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Spatial Policy and Analysis Laboratory

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GM Policy Hub Seminar

Transport for Greater Manchester

No one left behind: Enabling just access to EV charging in Greater Manchester

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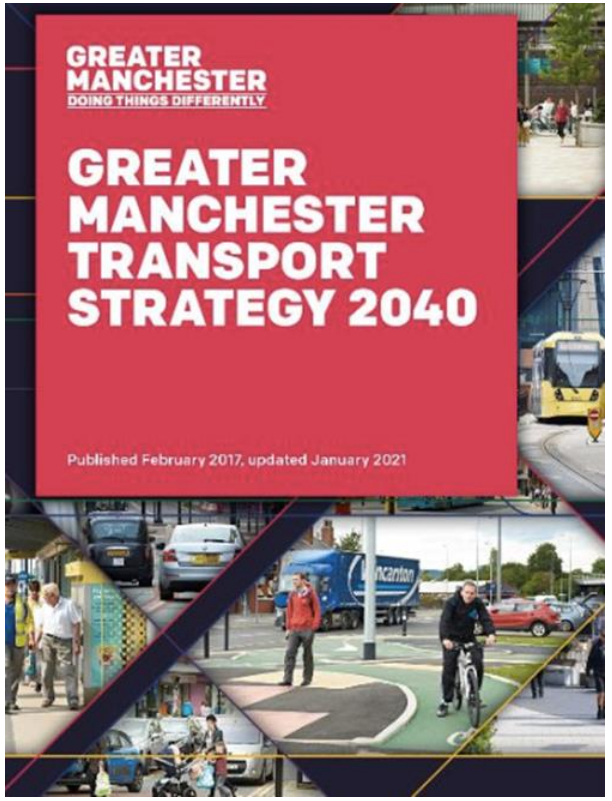
Dr Arijit De
Dr Alex Martinez
Dr Ruth Wood

Electrification of the Northwest Innovation Lab Award Project

Background

- **UK's path to 'net zero carbon' by 2050 – Decarbonising transport**
  - Accelerating modal shift to public and active transport
  - Decarbonising road transport

- **Path to net zero transport in Greater Manchester**
  - 31 policies outlined in GM Transport Strategy 2040
  - Policy 1: We will work with partners to ensure that taxis, private hire vehicles and other demand responsive services - as well as shared mobility solutions, including car clubs and cycle hire - are available, and fully integrated into the Greater Manchester transport network.
  - Policy 7: As we plan our transport network, we will support the creation of a more inclusive economy for GM by considering how best to improve the prospects of people living in deprived communities - including by ensuring that more people can access jobs, education, skills training and childcare.
  - Policy 10: We will work with partners to reduce transport carbon emissions to support Greater Manchester's ambition to be net zero carbon by 2038; and to implement measures to ensure our transport system is resilient to climate change
  - Policy 16: We will work with partners to support a rapid transition towards low emission vehicles in Greater Manchester, including developing a clear strategy on the Electric Vehicle Charging Infrastructure network required to provide greater confidence to residents and businesses to invest in electric vehicles



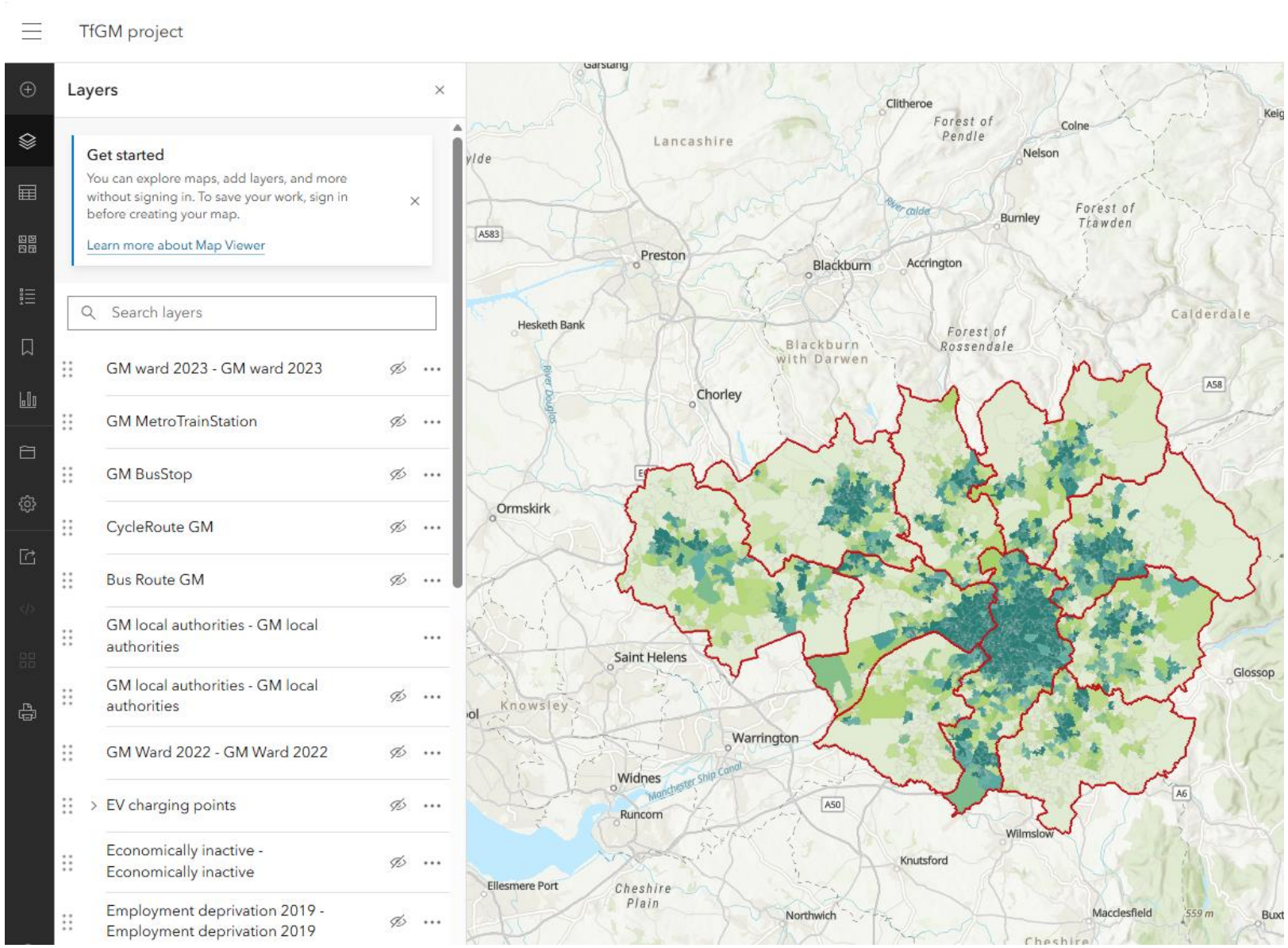
Project background and objectives

- Electric Vehicles (EVs) are essential for decarbonising road transport in Greater Manchester and across the UK.
- Many households face financial and infrastructural barriers to EV adoption — such as high levels of deprivation, lack of off-street parking, and limited access to public transport.
- This study aims to identify where investment in infrastructure and targeted interventions (e.g. shared mobility schemes) would be most effective to support **a just transition to transport decarbonisation**.

Objectives:

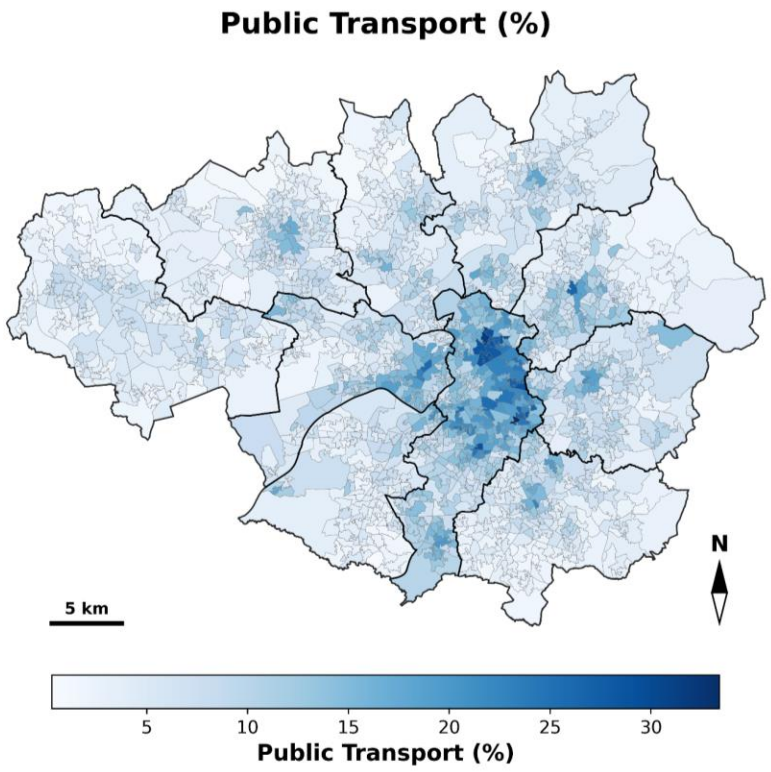
1. **Map priority locations for EV infrastructure based on clusters of target household groups:**
    - Households with fossil-fuel cars but no affordable access to EVs or home charging.
    - Households in transport poverty whose mobility could improve through shared EV access.
2. **Develop a prototype agent-based model to explore the operational performance and dynamics of EV car clubs under different fleet and charging scenarios**
    - If expanded in the future, it has the potential to serve as a tool to explore the dynamics of different transport interventions under alternative decarbonisation scenarios

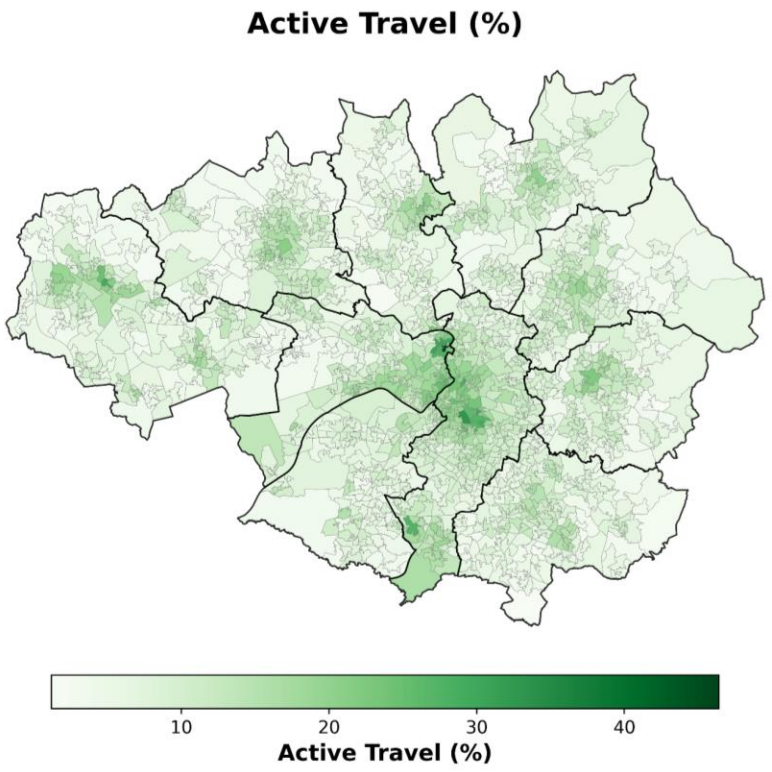
Spatial analysis and online portal

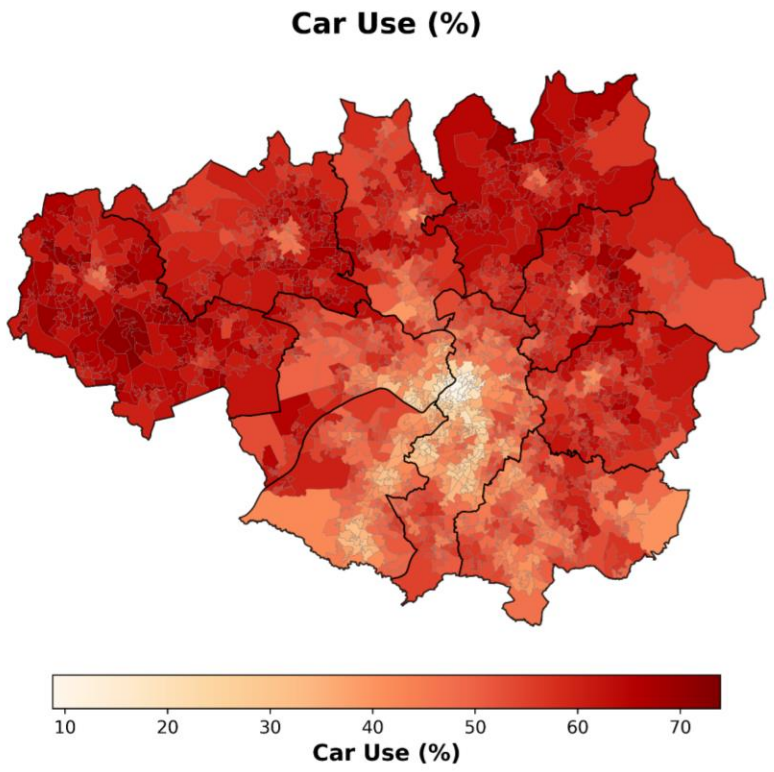


[Link to the interactive maps]

