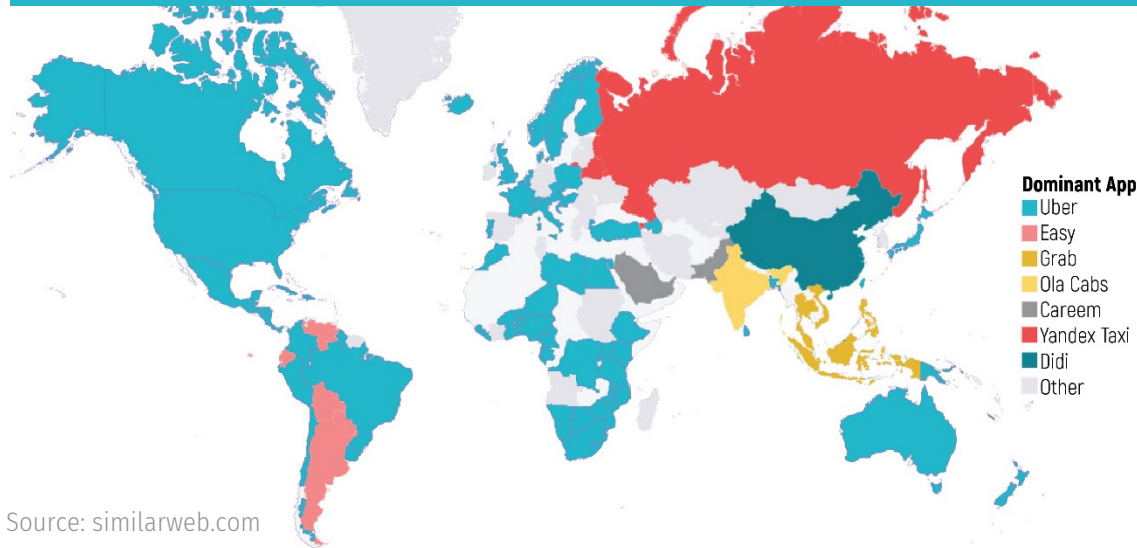


THE 'TECHNOLOGICAL SHIFT'

The convergence of emerging systems and technologies in transportation have the potential to converge and fundamentally shift existing mobility patterns.



Dominant ride-hailing apps in 171 countries around the world (2016)

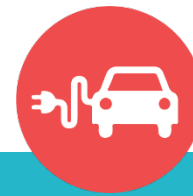
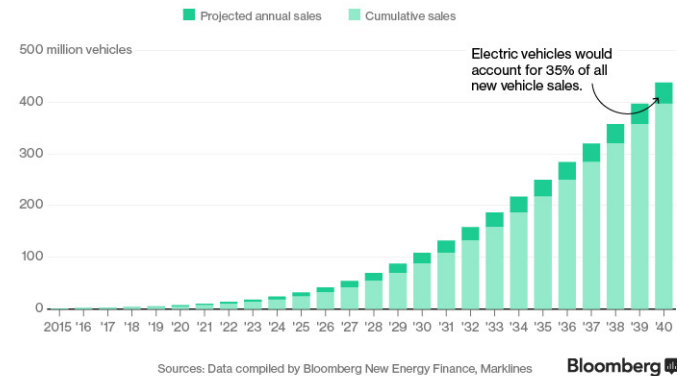


Source: similarweb.com



The rise of Electric Vehicles

By 2022 electric vehicles will cost the same as their internal-combustion counterparts. That's the point of liftoff for sales.



Increasing connectivity



Singapore on track to roll out 5G by 2025; Singtel, StarHub-M1 joint venture issued final awards



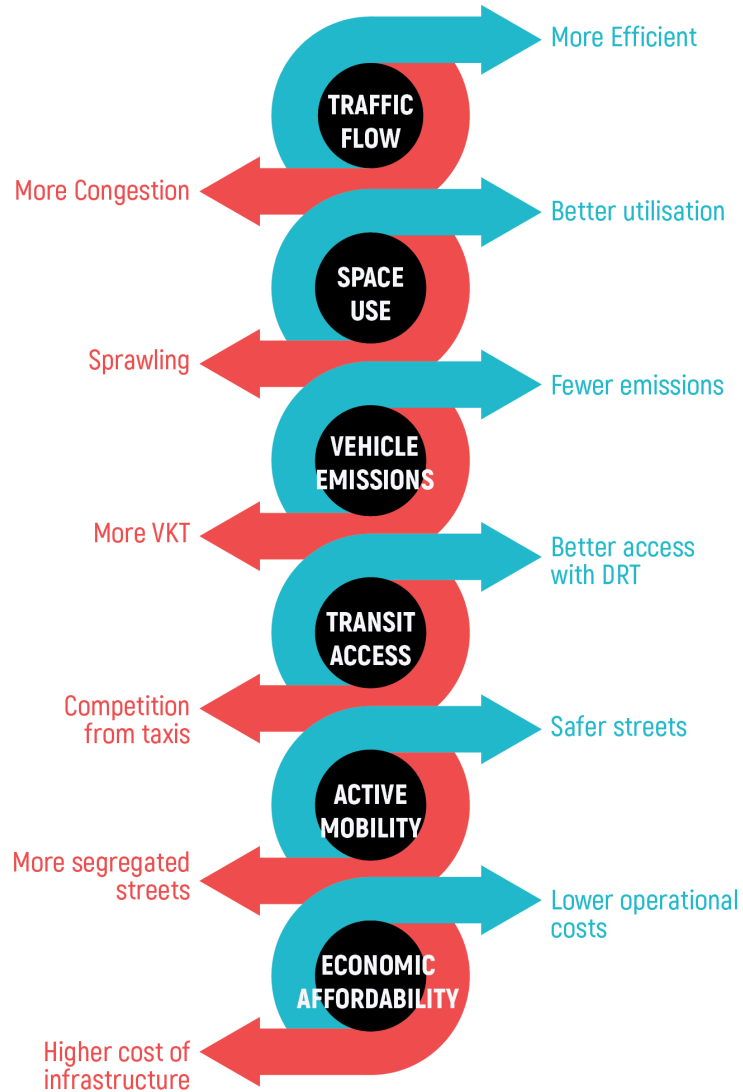
Source: channelnewsasia.com

DESIGN FOR AUTOMATED VEHICLES



Clockwise from top left:
Concept of a AV future town centre in Singapore (Source: Ministry of Transport)
From WSP Parsons Brinckerhoff Farrels 2016
Proposal by BIG Architects for the Audi Urban Future Award 2010 Source: archdaily.com
Loop NYC by EDG

IMPACT OF THE SHIFT



DRIVERS OF IMPACT

Drivers and levers that influence impacts

Technology

Technology readiness, customer acceptance, and technology penetration rate in the market.

Policy

Policy on pricing, for example minimum price for taxis to avoid competition with transit, pricing in the social cost of travel, pricing by distance.

Subsidies of to protect transit and shared modes.

Road pricing, curb use pricing

Limiting maximum fleet size, geofencing operation area of AVs

Policies that encourage or discourage the use of private AVs vs shared AV fleets

Operations

Shared vehicle operational decisions such as customer vehicle assignment, repositioning of empty vehicles, maximum allowable waiting time, detour ratio for shared vehicles, total fleet size and type.

Electric vehicle operational decisions such as type of batteries, battery range, density of charging points, charging speeds.

Planning

Existing urban context – level of urbanisation, density, street hierarchy, level of congestion, modal split, especially current levels of transit use and transit infrastructure development.

