Using Data Science to improve our understanding of UK Connectivity

A new UK national metric and a planning tool for local authorities

Edisa Livingstone
The links between spatial issues and transport outcomes are well established

- There’s a wealth of literature showing how transport outcomes are defined by spatial issues:
  - The location of new housing development influences modal splits (Headicar and Curtis, 1998)
  - The combination of urban density and transport in transit-orientated developments can reduce carbon emissions (Cervero and Murakami, 2010; Institute for Transportation and Development Policy 2017)
  - Urban density correlates with petrol use (Newman and Kenworthy, 1989)

- Yet spatial and transport planning disciplines often do not speak to one another

- In addition the UK has a strategic priority to “level up” the country
Previous Journey Time Statistics

- Prior to this work commencing the UK already had “journey time statistics”: [https://www.gov.uk/government/collections/journey-time-statistics](https://www.gov.uk/government/collections/journey-time-statistics)
- These were used in various policy documents and strategies to understand how well linked different locations were to a “basket” of key services, albeit with a focus solely on journey time itself – no weighting was given to the types of journeys the population actually makes
- The method used legacy technology – a specialist piece of software that calculated real journey times using network maps and timetables and averaged the result
- The software processing times were exceptionally long – it took over a year to produce a year’s worth of data
- As Government policy shifted, this approach was found to be no longer well aligned to the pace required or the objectives being aimed for
Access to network vs connectivity to destinations

• Let’s consider how different metrics across these two scenarios affect the score of the houses in black

Access to network 
illustrative score

5

Connectivity to destinations 
illustrative score

6

5

1

10 min frequency
30 min journey

10 min frequency
30 min journey
What is ‘Connectivity’?

• The metric measures someone’s ability to get to where they want to go.
• It accounts for different destinations, modes of travel, and travel time.
• It’s an index measure – showing relative Connectivity.
• Calculated for 181,000 Output Areas - typically made up of between 40 and 250 households and usually resident population between 100 and 625 persons:

Where people want to go:
- Shopping
- Visit people
- Work
- Education
- Entertainment

By which mode:
- Car
- Public transport
- Cycling
- Walking

Connectivity score (out of 100): 75
Connectivity tool – underlying methodology

Method overview:
1. Identify closest 'start node' to starting location.
2. Compute 1-hr reachable nodes from start.
3. Locate closest nodes to destinations.
4. Estimate travel times to destinations.
5. Calculate Connectivity score components via impedance function.
6. Calculate total Connectivity score with breakdowns by time of day, mode, purpose
7. Weight scores by English National Travel Survey data for final Connectivity score.

In terms of technology, the model is powered by cloud computing, using the Python and Rust coding languages.
Connectivity tool – underlying methodology

Accounting for destination value

• Each node has a Connectivity “value” for each mode/purpose-combination.
• Value depends on node's relevance to travel purpose (e.g., Business, Leisure).
  — Shopping, education, healthcare → Larger locations = more value
  — Visiting friends → higher relative household population = more value
  — Business → more jobs = higher value.

Where people want to go:

More technical details can be found in paper ECE/TRANS/WP.6/2024/4, with further detail available once the full analysis is published.
Accounting for travel preferences

- The England National Travel Survey (NTS) is a major household survey that gathers statistics on the travel behaviours of approximately 15,000 households.
- NTS data is used in the model to show variations in willingness for travel, by:
  - Time of day
  - Mode of transport
  - Purpose of travel
- Proximity impacts destination desirability in Connectivity score.
- Our model accounts for this using impedance functions.
Calculating the scores: recap

Connectivity scores account for many factors:
- Number of destinations, their size, the number of people and jobs
- Travel times and willingness to travel
- Modes and purposes of travel
- Road congestion

Total Connectivity score aggregates all destinations flexibly:
- Users can provide their own mode- and purpose-specific weights to obtain scores to suit their needs.
Next steps with this work

• The results from the Connectivity tool are still as yet unpublished
• When published there will be:
  a) a set of metrics / statistics that show estimates of connectivity across the country
  b) an online tool that visualises these estimates and allows users like local authorities to simulate the impact of changes to their network – this is demonstrated on the next few slides
     They will also be used to report on the progress of various key UK Government strategies

• There is the potential to do more on this, developing the method and setting international standards for how “connectivity” could/should be measured
  • Example question – How to handle changes in the score when connectivity improves? Should the connectivity score increase linearly, or should there be a non-linear relationship, e.g. to indicate a point beyond which additional connections or services do not add as much additional value?
Connectivity tool demo
Questions?