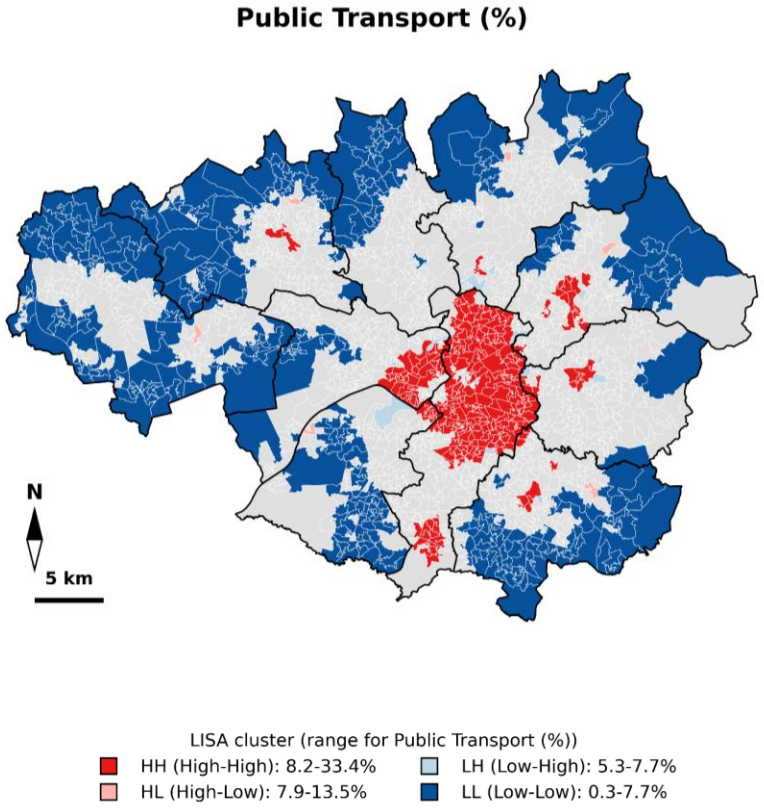
Commuting Mode Share by LSOA in Greater Manchester (2021)

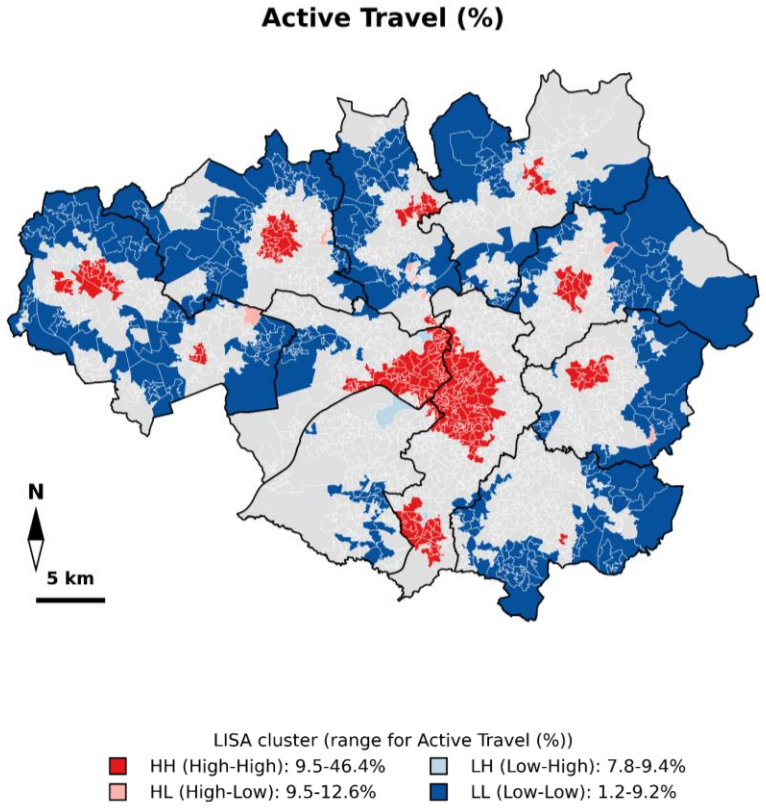


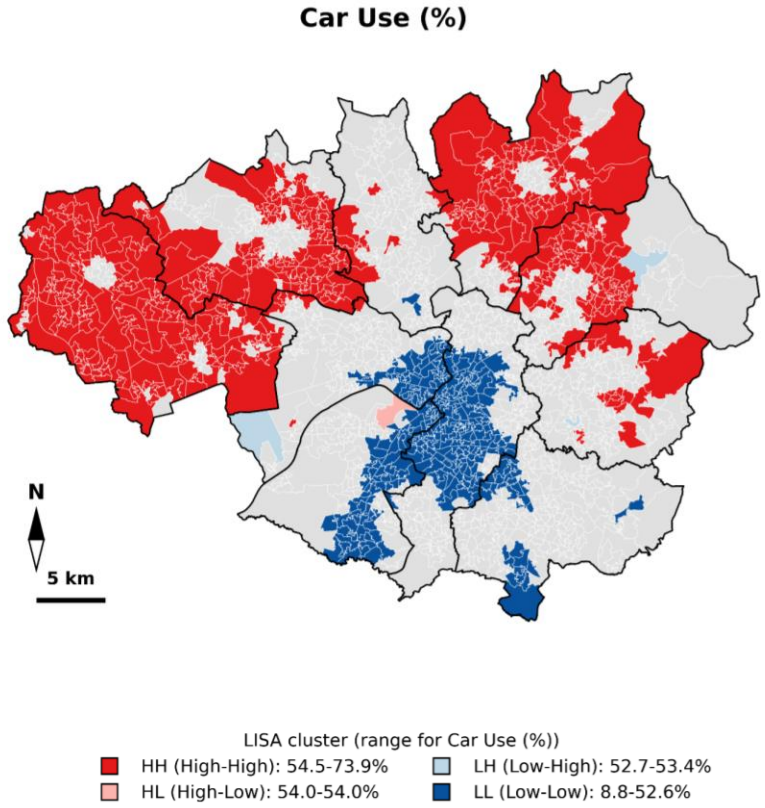




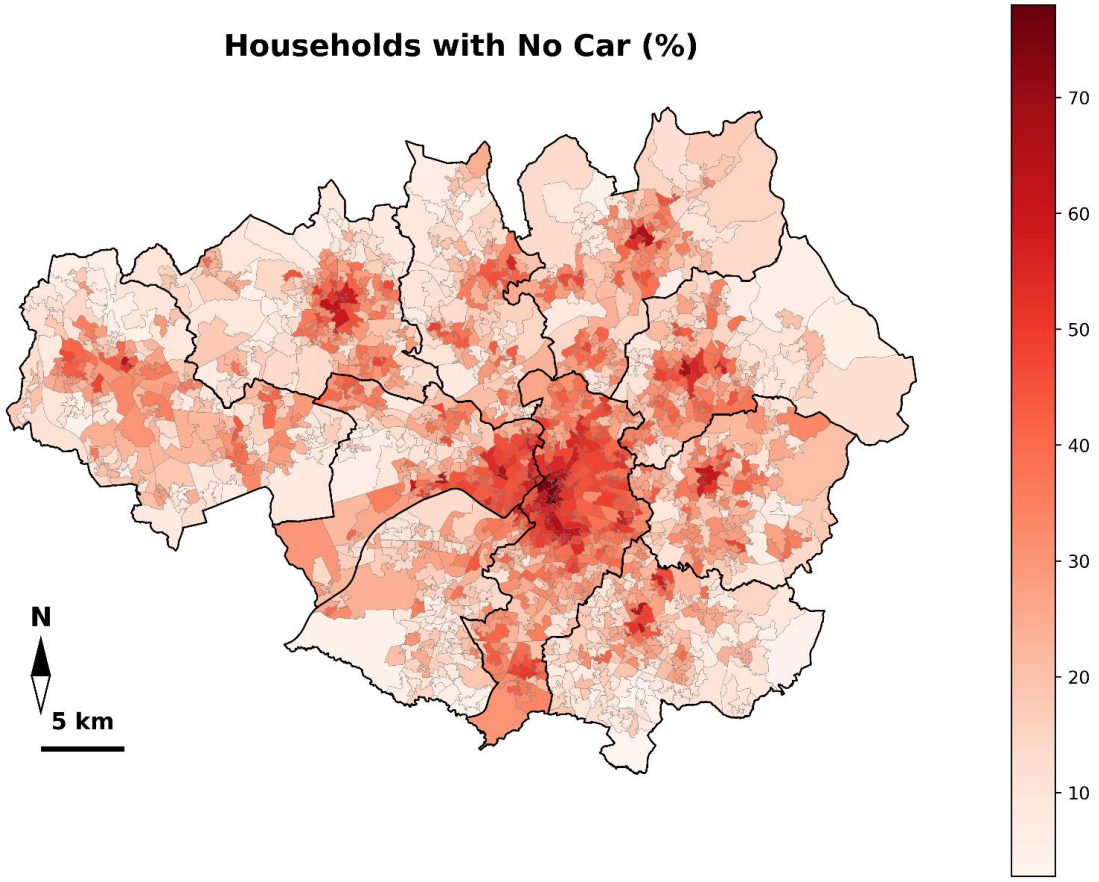
Cluster and outlier analysis – Commuting modes 2021