Design interventions – transit oriented development, urban design for active mobility, walkability, location, size and frequency of PUDOs, parking infrastructure design, design for segregation by mode, design of street hierarchy and network topology, intersection design

URBAN FORM AND TRANSPORT FLOWS

A. Reclaiming Street Space



A1: BAU

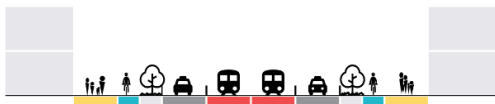
A2: Reducing lane width

A2: Reducing no. of lanes

B. Segregating Street



B1: Grade separation

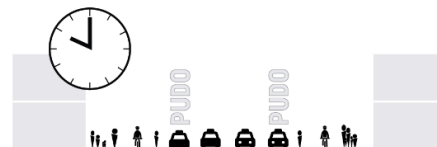
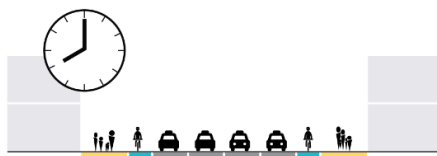


B2: At-grade physical buffer



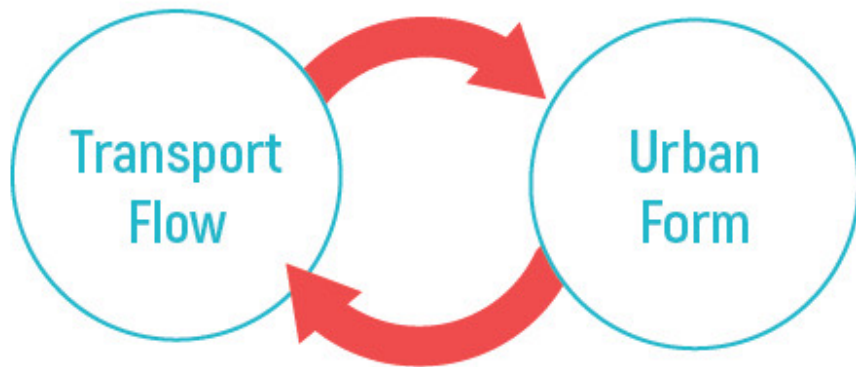
B3: Shared street

C. Responsive Streets



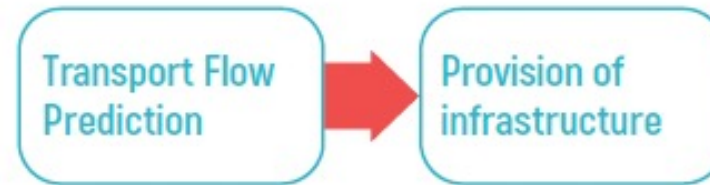
URBAN FORM AND TRANSPORT FLOWS

Transport flows have a spatial imprint
Changes in transport technology alters urban form



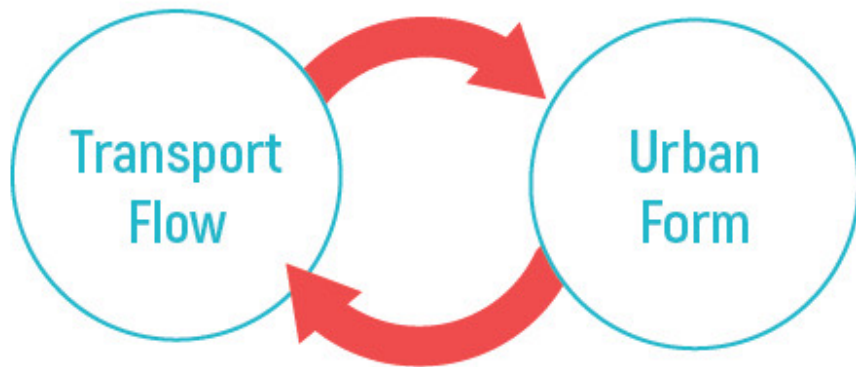
Urban form induces transport flows
Changes in urban design influences travel behaviour

Predict and Provide



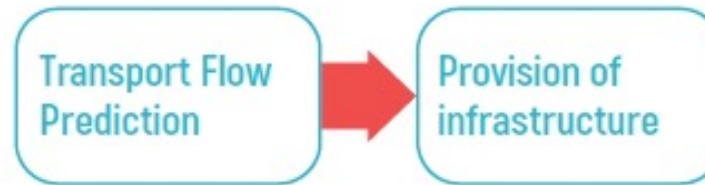
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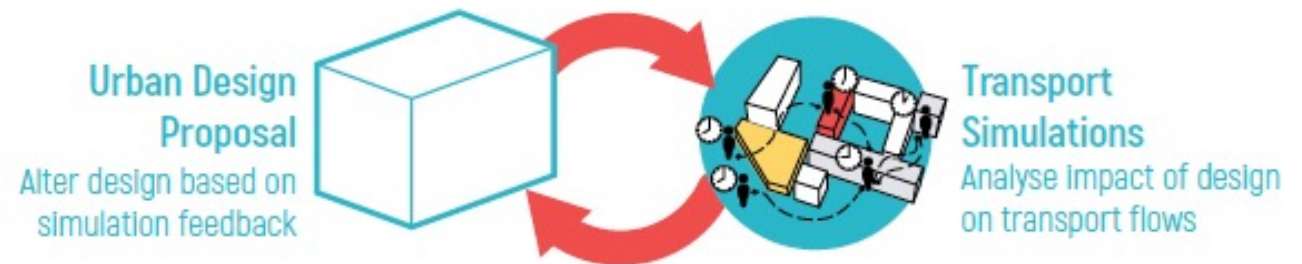


Urban form induces transport flows
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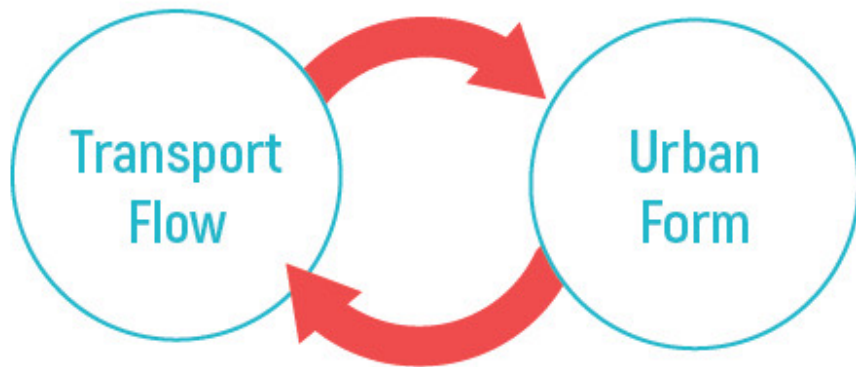


Iterative Urban Design and Transport Simulation



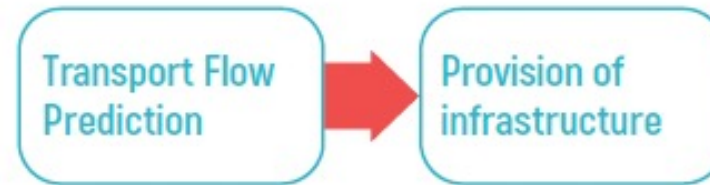
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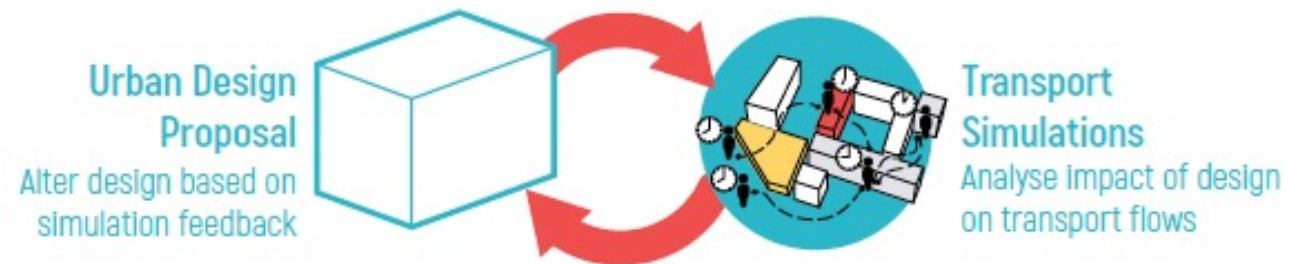


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Iterative Urban Design and Transport Simulation

