Consumer Data Research Centre

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Transport for West Midlands

Deriving Recommendations for Cross-Boundary Bus Services in the West Midlands From Aggregated Origin-Destination Data and Bus Line Networks

Clare Rickard[1], Charmaine Grant and Abdul Noor[2],
[1]University College London, [2]Transport for West Midlands

Background and Motivation

Understanding cross-boundary bus services is imperative for transport planners in the West Midlands, in anticipation of bus services being brought under greater public control.

This study uses transit smart card data to find how people use cross-boundary routes and highlight areas where service can be improved or expanded.

Data and Methods

These analyses use 2023 origin-destination weekday bus passenger data from the Swift transit smart card, the 2025 bus line network, and 2021 census-recorded commuter flows. Cross-boundary routes are defined as those that leave the West Midlands Metropolitan Area (WMMA) for the West Midlands Region and vice versa.

Three geographically distinct types of trips were analysed using K-Means analysis on the start time, age, distance, and concessionary status. The three types were defined as trips within the WMMA, trips leaving the WMMA, and trips entering the WMMA.

Each MSOA was assigned a centrality value from the bus line network and the bus passenger network. A linear regression was used to predict the bus line centrality from the bus passenger centrality, and a Moran's I test was run for the residuals. A bivariate Moran's I test was run for these centralities. A bivariate Moran's I test was also run for the centralities of census-recorded commuters and bus commuters.

Key Findings

Cross-boundary trip clusters had median distances about 3 times as long as internal trips. The trip start times for the cross-boundary clusters were half an hour earlier than the internal trips. The clusters showed that trips were leaving the WMMA in the morning and returning in the afternoon.

The linear residual centrality analyses found the west of Birmingham had relatively high service compared to bus passenger demand, while east of Birmingham had relatively low service. The bivariate analyses suggested that areas just outside the WMMA have high levels of commuters and could be potential markets.

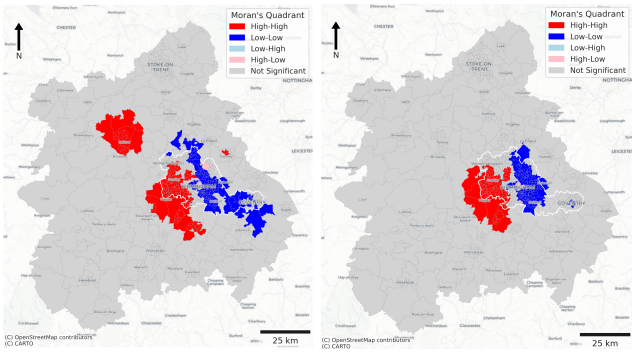

Figure 1: Spatial Clusters of Linear Residuals Predicting Bus Centrality from Passenger Centrality: Degree at 10:00 (left), Eigenvector at 12:00 (right)

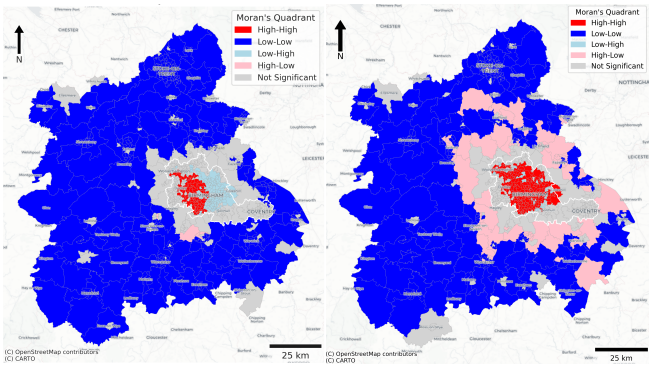

Figure 2: Bivariate Moran's I Clusters : Bus and Passenger Eigenvector Centrality at 12:00 (left), Census-Recorded Commuter and Bus Commuter Degree Centrality (right)

Value of Research

The K-Means analyses separated by geographic type found distinct groups of people traveling over the boundary and back. The centrality research demonstrates that network theory can provide actionable recommendations for service, even when aggregated to the MSOA level. This research can be used to increase efficiency and ridership in the bus system.

Geographic Data Service