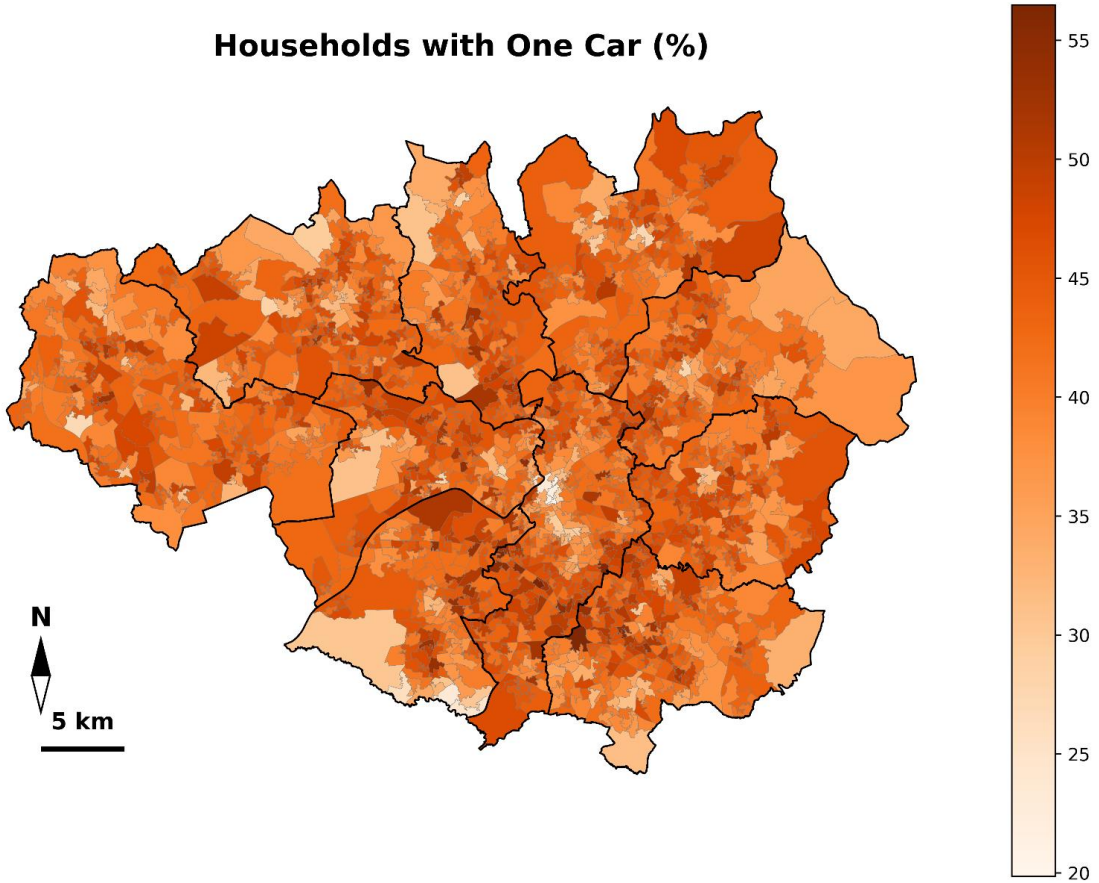




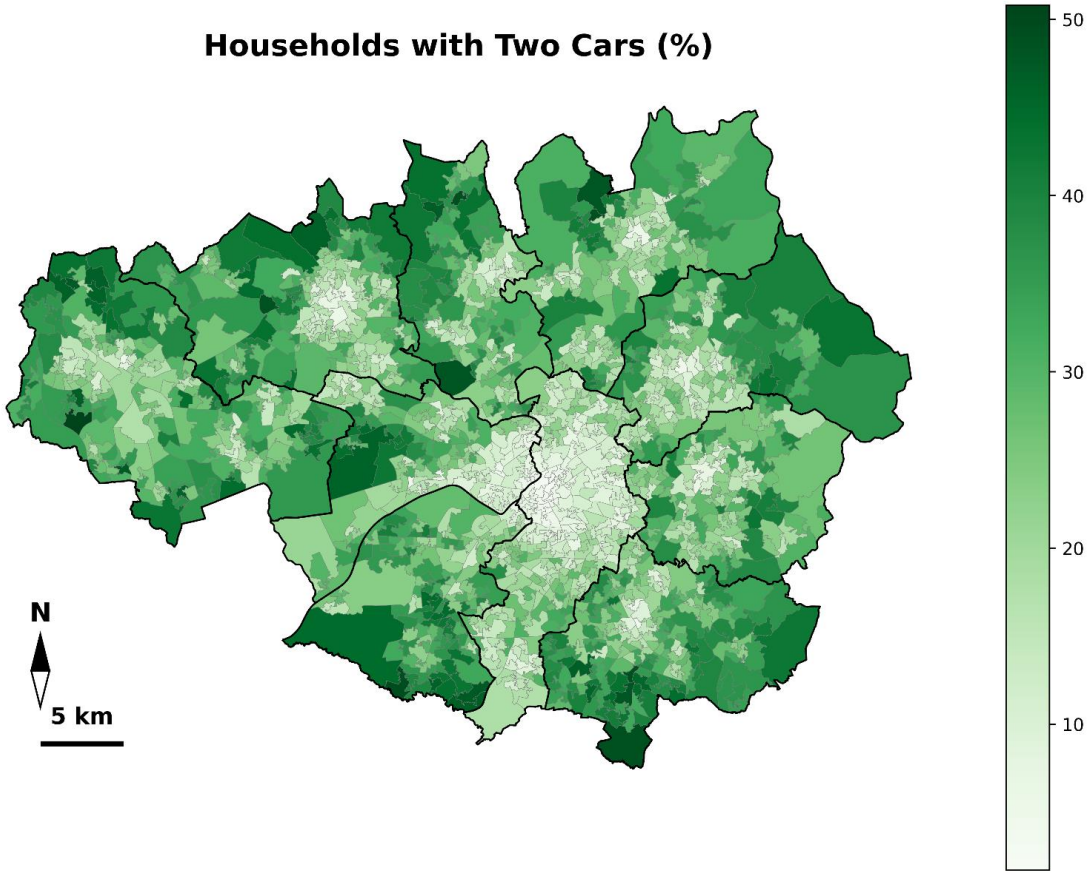


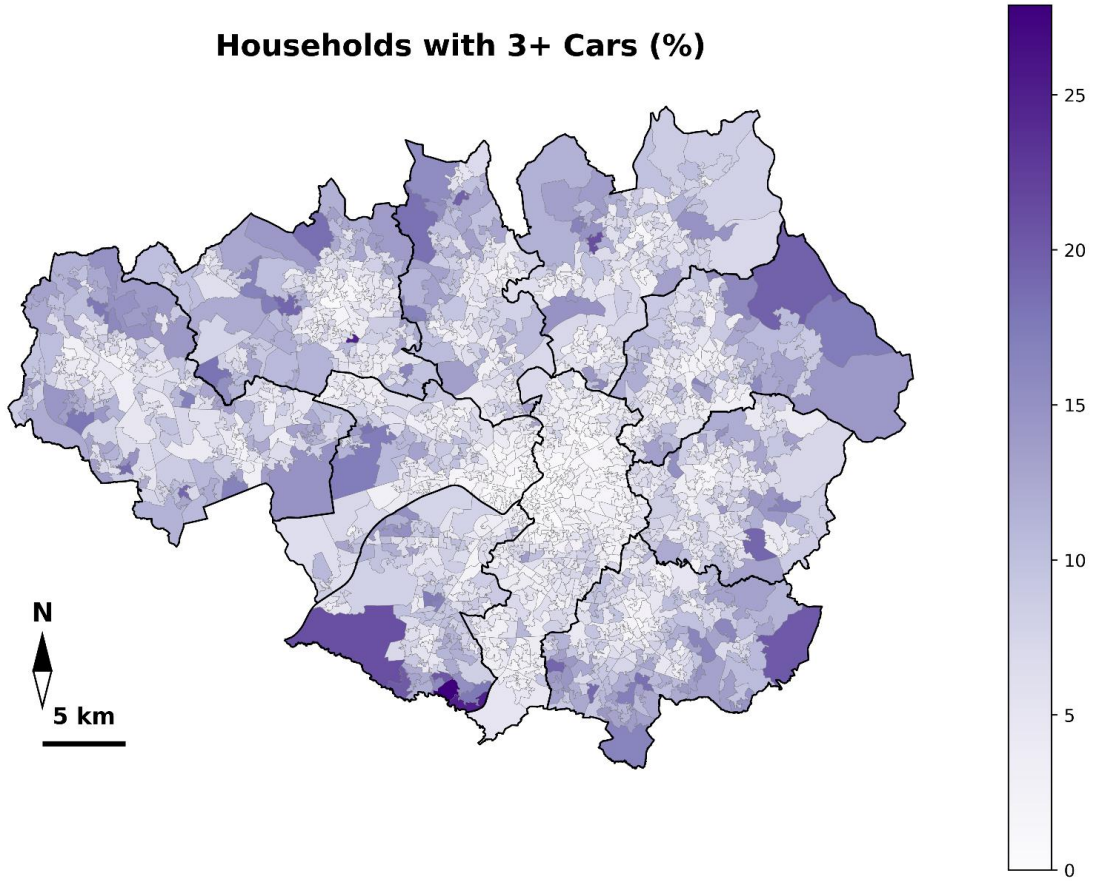
Car ownership by LSOA in Greater Manchester (2021)





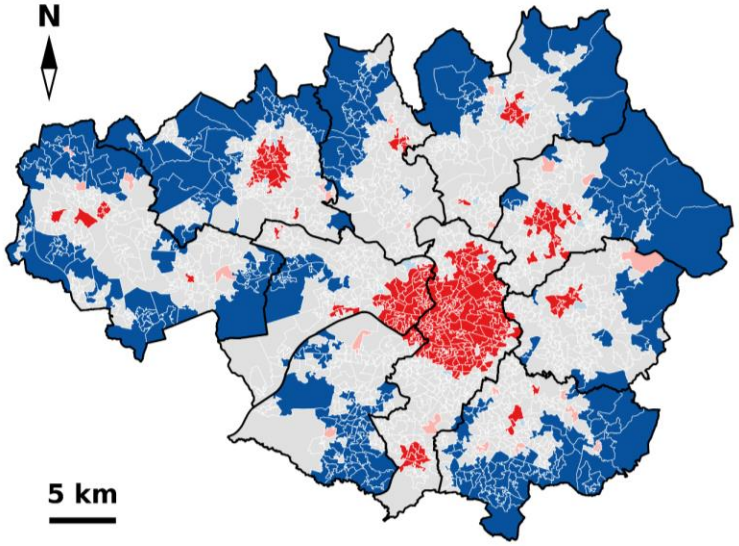
Car ownership by LSOA in Greater Manchester (2021)





Cluster and outlier analysis – Car availability in 2021

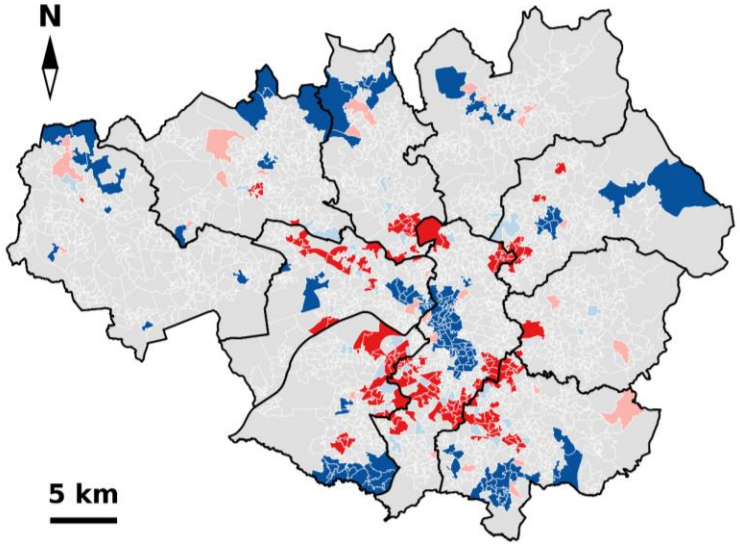
Households with No Car (%)



LISA Cluster (Range for Households with No Car (%))

- HH (High-High): 26.9-78.0%
- LH (Low-High): 15.7-25.7%
- HL (High-Low): 26.2-42.0%
- LL (Low-Low): 2.8-25.8%

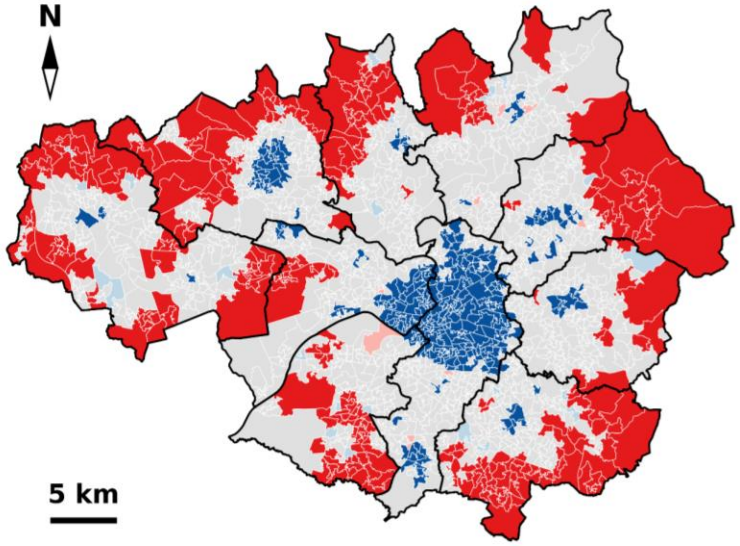
Households with 1 Car (%)



LISA Cluster (Range for Households with 1 Car (%))

- HH (High-High): 42.9-56.5%
- LH (Low-High): 34.3-42.8%
- HL (High-Low): 42.9-50.4%
- LL (Low-Low): 19.9-42.8%

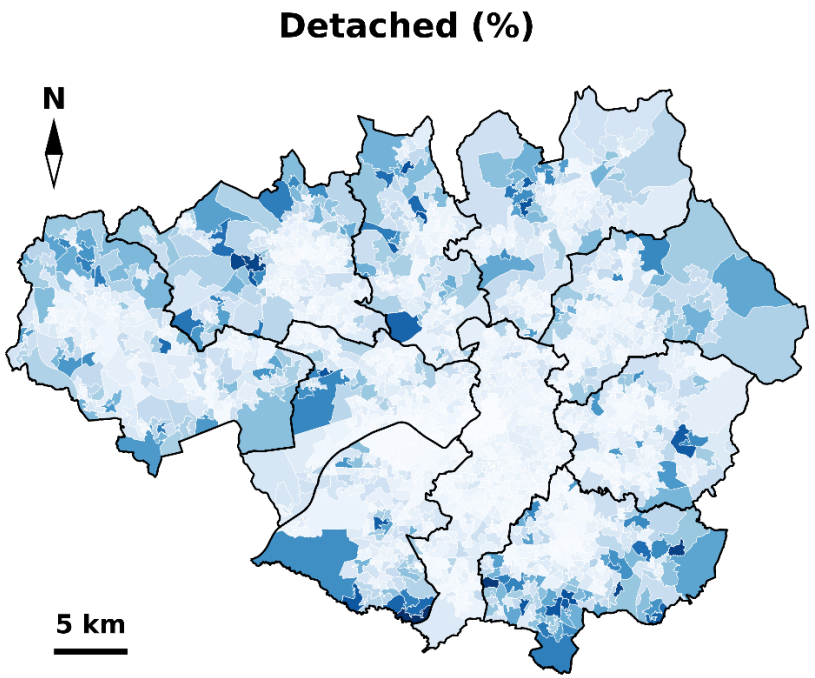
Households with 2+ Cars (%)

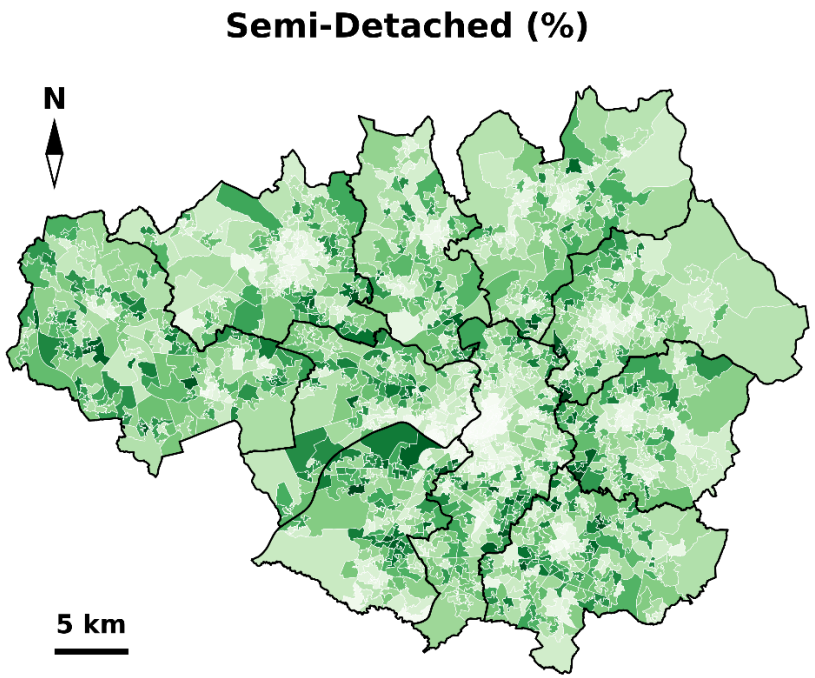


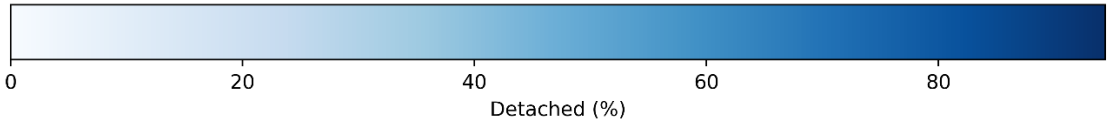
LISA Cluster (Range for Households with 2+ Cars (%))

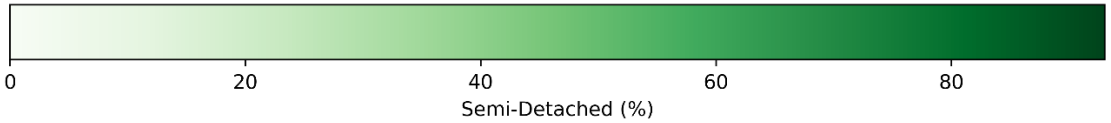
- HH (High-High): 31.2-72.0%
- LH (Low-High): 15.9-30.6%
- HL (High-Low): 31.3-41.0%
- LL (Low-Low): 2.1-30.7%