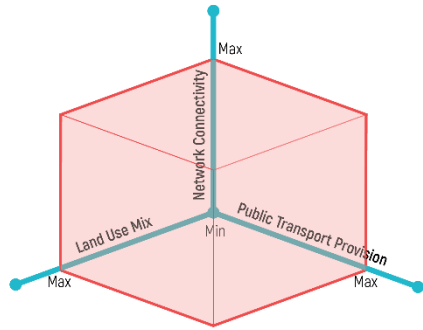


Time-consuming

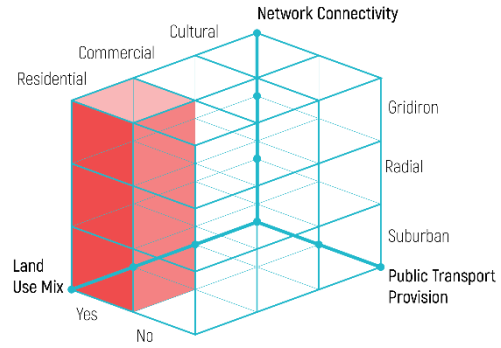
Expensive

Data-hungry

METHODOLOGY

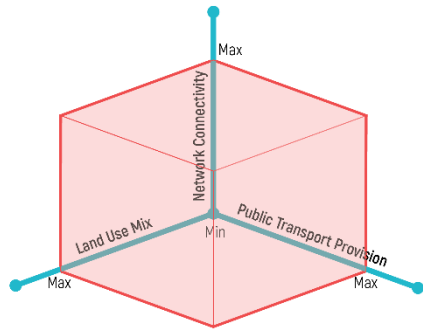


Large parameter space

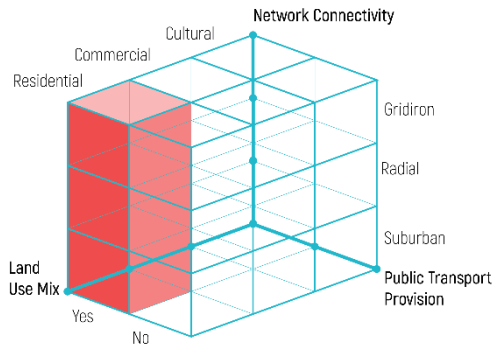


Reduced parameter space based on questions of interest

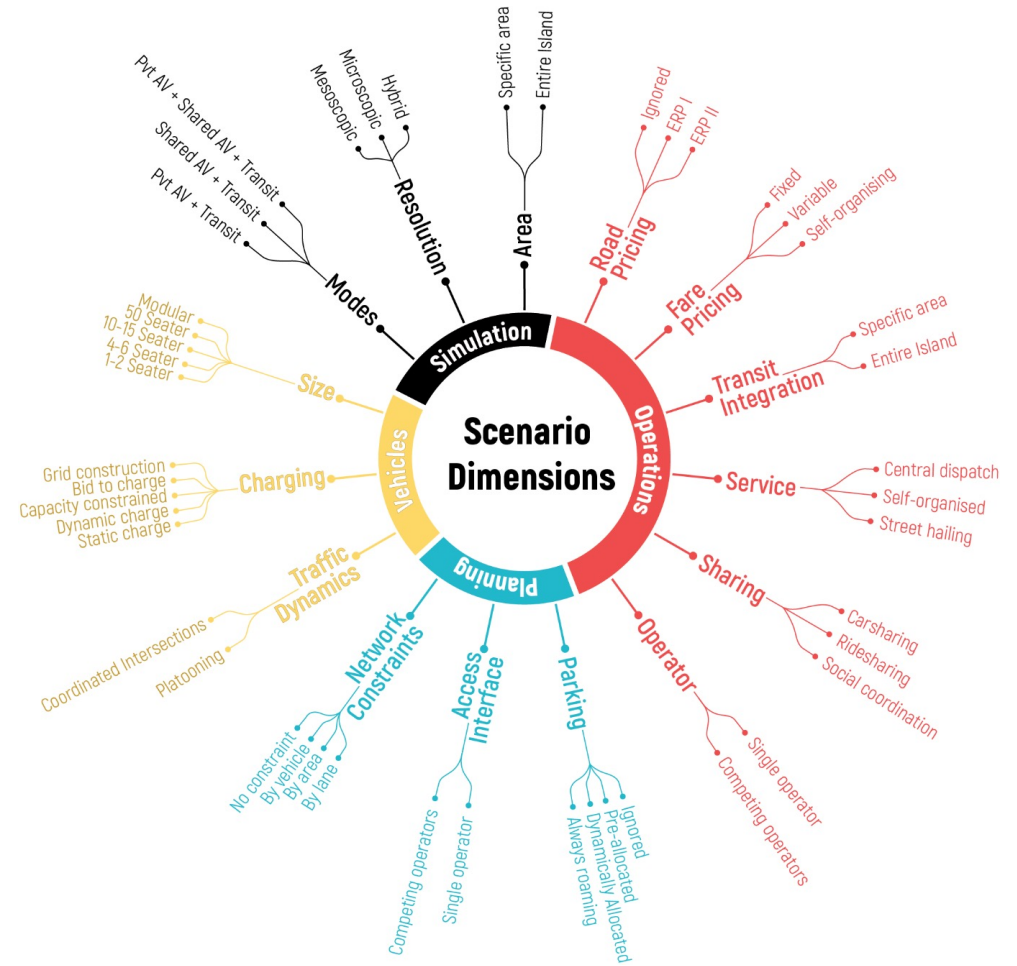
METHODOLOGY



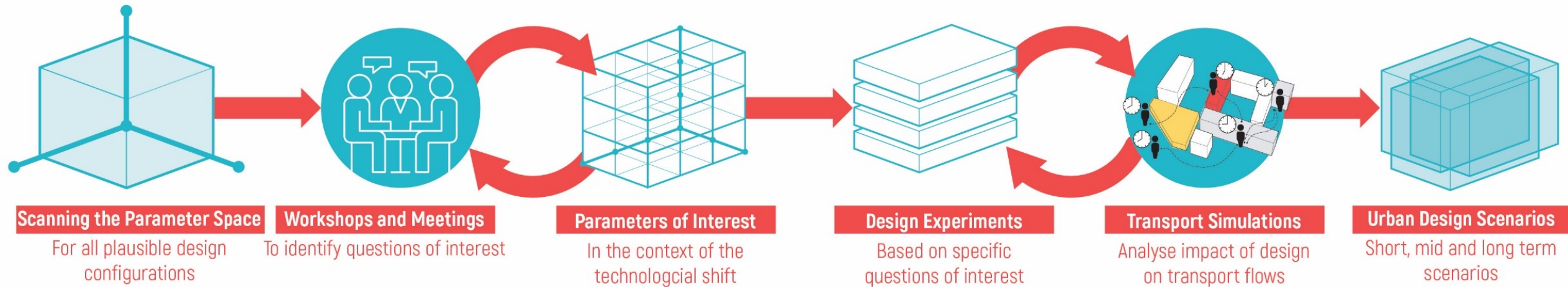
Large parameter space



Reduced parameter space based on questions of interest



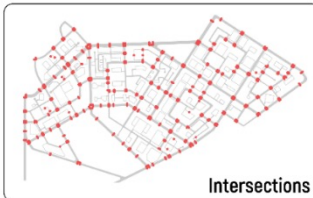
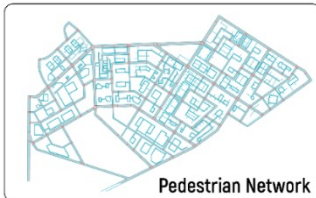
METHODOLOGY



DESIGN EXPERIMENT SITE

Fictional New Town Prototype

Transport options



Privately owned AVs



Single person automated taxi pods



6-20 seater Demand Responsive Transit or DRT



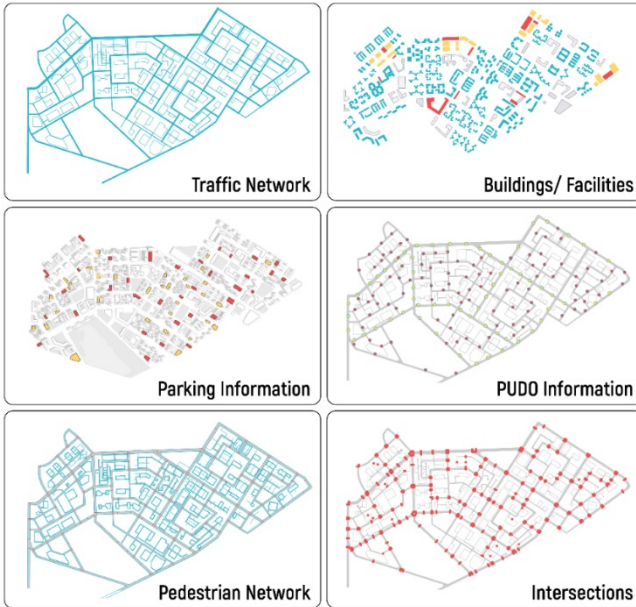
Fixed route scheduled automated buses



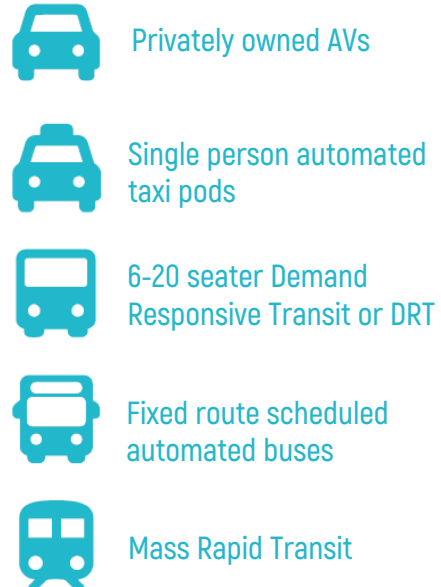
Mass Rapid Transit

SKETCH MATSIM

Fictional New Town Prototype



Transport options



Sketch MATSim User Interface developed by Ordoñez and Fourie



Intelligibility

Modularity

Agility

NETWORK EXPERIMENT

Loops



Grid



Superblock



NETWORK EXPERIMENT

	Loops	Grid	Superblock
Mean distance travelled/ride (km)	5.67	3.86	3.70
Detour Ratio	2.09	1.85	1.59

Loops



Grid



Superblock



NETWORK EXPERIMENT

	Loops	Grid	Superblock
Mean distance travelled/ride (km)	5.67	3.86	3.70
Detour Ratio	2.09	1.85	1.59

First/last mile connectivity remains an issue in the existing hierarchical and disconnected street network, despite DRT deployment.

