

Assessing retail space use using mobile location histories and street centrality in Cambridge, UK

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Project Background

The project aimed to utilise mobile GPS location histories in an assessment of footfall around retail spaces and the comparison with street betweenness centrality. The space syntax framework is a popular method to break down an urban area into its topology and apply graph theory to provide insights on urban phenomena. It has found many successes in linking the urban grid and land uses and densities, building genotypes, and models for pedestrian movement and traffic flow. Of particular interest for this project, a number of studies had found strong correlations between the 'betweenness centrality' of the road network and retail density. This was a jumping off point for the project, by applying this framework to the road network of an urban area, and then using the GPS location histories to verify and compare to street network betweenness.

Data and Methods

The largest dataset utilised in this project is the mobile GPS location histories which were provided by CBRE. These data included over 35,000,000 records, covering a large area of Cambridge town centre, and some periphery residential areas. After some data processing the dataset was chunked by month to ease analysis. Trajectories for each unique device were established using python, and an algorithm written to identify 'stay points' where the device users appeared to stay within a 50m area for more than 10 minutes. The OS MasterMap ITN was used for the street network analysis, after being read into R and transformed into a graph and betweenness calculated using the igraph library. Experian Shop*Points and nodes extracted from Open Street Map (OSM) were used for retail densities. Once these calculations were done KDE analysis allowed ArcMap to be used to compare raster outputs resulting in a series of correlation matrices.

Key Findings

The initial research question involved following the methodology of previous papers with the hope of confirming that betweenness centrality has a strong correlation with retail density – however in Cambridge this didn't seem to be the case. The correlation was lower than expected, which then began to shape the rest of the findings. Using the OSM tag for amenities like restaurants, cafes, bars and pubs, it was found that densities of food and beverage (F&B) correlated higher with betweenness than retail.

Correlations were again weak for betweenness and stay densities. This could in some way be expected as betweenness as a measure of connectivity and routes of most traversals and is being compared to the densities of areas where people are pausing for some duration. However, that doesn't match up with the theory that betweenness is a good indicator of retail density. As expected stay densities correlated higher with F&B locations than retail, and there was evidence that with higher densities of stays around F&B locations there were longer durations of stays.

As the assessment went on there was a clear seasonality pattern which seems to be a symptom of Cambridge being a university town. There was a significant reduction in GPS points during the summer vacation period. By breaking down the retail and F&B locations by type, it appeared that the densities of stays did not reduce equally during this period. Clothes, and jewellery shops and bars were much more vulnerable to this reduction in footfall, whereas mainstays like hairdressers, convenience stores, cafes, and restaurants did not suffer such a great reduction in stay densities.

Value of the Research

The research demonstrated the power of using mobile location histories to verify theories about store location, and also highlighted how unique characteristics for individual towns mean there are not catch all rules for retail phenomena, and each location should be independently assessed.

The project allowed an interesting combination of academic theory and realistic commercial data sources with a mutually beneficial aim. Without access to the data provided by CBRE, location analysis using mobile GPS data would've been impossible to do at this scale.