Housing type by LSOA in Greater Manchester (2021)

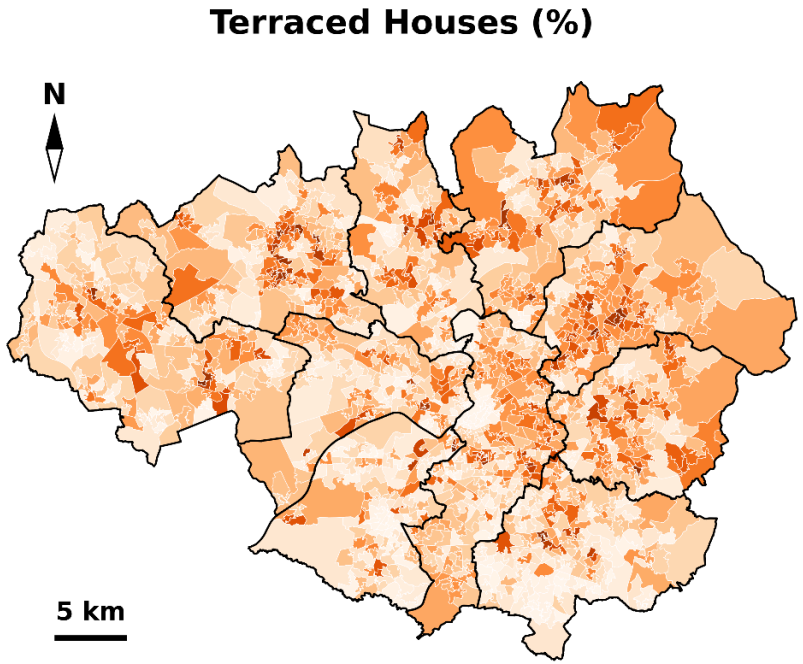


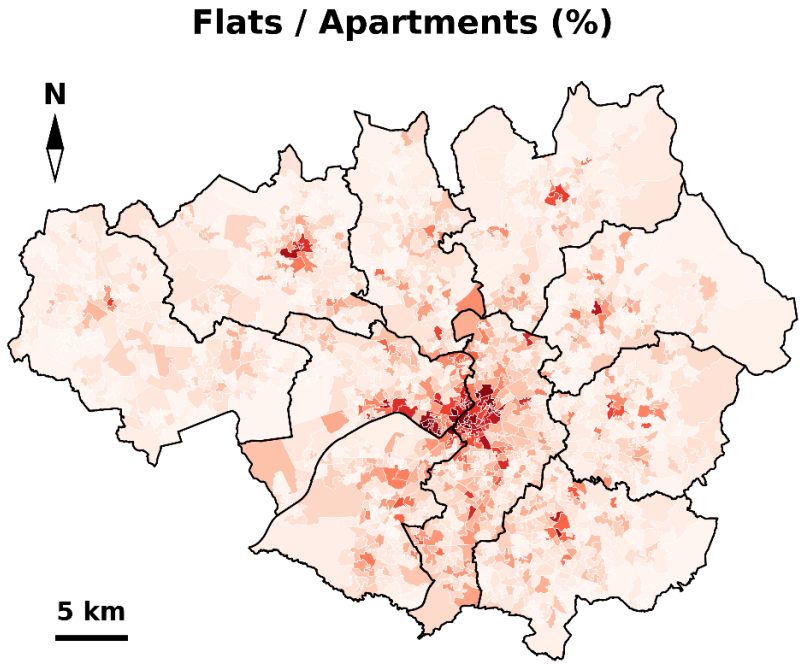


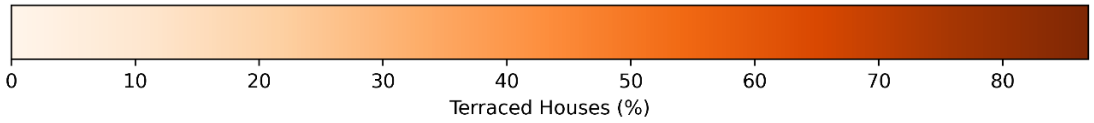




Housing type by LSOA in Greater Manchester (2021)

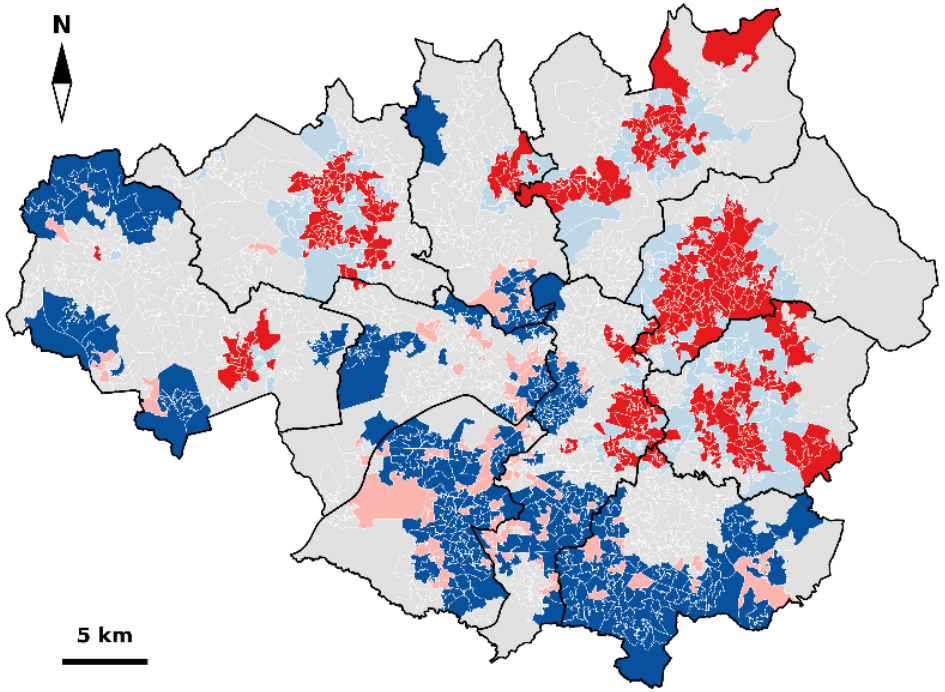






Cluster and outlier analysis – Housing types in 2021

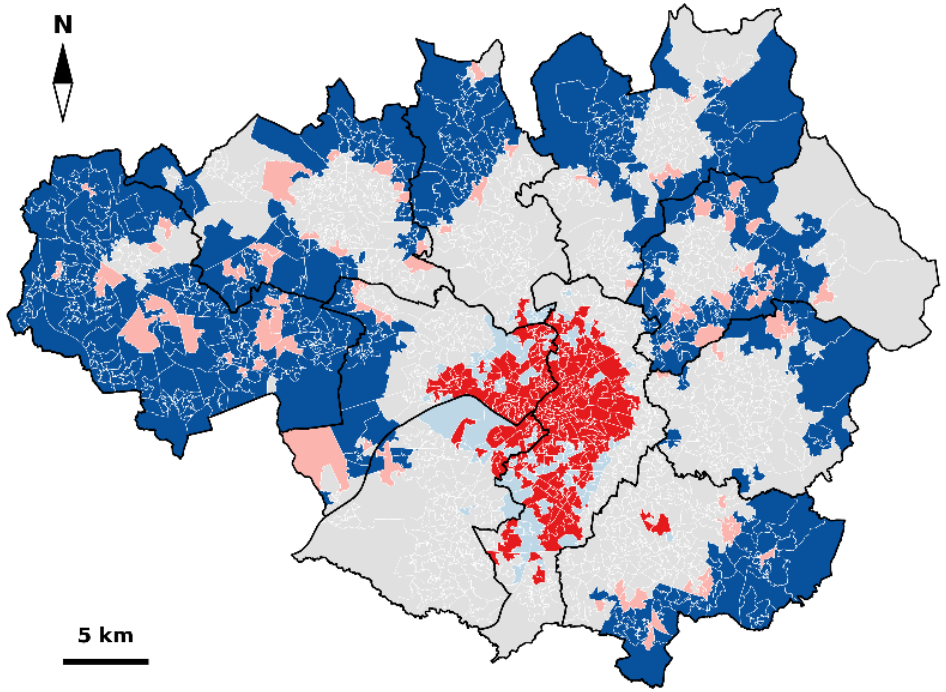
Terraced Houses (%)



LISA Cluster (Range for Terraced Houses (%))

- HH (High-High): 28.1-85.3%
- HL (High-Low): 28.2-86.9%
- LH (Low-High): 0.4-27.8%
- LL (Low-Low): 0.0-28.0%

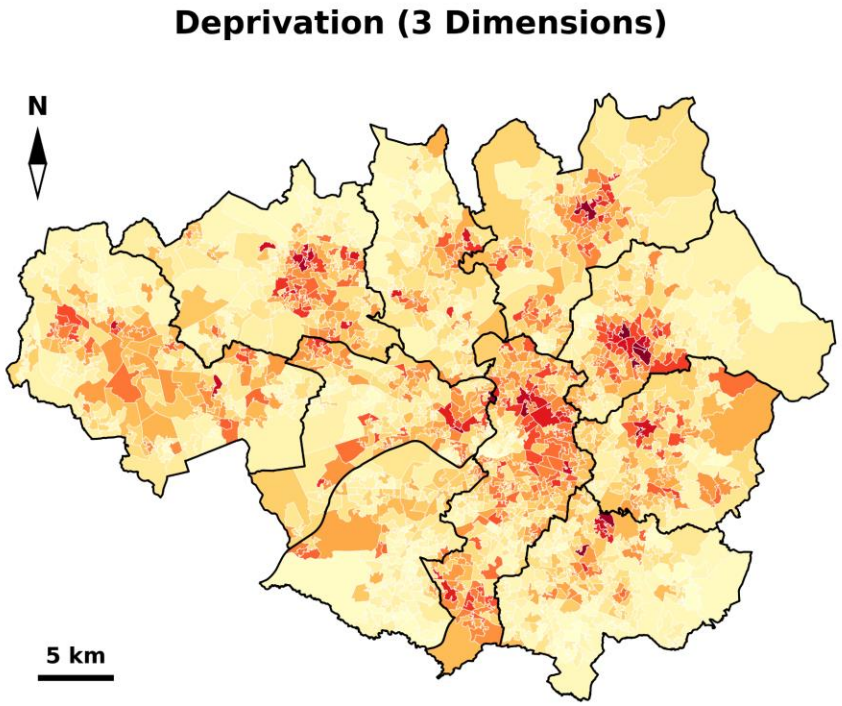
Flats / Apartments (%)

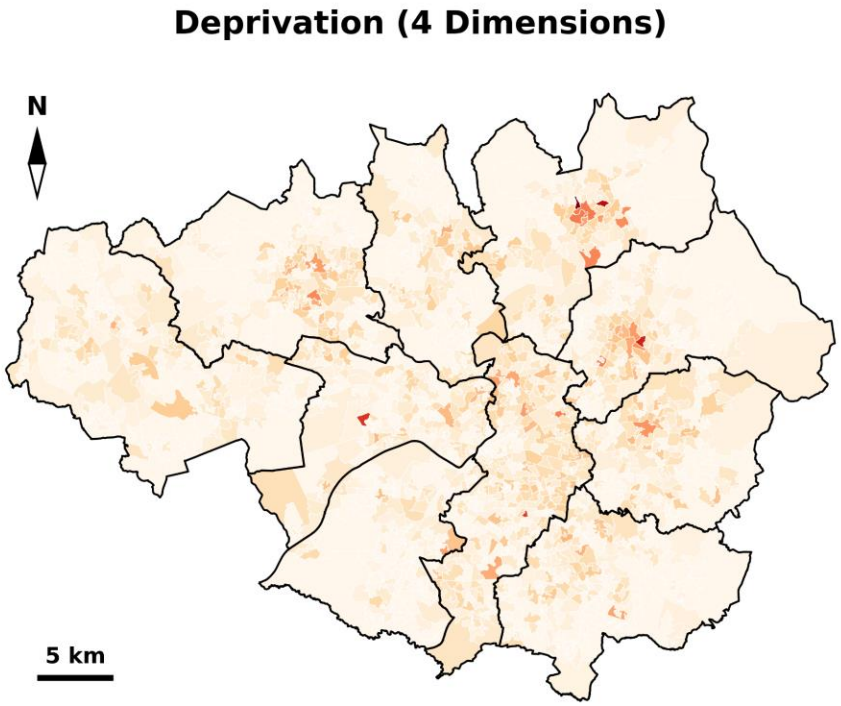


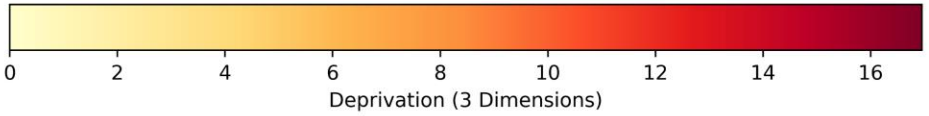
LISA Cluster (Range for Flats / Apartments (%))

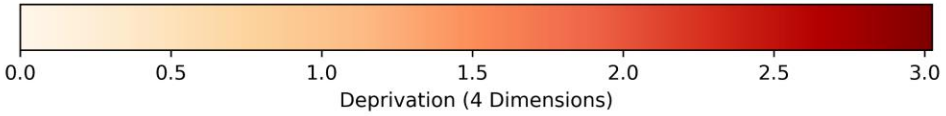
- HH (High-High): 15.0-99.3%
- HL (High-Low): 15.5-49.0%
- LH (Low-High): 0.2-14.8%
- LL (Low-Low): 0.0-14.8%

Deprivation by LSOA in Greater Manchester (2021)