Loops



Grid

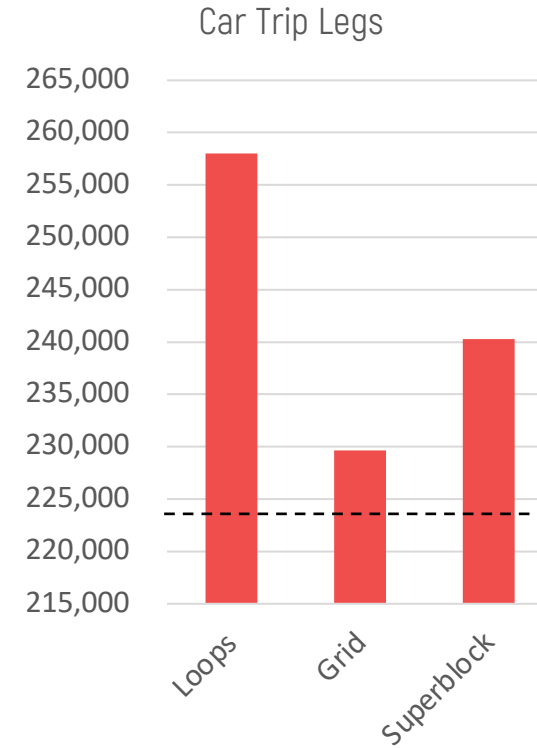
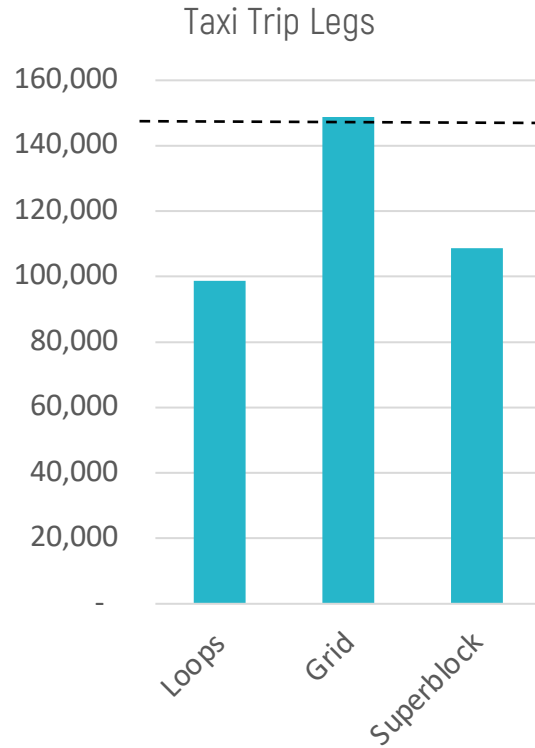
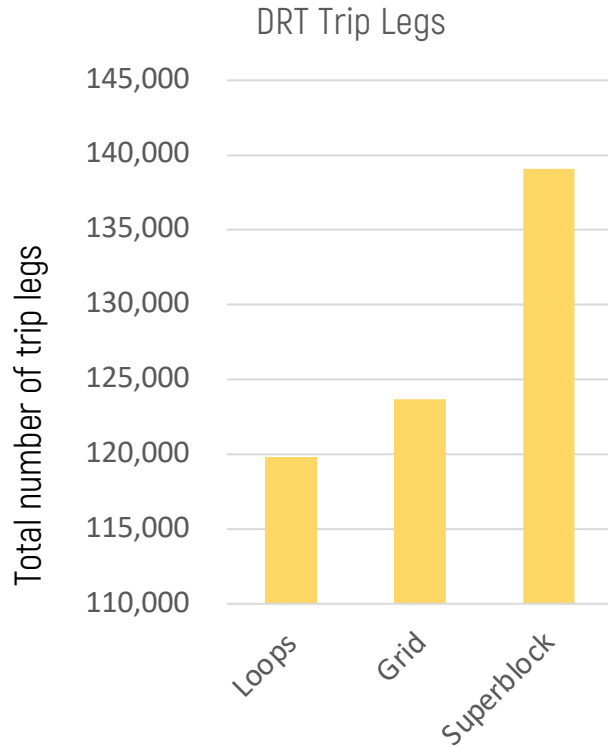


Superblock



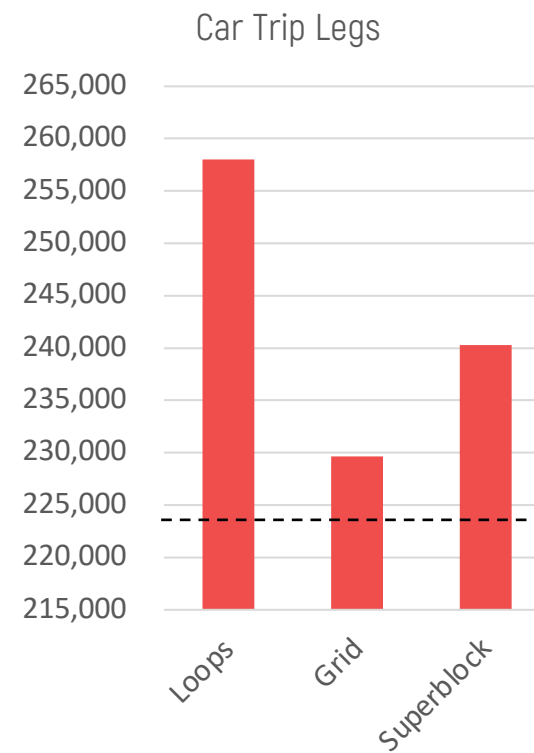
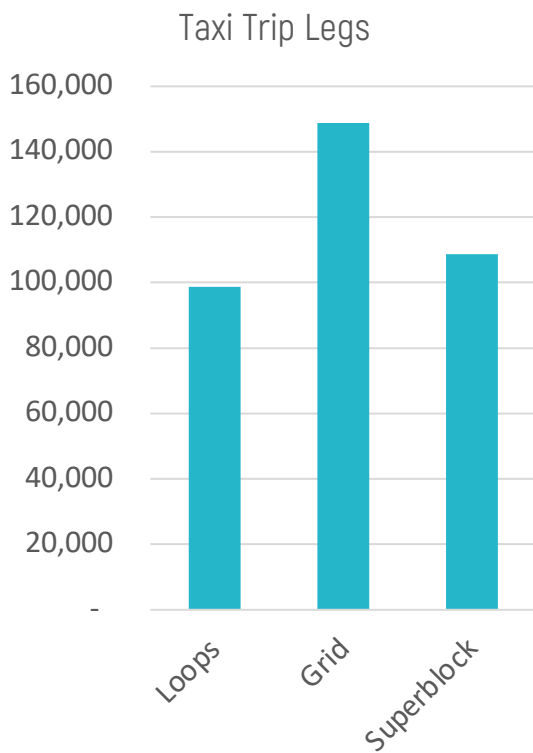
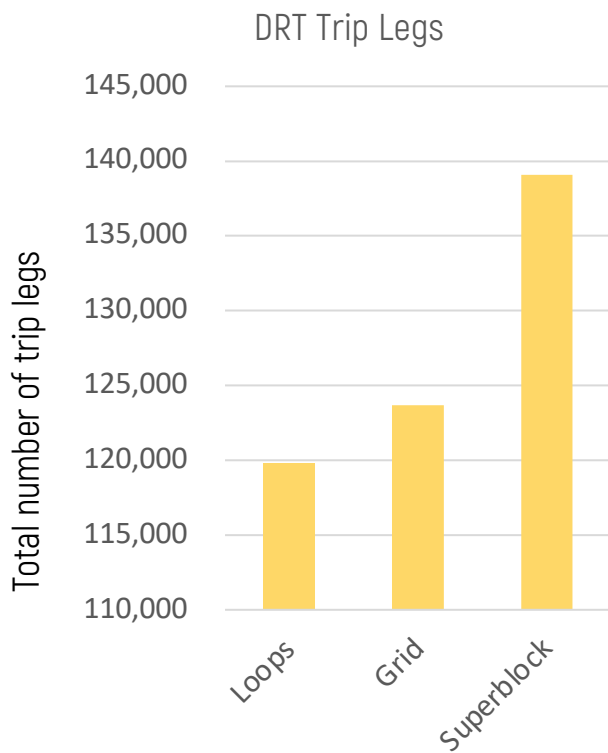
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NETWORK EXPERIMENT

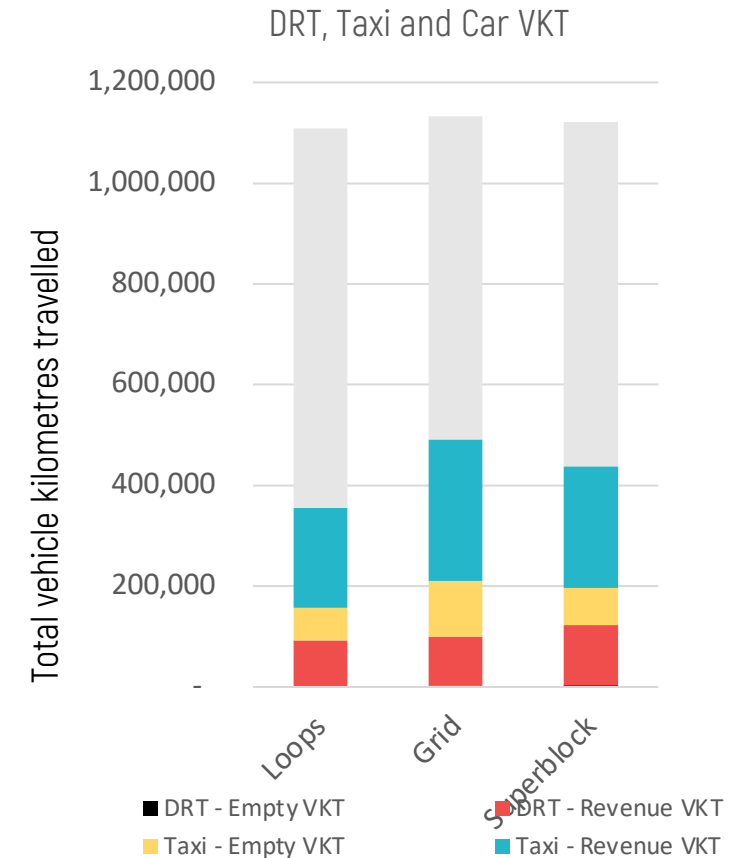
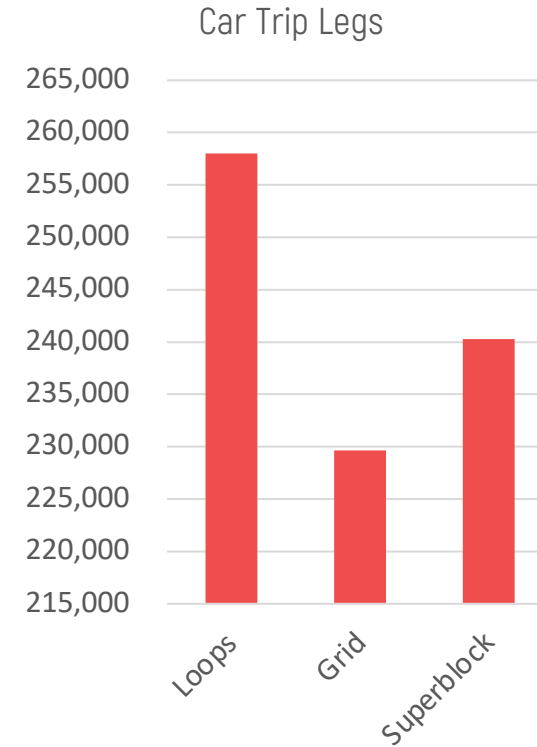
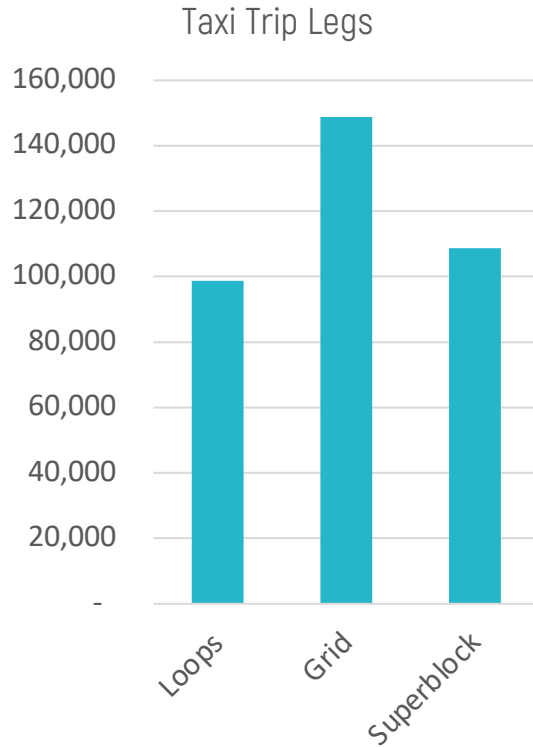
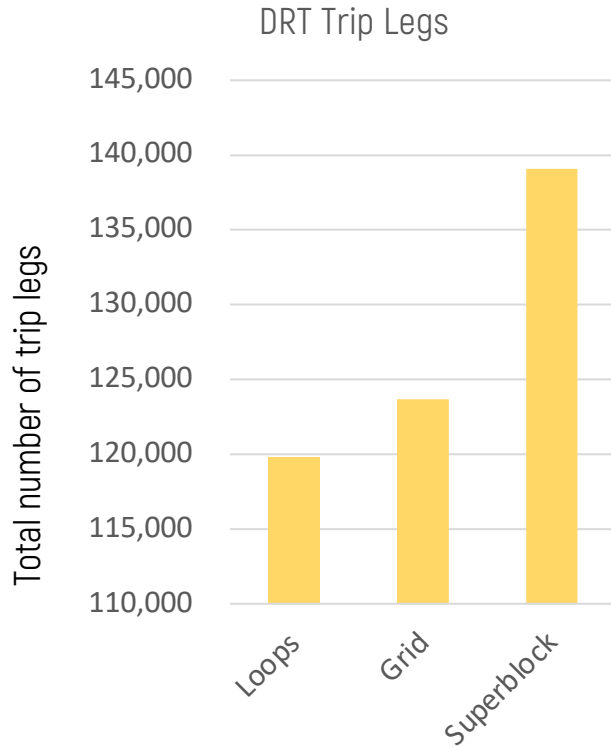
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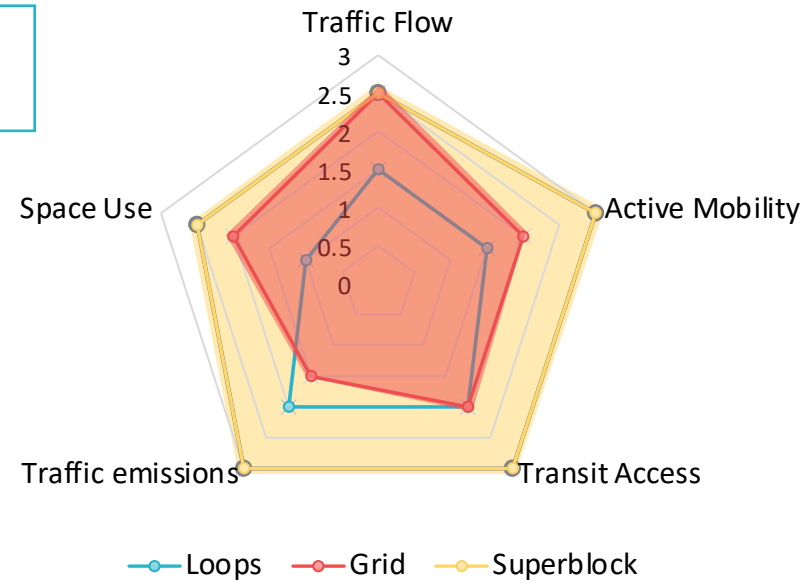
NETWORK EXPERIMENT

In a more connected street network, well-designed active mobility network is a necessary complement.