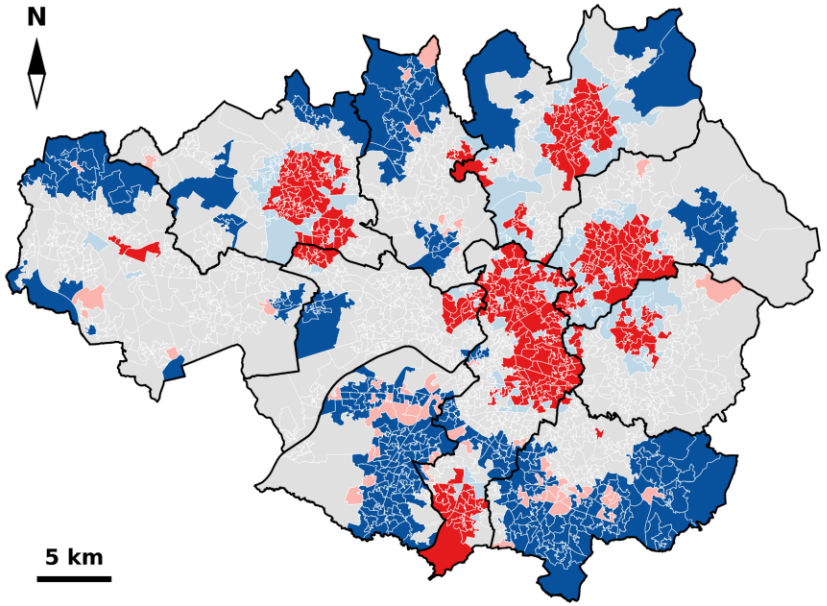






Cluster and outlier analysis – Deprivation in 2021

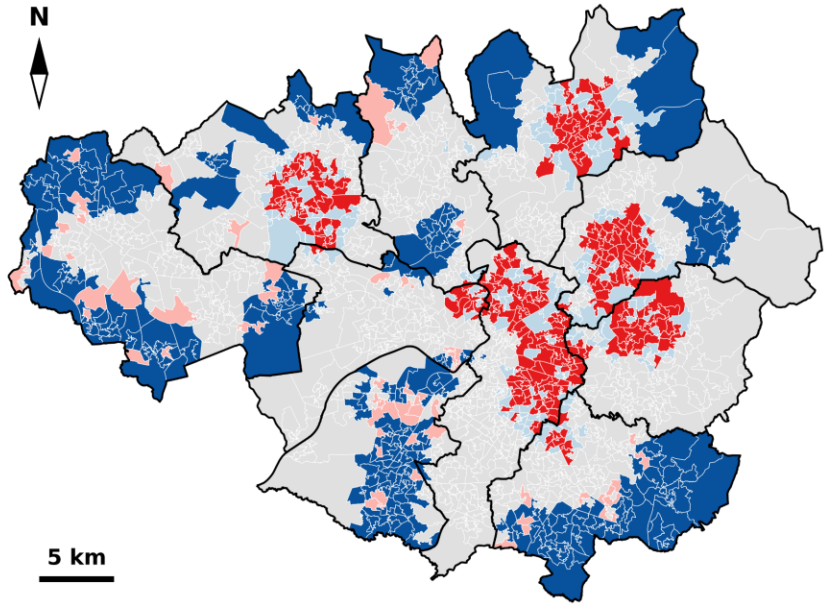
Deprivation (3 Dimensions)



LISA cluster (range for Deprivation (3 Dimensions))

- HH (High–High): 4.8-16.9
- HL (High–Low): 4.8-12.1
- LH (Low–High): 0.5-4.8
- LL (Low–Low): 0.0-4.8

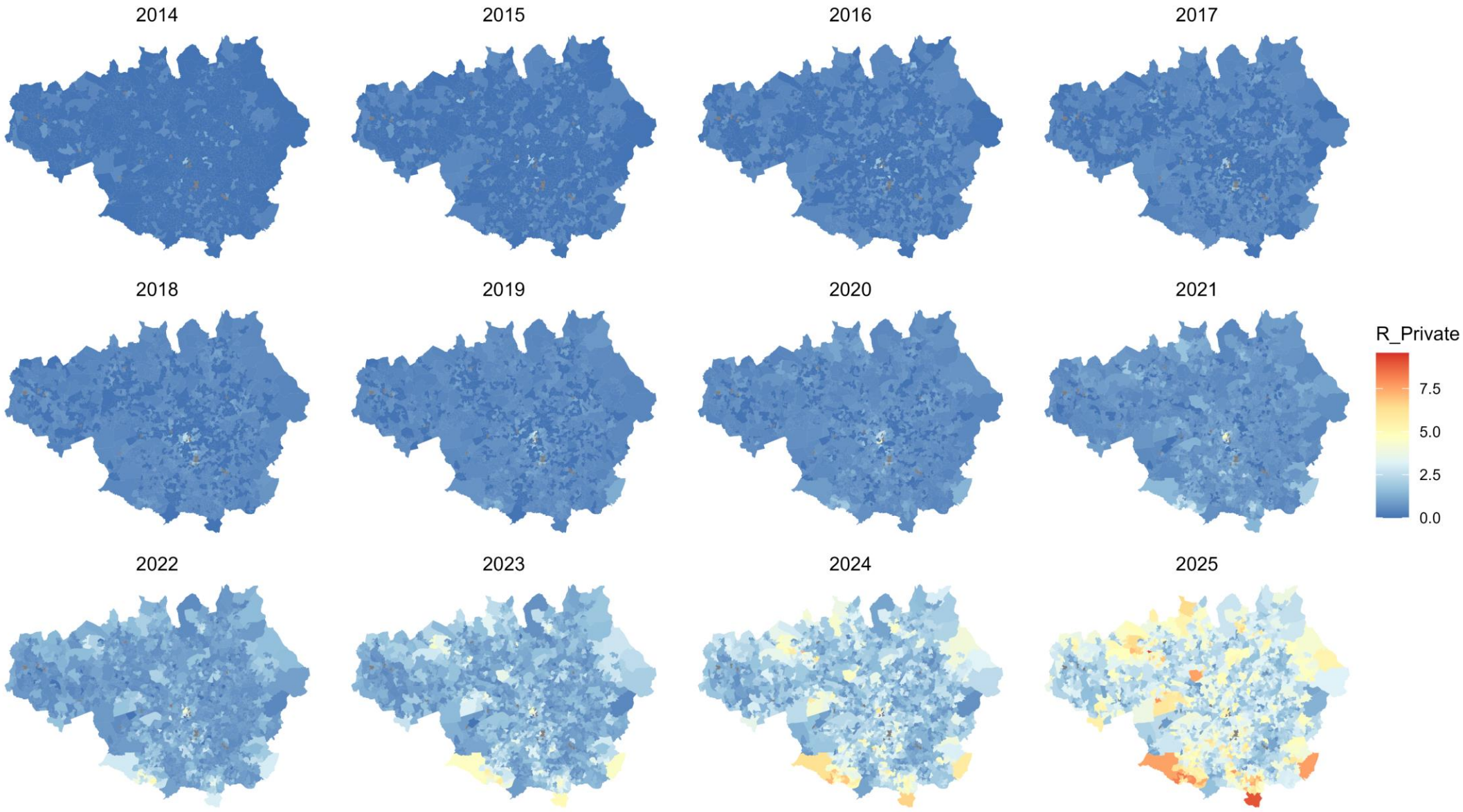
Deprivation (4 Dimensions)



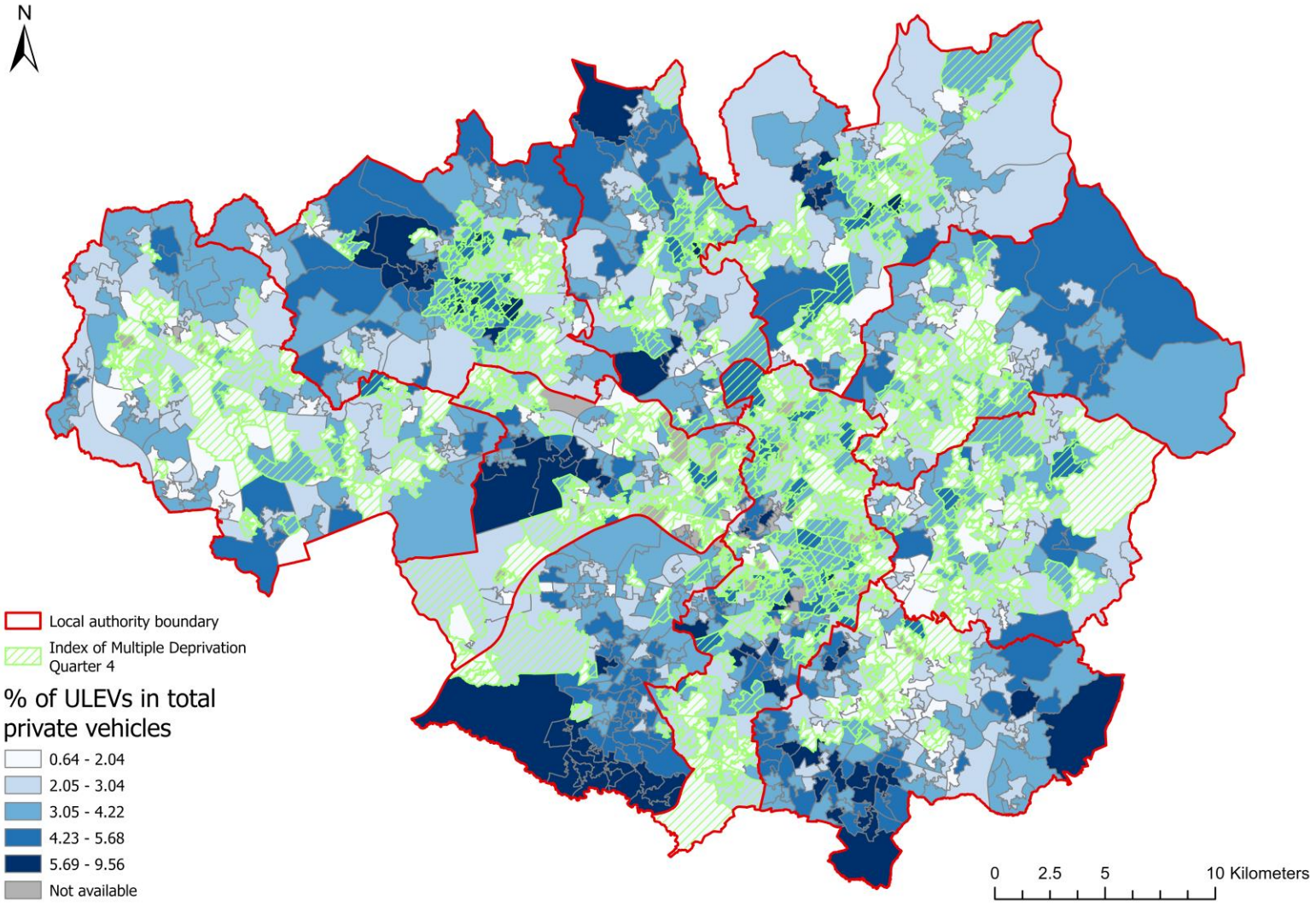
LISA cluster (range for Deprivation (4 Dimensions))

- HH (High–High): 0.3-3.0
- HL (High–Low): 0.3-1.3
- LH (Low–High): 0.0-0.3
- LL (Low–Low): 0.0-0.3

The Share of Ultra Low Emission Vehicles (ULEVs) in Total Vehicles



The Share of ULEVs in Q2, 2025 & IMD 2025



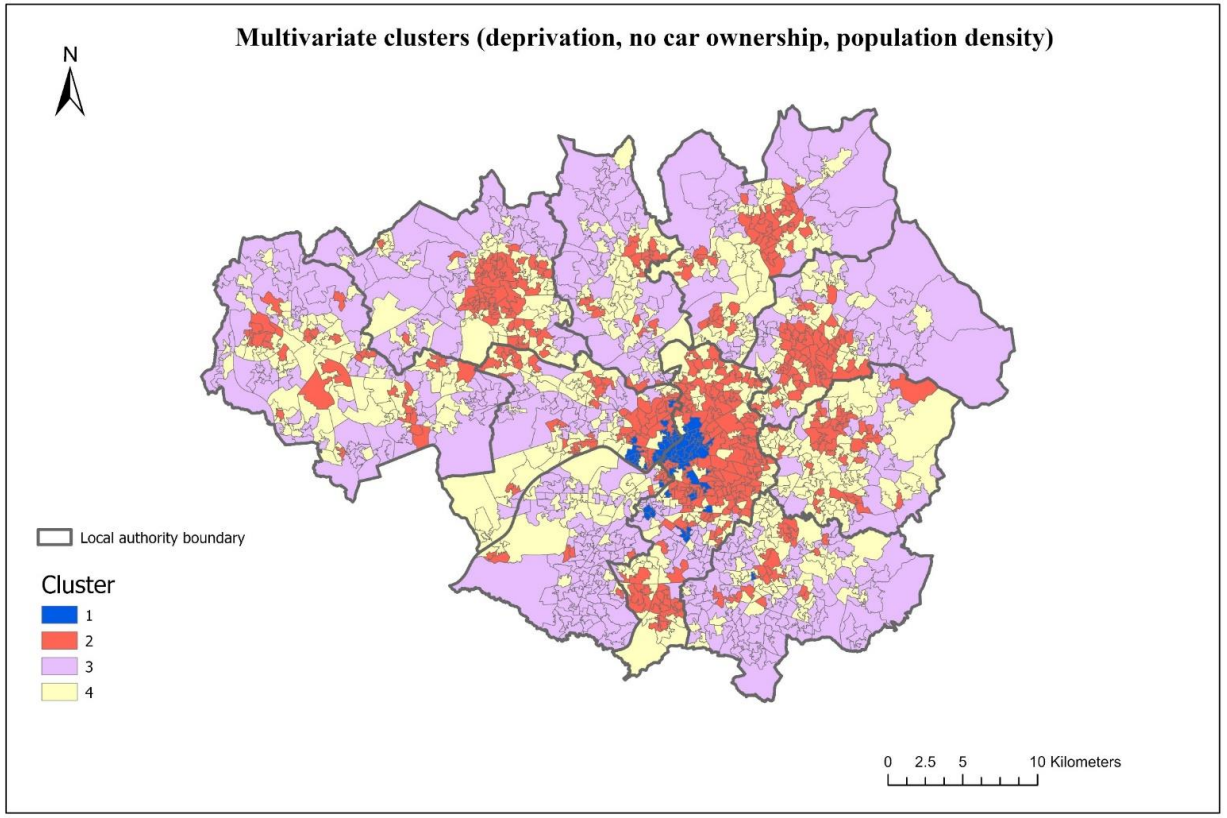
Priority areas

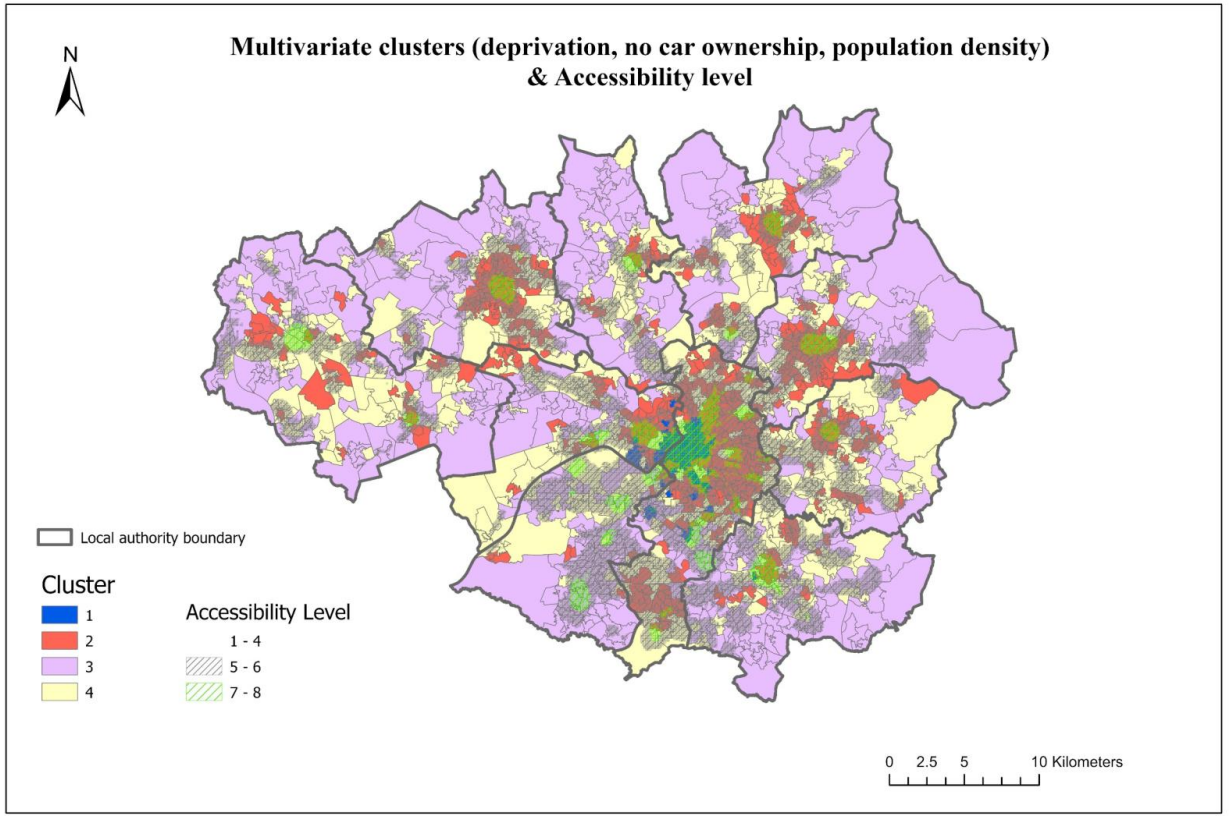
1) Households in transport poverty, whose mobility could be improved by better public transport and access to a car club (characterised by: Limited access to public transport, high social deprivation, no car ownership)

2) Households with one/two petrol or diesel cars who are unable to afford an EV and/or for whom lack of access to home charging makes EV ownership financially inaccessible (characterised by: Medium to high social deprivation, one or two-car ownership, limited access to public transport, no off-street parking)

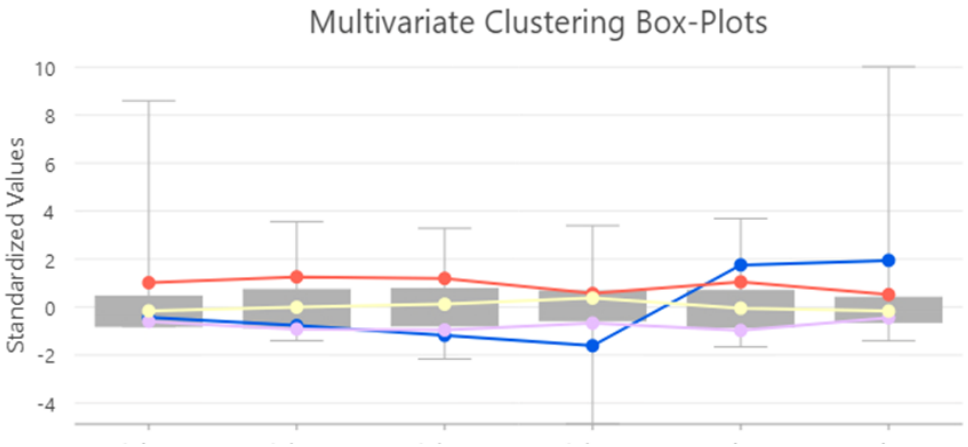
3) Households with multiple cars, who may consider reducing their car ownership if they had access to a car club (characterised by multiple car ownership).

Mapping priority areas 1: high deprivation, transport poverty, high population density



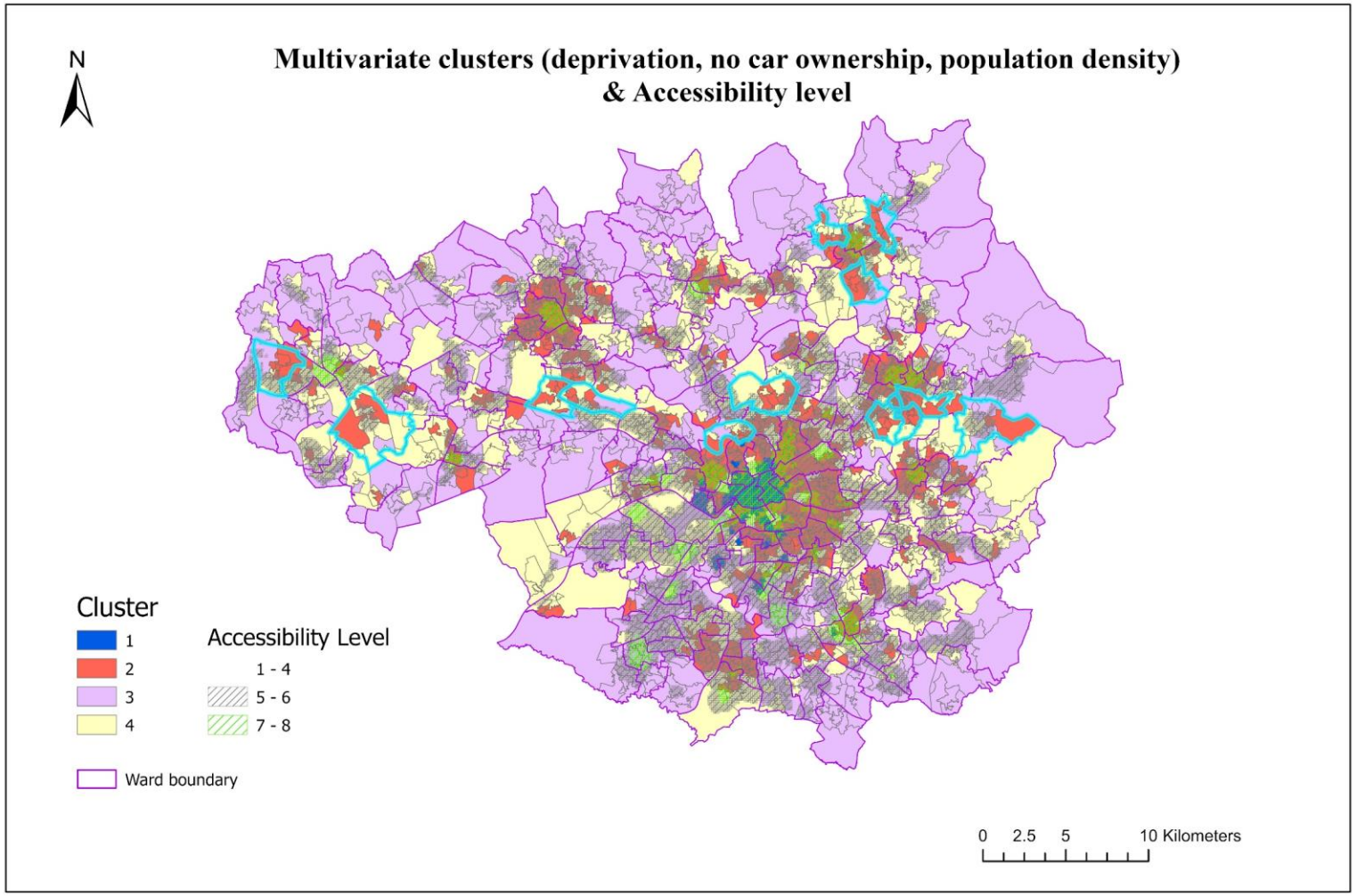


Mapping priority areas 1: high deprivation, transport poverty, high population density