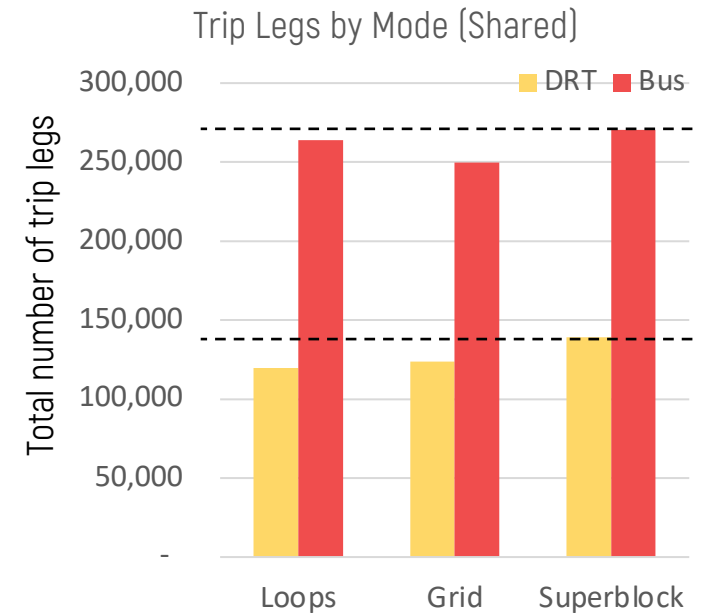
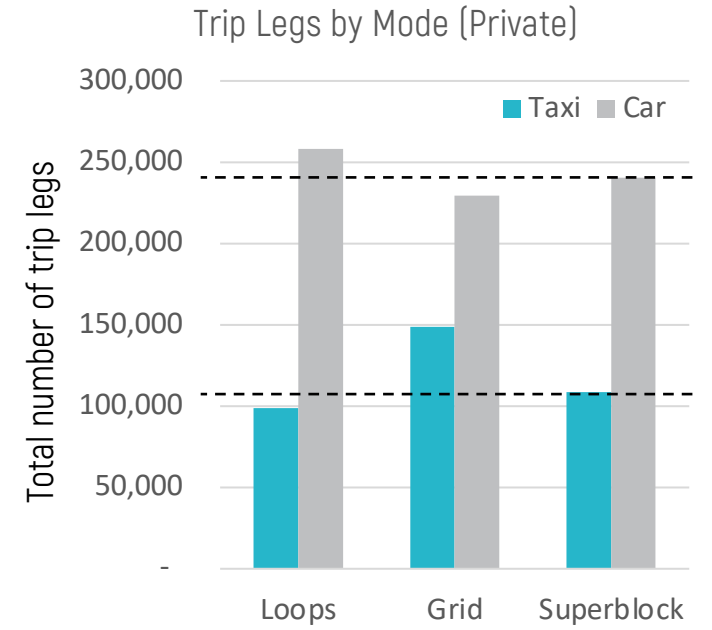
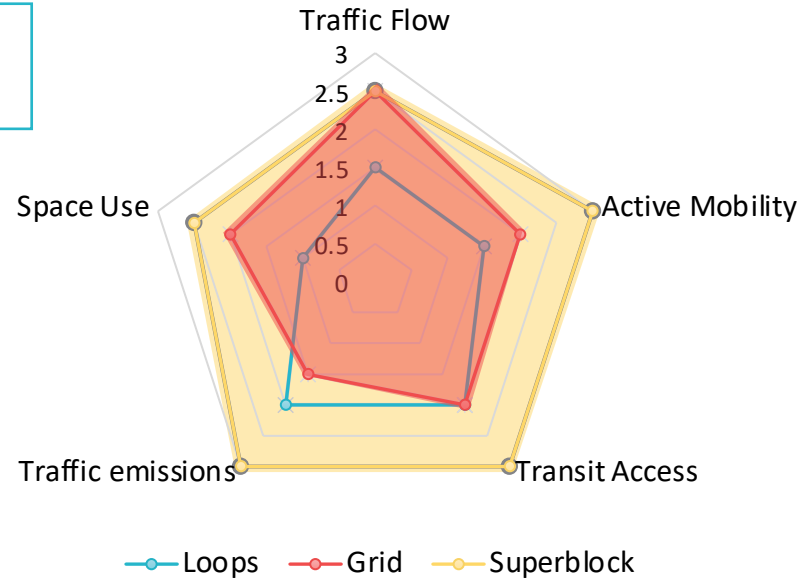
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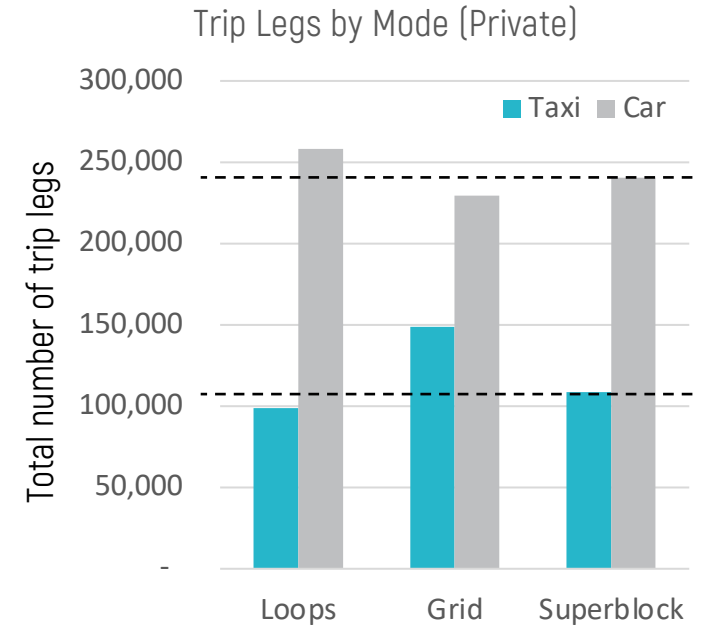
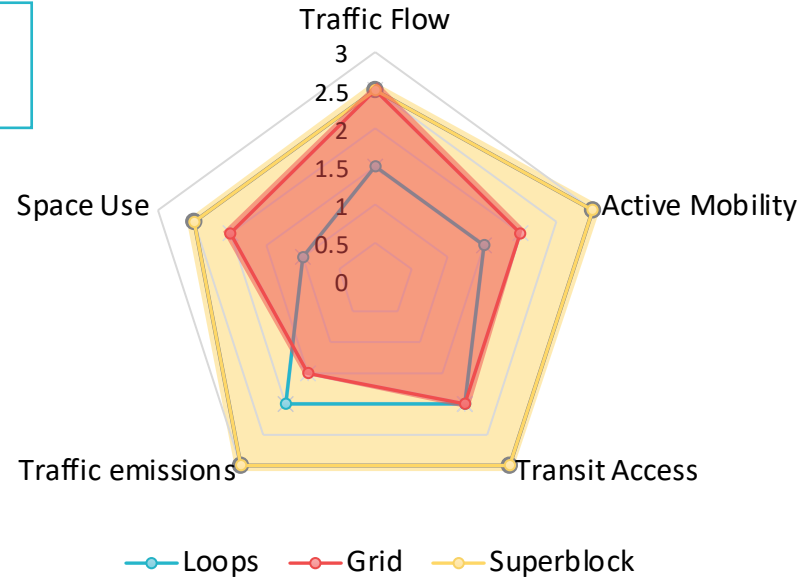
NETWORK EXPERIMENT



NETWORK EXPERIMENT

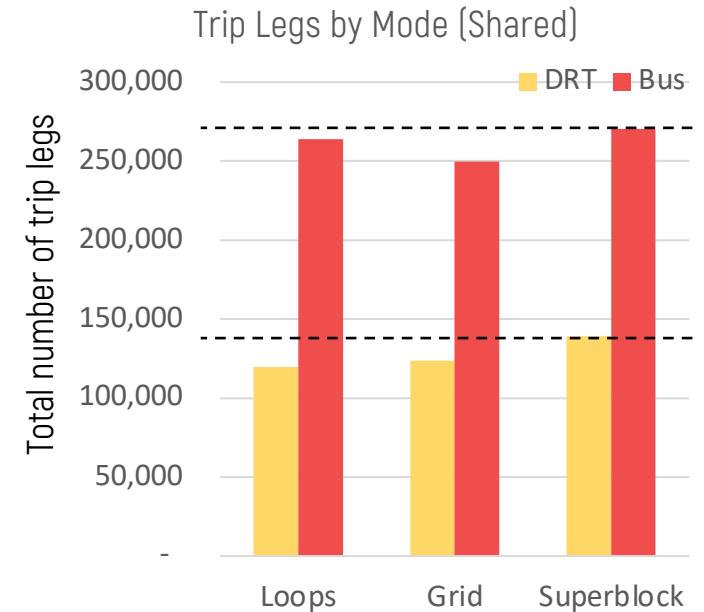
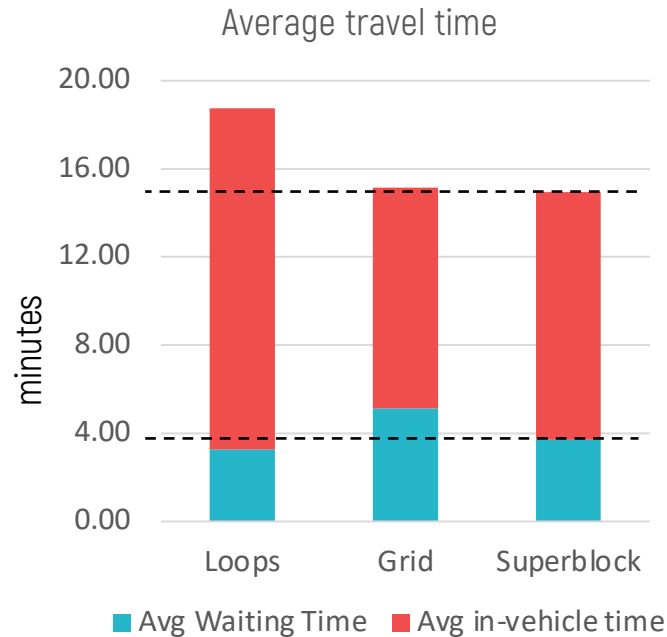


NETWORK EXPERIMENT



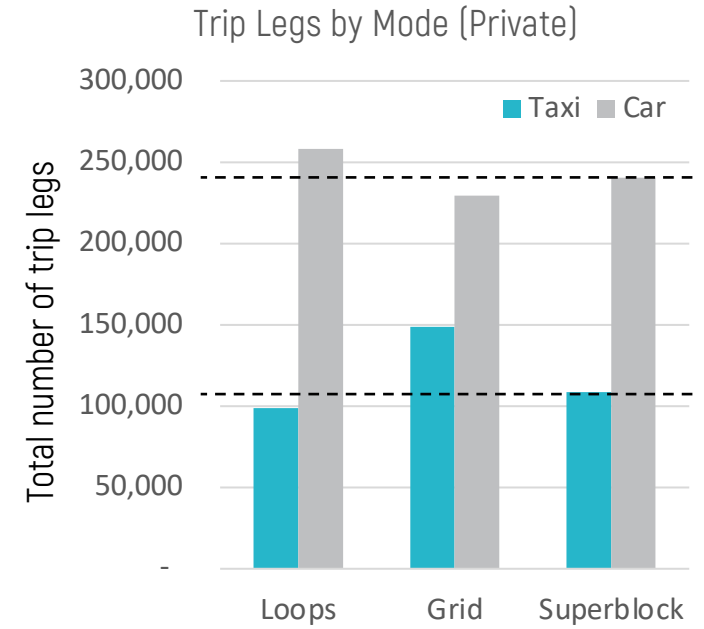
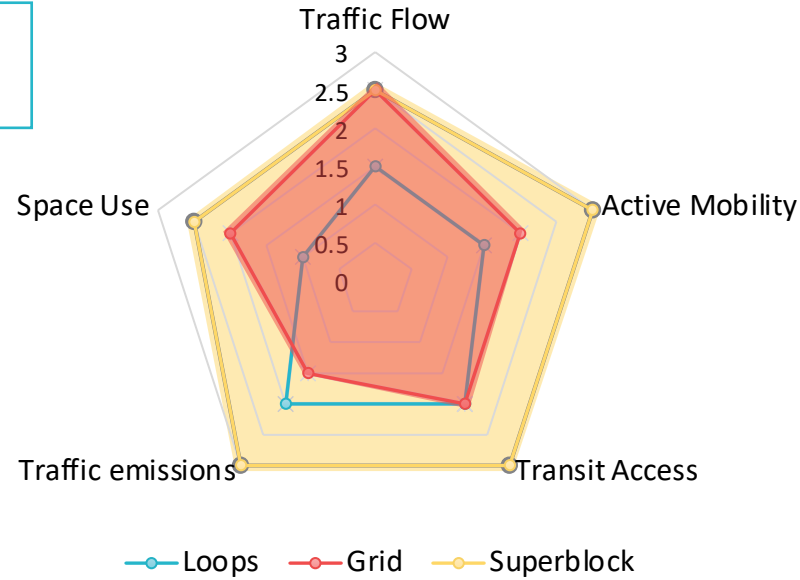
	Loops	Grid	Superblock
Avg peak speed*	38.89	38.56	26.68
Avg peak speed/free speed	0.93	0.94	0.95

* Average of average speed on all links, weighted by link length



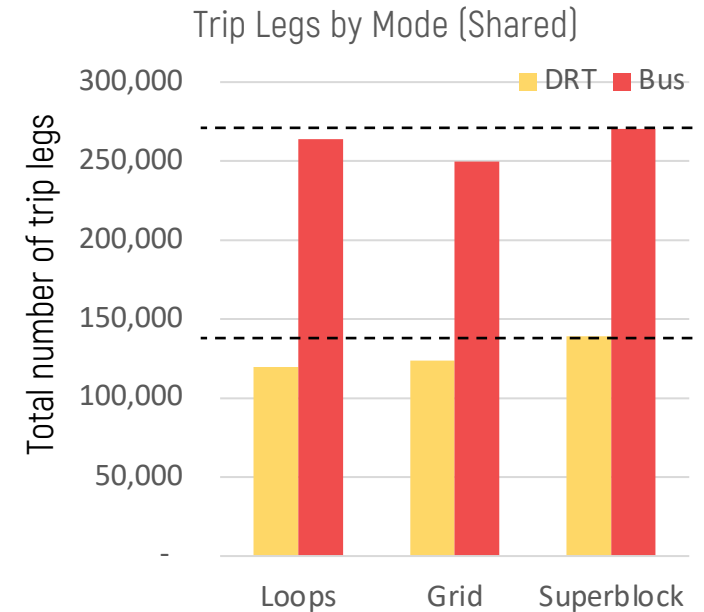
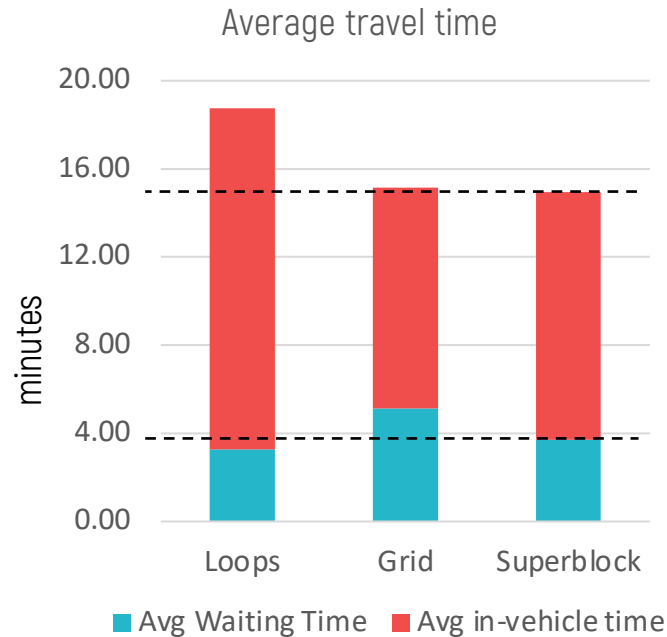
NETWORK EXPERIMENT

Superblocks are slow but not congested.



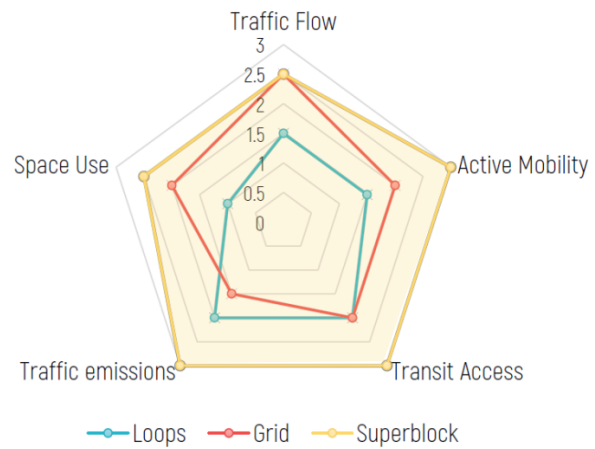
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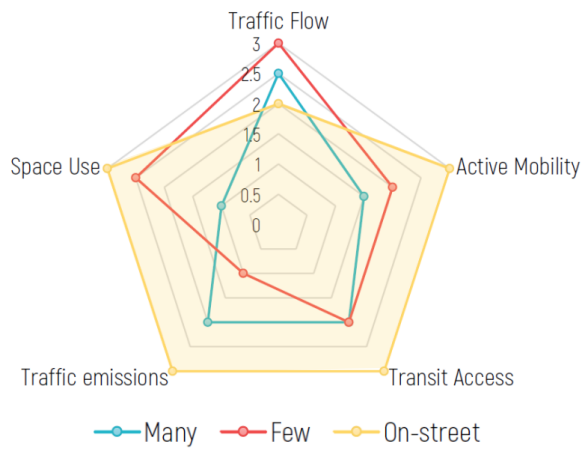