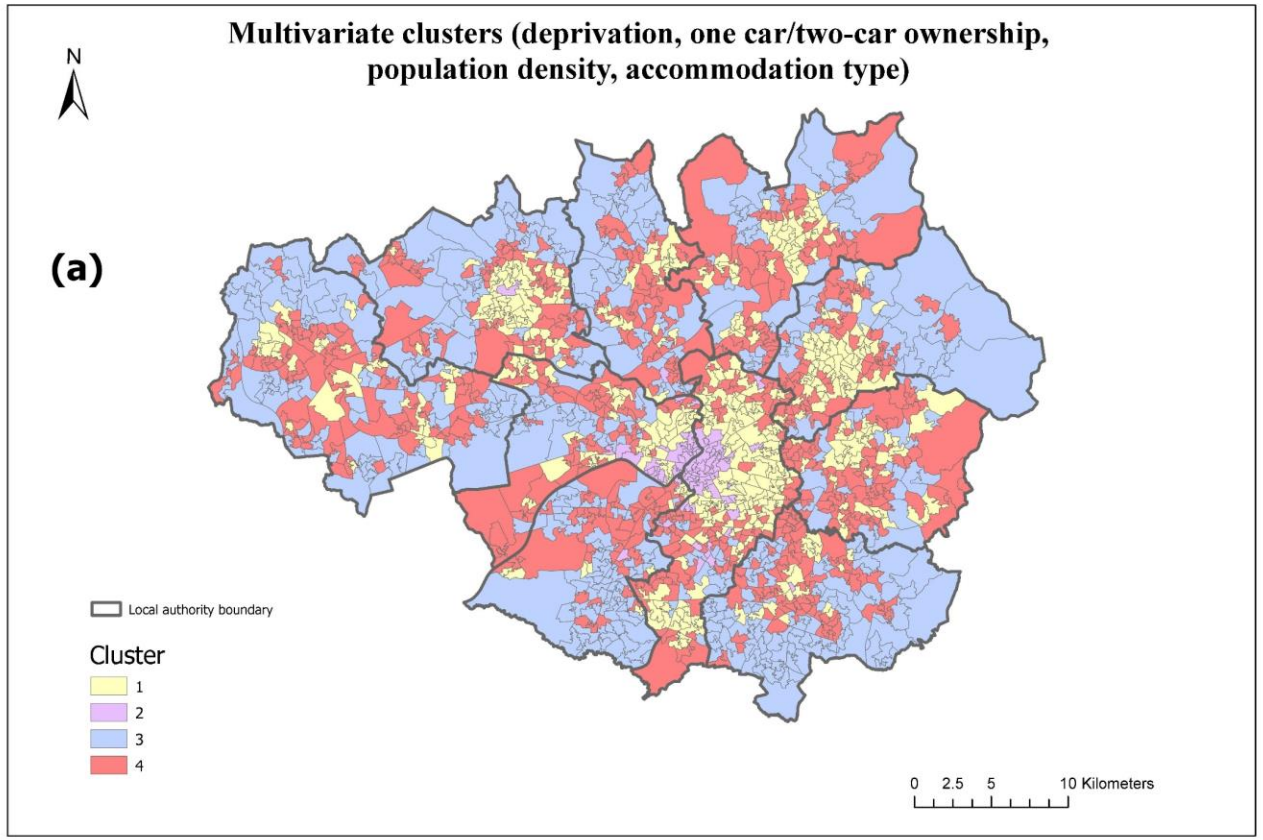


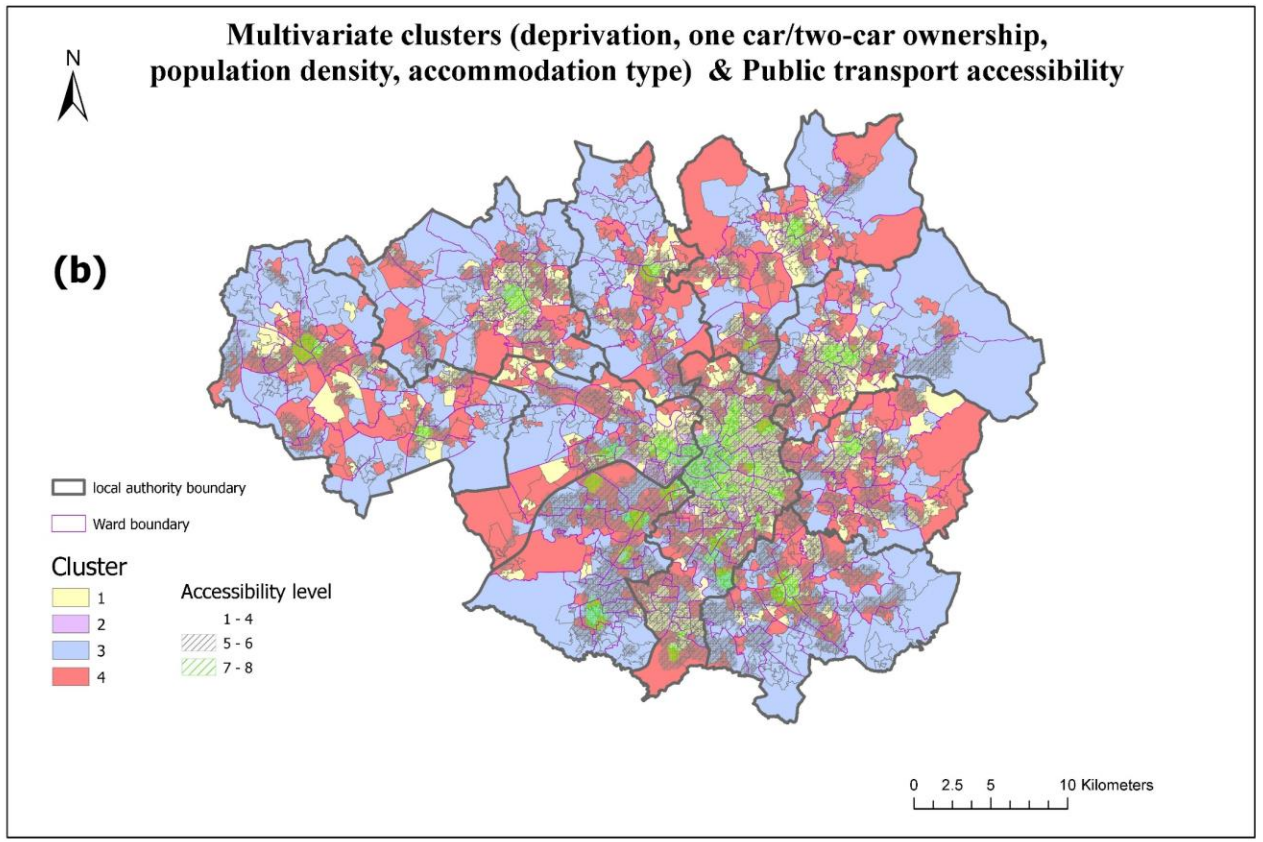
- V1 Percentage of households deprived in four dimensions
- V1 Percentage of households deprived in three dimensions
- V3 Percentage of households deprived in two dimensions
- V4 Percentage of households deprived in one dimension
- V5 Percentage of households without cars
- V6 Population density: persons per km^2

social deprivation, car ownership, and population density, and public transport accessibility levels.

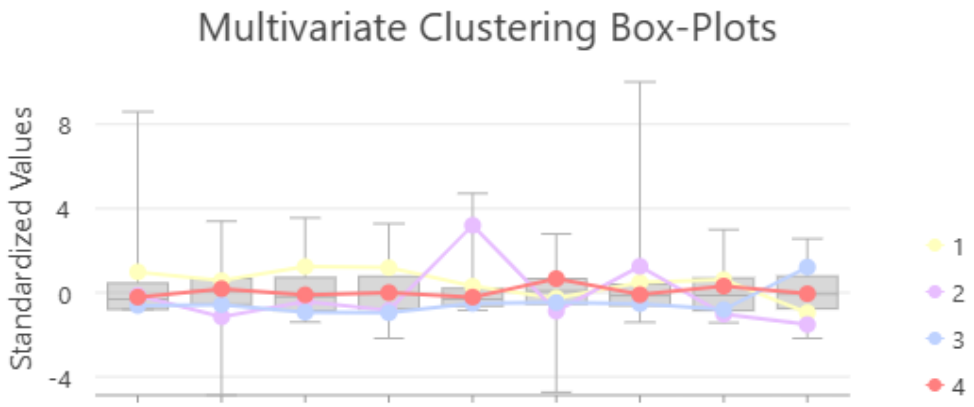


Mapping priority areas 2: moderate to high population density, high levels of terraced housing, and moderate levels of car ownership

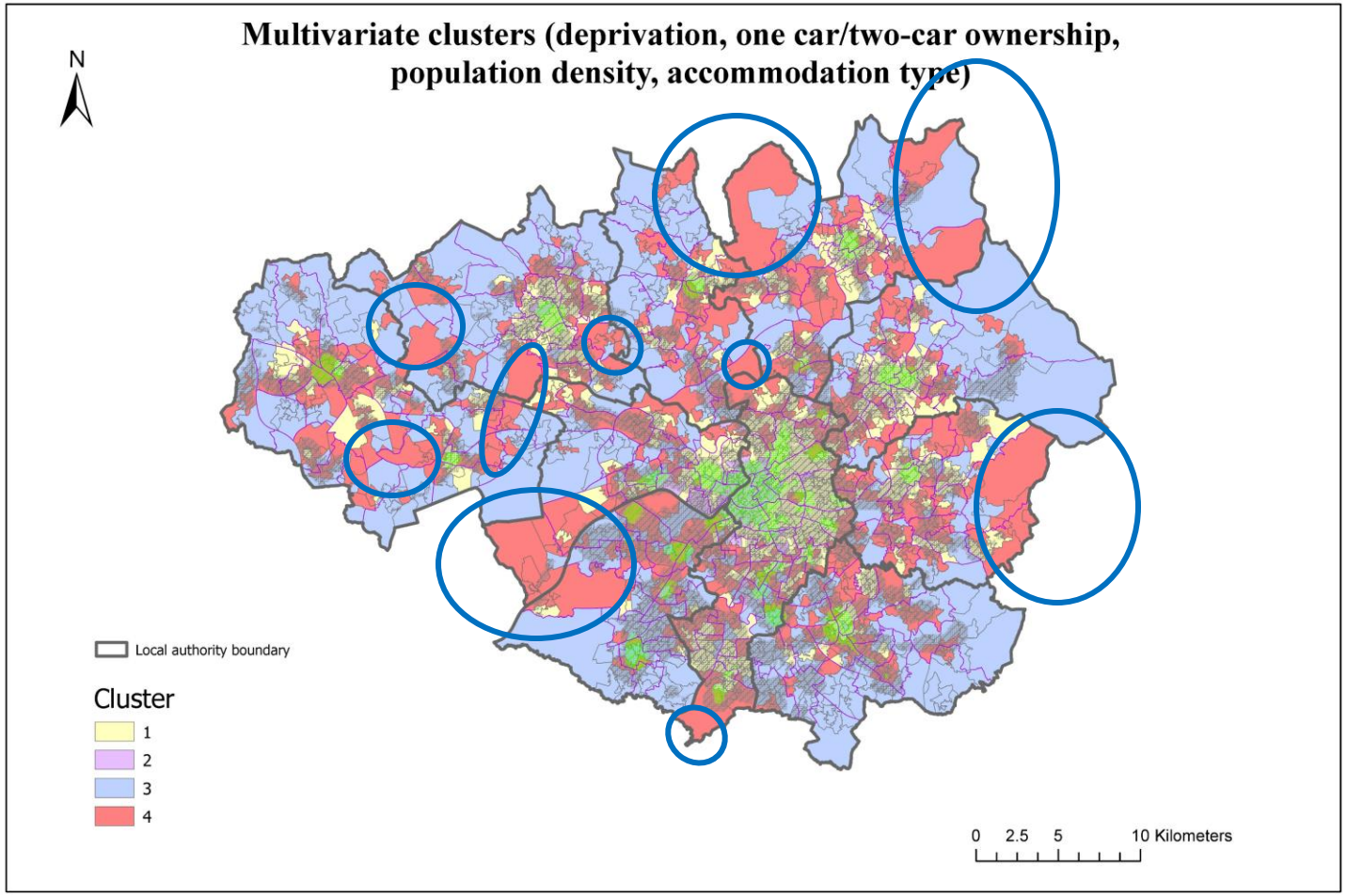




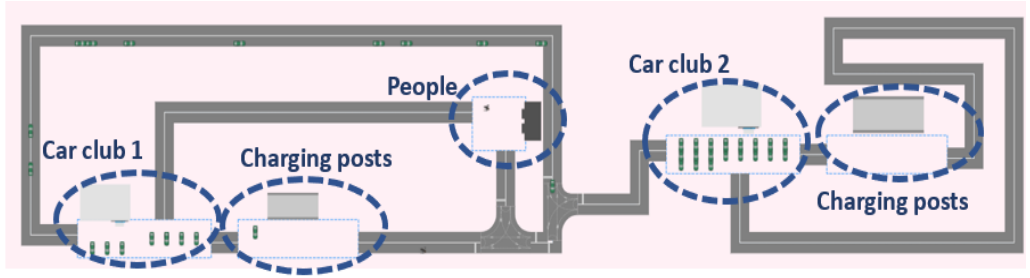
Mapping priority areas 2: moderate to high population density, high levels of terraced housing, and moderate levels of car ownership



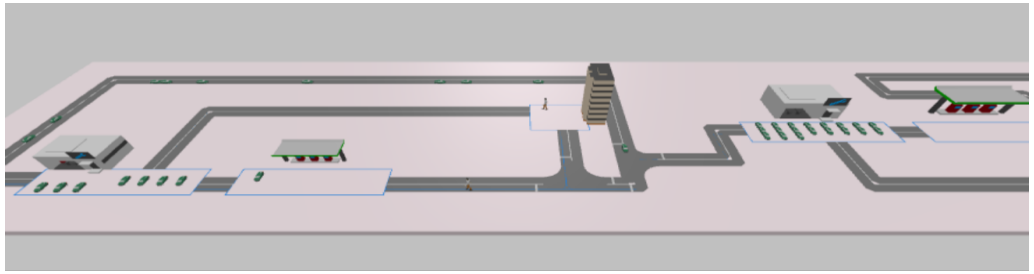
- V1 Percentage of households deprived in four dimensions
- V2 Percentage of households deprived in three dimensions
- V3 Percentage of households deprived in two dimensions
- V4 Percentage of households deprived in one dimension
- V5 Percentage of households living in flats
- V6 Percentage of households living in terraced house
- V7 Percentage of households with one car or van
- V8 Percentage of households with two cars or vans
- V9 Population density: persons per km^2



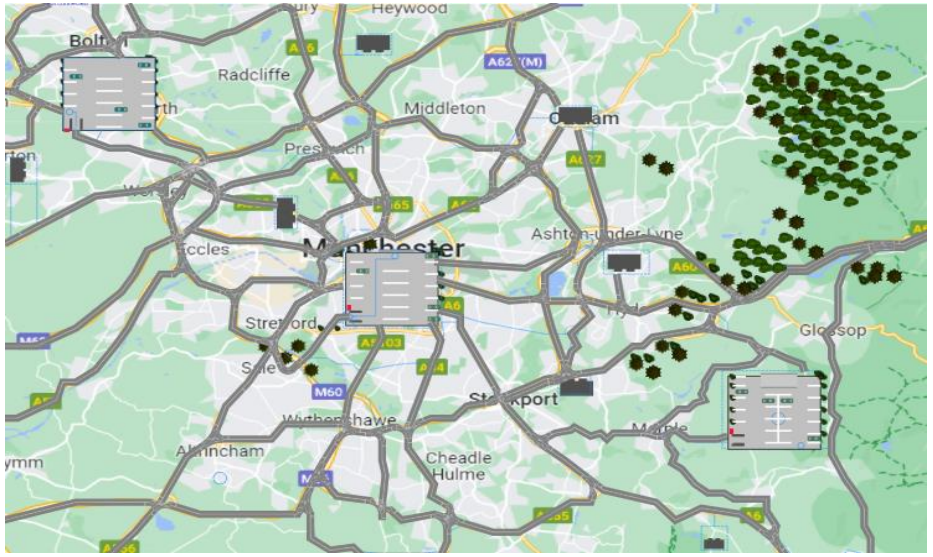
Agent Based Simulation Model (ABM)



2D representation of EV CC network to test ABM



3D representation of EV CC network to test ABM



2D representation of EV CC network in Greater Manchester

Inputs

Agents

EV cars

People

Parameters

Trip Duration

Demand

Number of cars in each car club

Unmet demand

Simulation and Analysis

Simulation

Visual Framework

People – decision-making algorithm

Simulation Time

Sensitivity Analysis

Parameter sensitivity – number of cars per car club

Varying demand

Simulation Output

Output

Optimized number of cars per car club

Number of consumers waiting at each car club

Varying trip duration

Varying recharge times

Representation of cars ready for hire and hired car from CC

Sample : Simulation - AnyLogic Professional [EVALUATION USE ONLY]

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Agent-Based Model for car club optimization in Manchester

Number of cars in car club -1

Number of cars in car club -2

Number of cars in car club -3

cc1 15

cc2 15

cc3 15

x10

Idle

Sample : Simulation - AnyLogic Professional [EVALUATION USE ONLY]