RECOMMENDATIONS

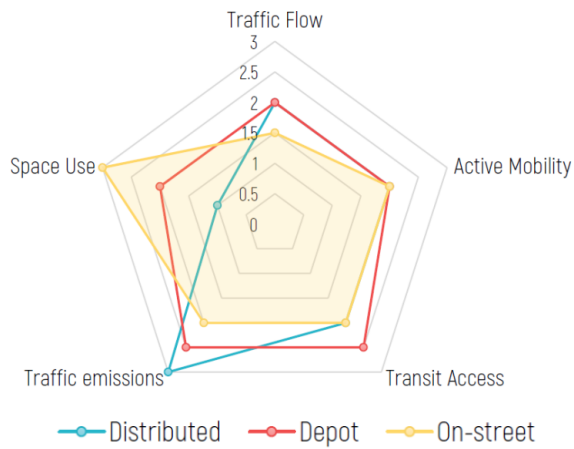
Network Experiment



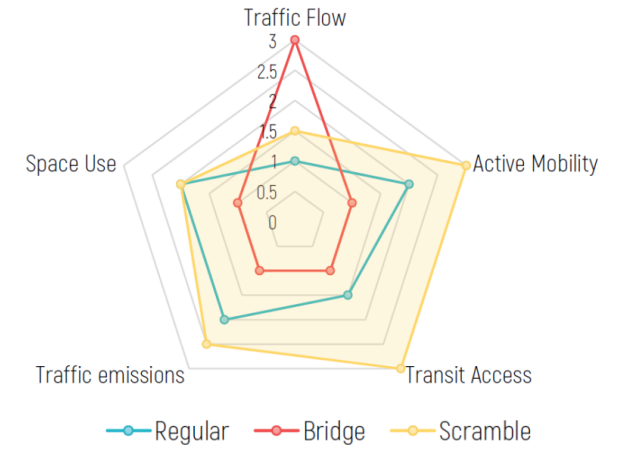
PUDO Experiment



Parking Experiment



Intersection Experiment



POST ROAD CITY



LIMITATIONS

Active mobility under-represented

Freight and service traffic not considered

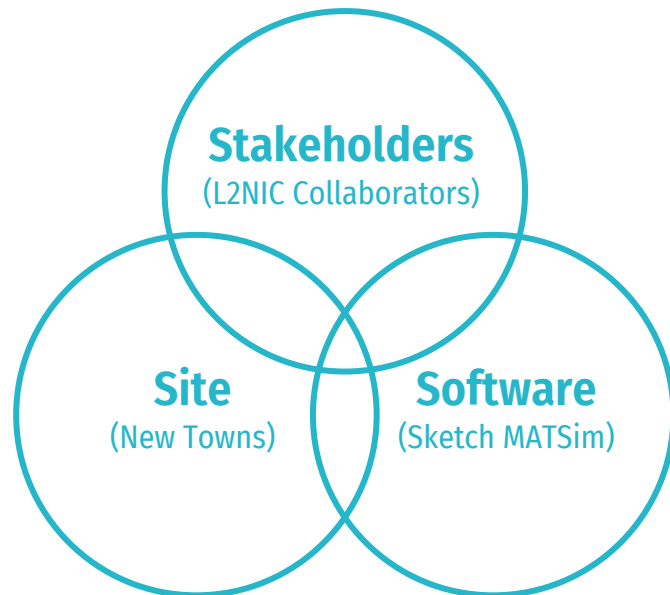
Variations in pricing and land use not explored

LIMITATIONS

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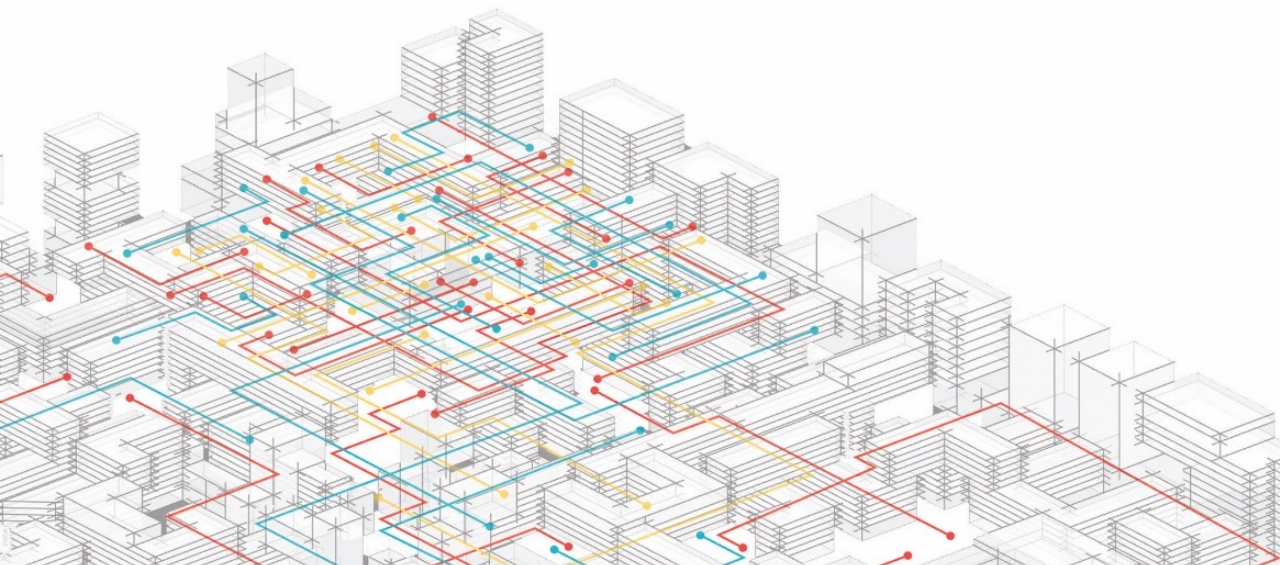
Variations in pricing and land use not explored



REFLECTIONS

Design discipline needs to embrace new planning tools, methods and procedures to understand the consequences of design decisions in complex urban systems.

Transport models need to shift away from its consolidative predictive role to a more heuristic role to better interact with urban design and planning processes in early stages.

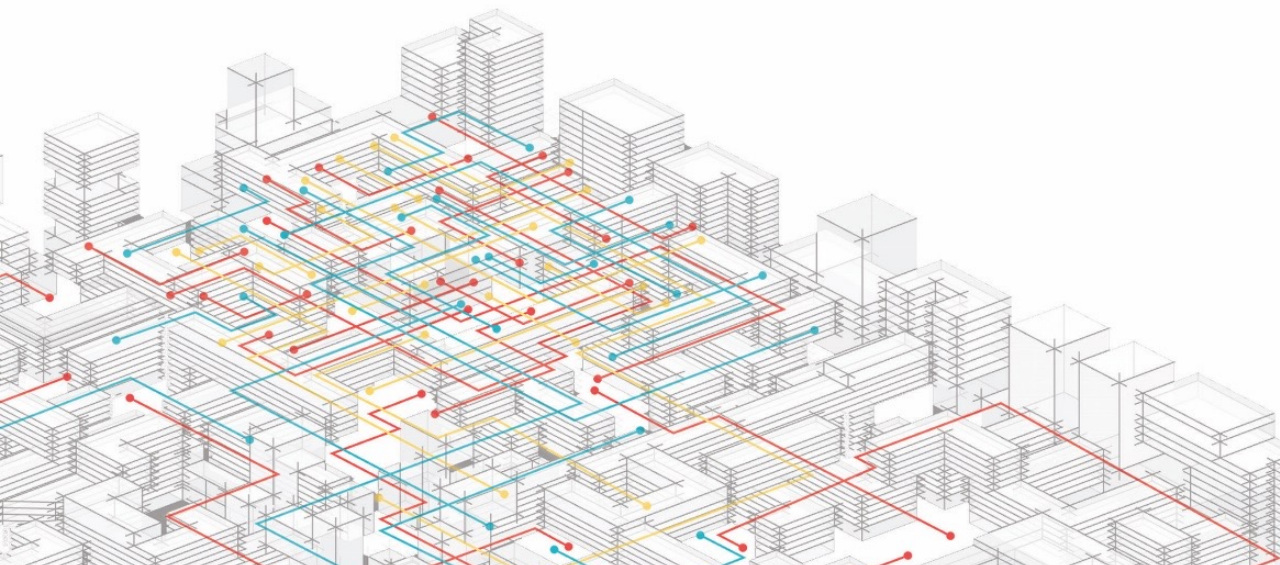


ACKNOWLEDGEMENTS

Pieter, Sergio and Biyu
(the team behind Spatial DRT and Sketch MATSim)

All collaborators involved in L2NIC Project

(This material is based on research supported by the Singapore Ministry of National Development and National Research Foundation under L2NIC Award No. L2NICTDF1-2016-3. The research was conducted at the Future Cities Laboratory at the Singapore-ETH Centre, which was established collaboratively between ETH Zurich and Singapore's National Research Foundation (FI370074016) under its Campus for Research Excellence and Technological Enterprise programme.)



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