Transport for Greater Manchester

MANCHESTER 1824 The University of Manchester

Agent-Based Model for car club optimization in Manchester

Number of cars in car club -1

Number of cars in car club -2

Number of cars in car club -3

cc1 15

cc2 15

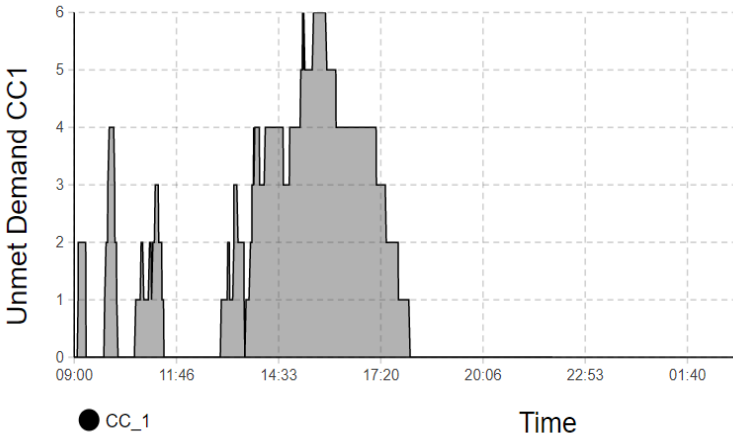
cc3 15

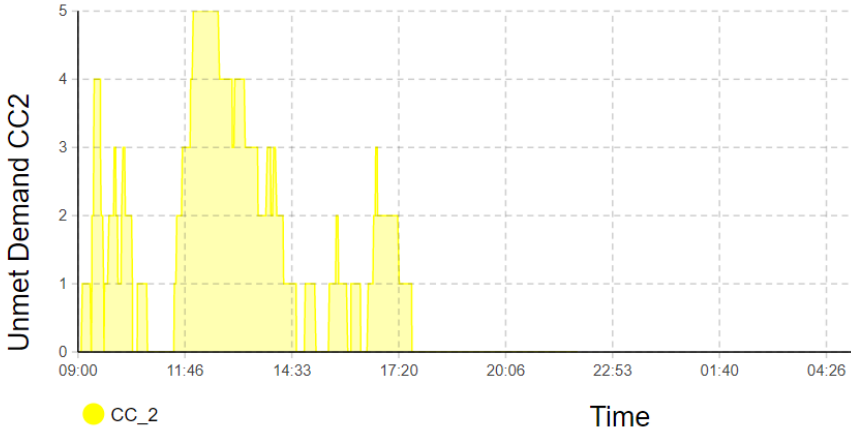
x10

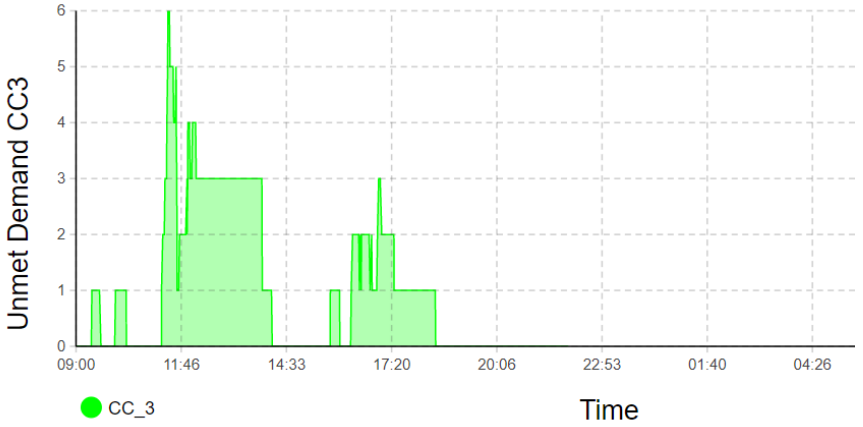
Idle

Analytics – Agent Based Simulation Model

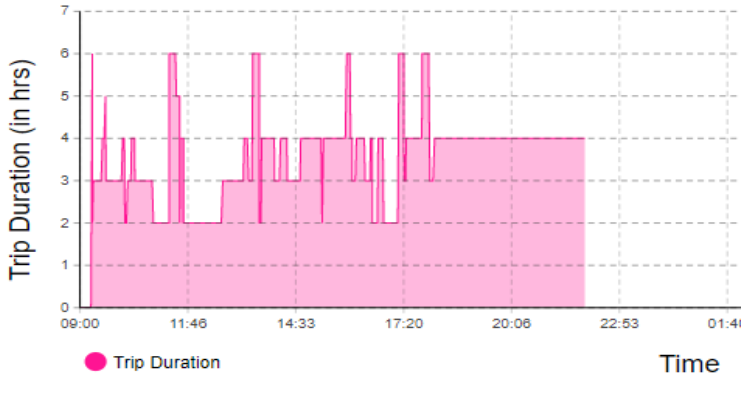
The outcome of the simulation model is depicted in the form of time plots, illustrating the unfulfilled demand or the number of users awaiting vehicle availability for each car club. The horizontal X-axis corresponds to time intervals in a 24-hour format (HH: MM), while the vertical Y-axis depicts the numerical values representing the real-time unmet demand attributed to each car club.

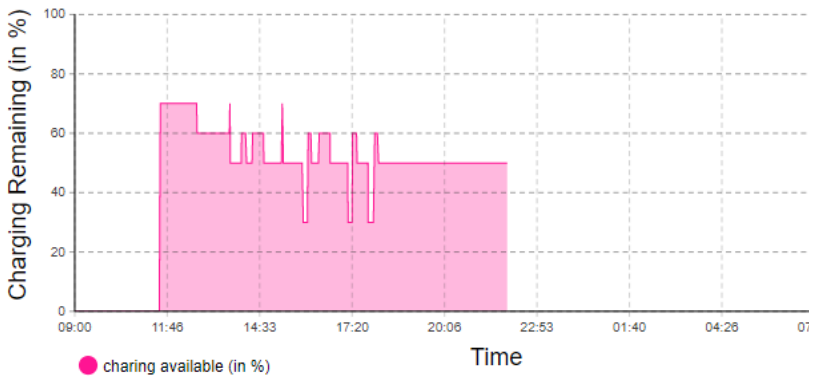


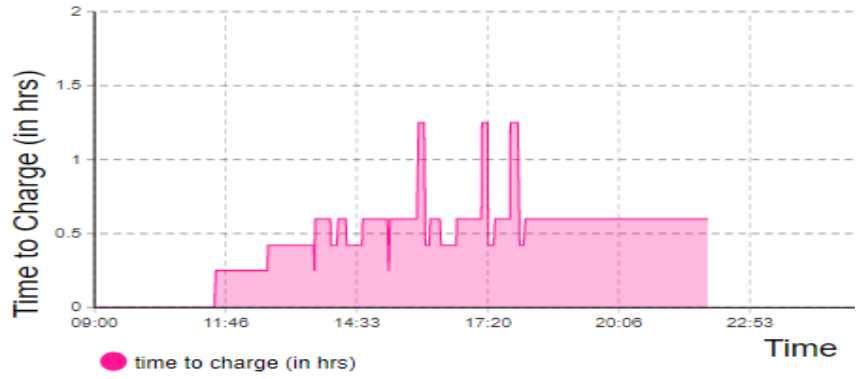




Furthermore, an additional aspect considered is the depiction of the variability in booking or trip durations, represented graphically. Additionally, graphical representations were generated to showcase the temporal trends of two specific parameters: the proportion of remaining charge in the electric vehicle post-trip completion, and the duration required for the vehicle to attain a full charge in preparation for its subsequent trip



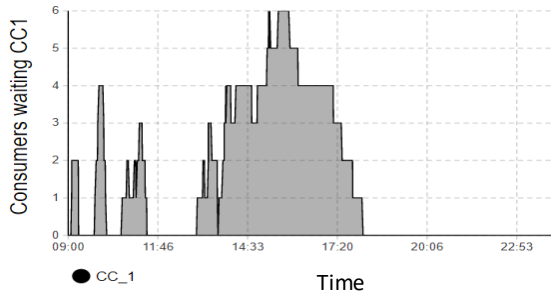


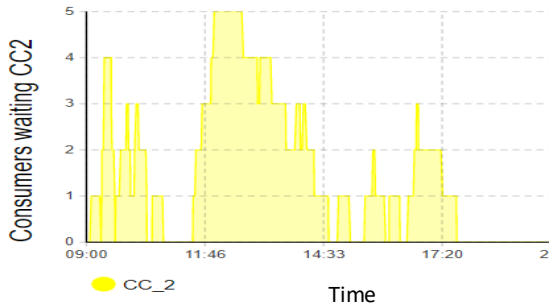


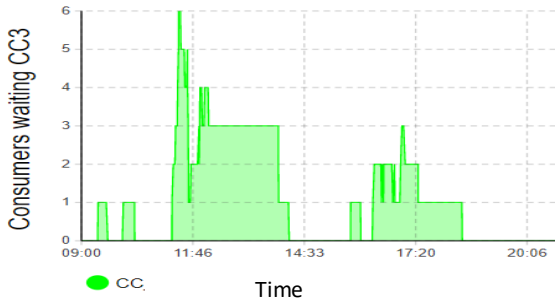
Analytics – Agent Based Simulation Model

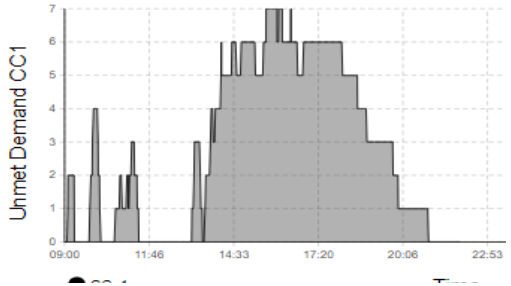
Application of Agent Based Simulation Model

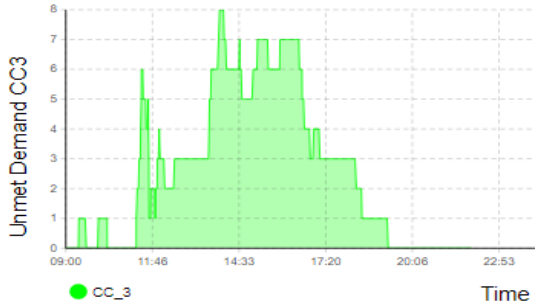
ABM studies the increase in charging time and its impact on unmet demand or customers waiting for vehicles as returned vehicles take more time in charging. ABM highlights the importance of installing fast-charging posts in enhancing operational efficiency and user satisfaction.

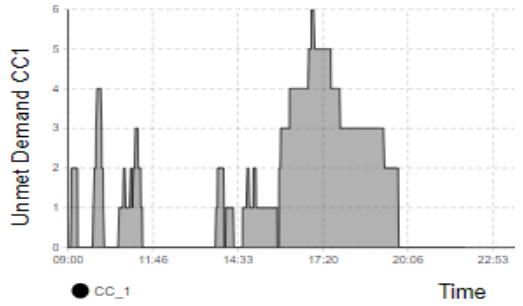


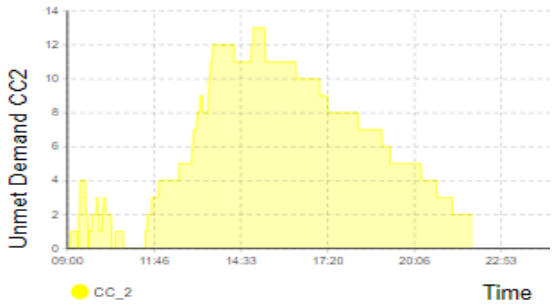












Percentage of charging remaining	Time to full charge (in mins)
70	15
60	25
50	35
40	55
30	75

Charging time increased by 2 times

Cars in cc1 = 10

Cars in cc2 = 10

Cars in cc3 = 10

Percentage of charging remaining	Time to full charge (in mins)
70	30
60	50
50	70
40	110
30	150

Charging time increased by 3 times

Cars in cc1 = 10

Cars in cc2 = 10

Cars in cc3 = 10

Percentage of charging remaining	Time to full charge (in mins)
70	45
60	75
50	105
40	165
30	225

Policy recommendations

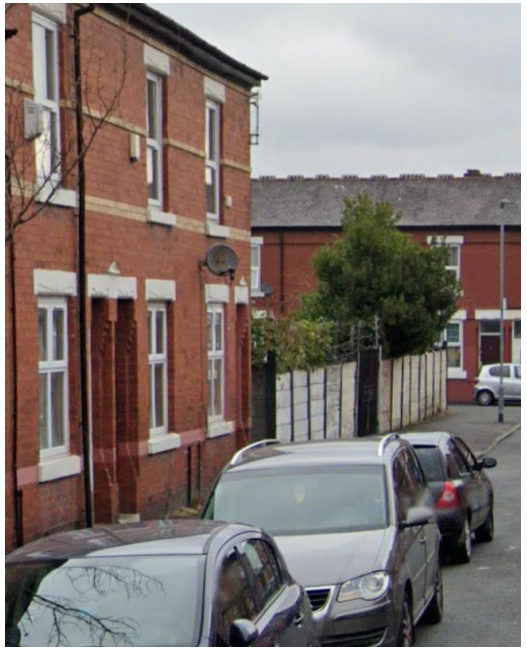
- Prioritise investment in deprived areas where residents face: high social deprivation, lack of off-street parking and unaffordable private vehicle costs
- Go beyond charging infrastructure: investing in E-car clubs and Pay-as-you-go EV schemes
- Enhance public transport in transport-poverty hotspots, where shared EV schemes alone are insufficient; improve reliable and affordable public transport.
- Empower metro mayors and local authorities to integrate shared mobility into local transport strategies
- Promote cross-sectoral coordination between different departments and sectors
- Apply spatial analysis and agent-based simulation for more informed decision-making

Future prospects

Expand the spatial analysis by incorporating other data and variables (e.g. on-street parking availability) to refine transport decarbonisation vulnerability mapping

Integrate behavioural and socio-economic data to model household decision-making and uptake of EV and shared EV schemes

Link the agent-based model with AI to forecast demand and simulate infrastructure investment scenarios under different policy incentives (e.g. subsidies, pricing).



Thank you

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