Austin, John (2022): Developing a Methodology for identifying potential Mobility Hub locations

Final report prepared as part of a Fellowship with the Foundation for Integrated Transport, 2021/22

1. Project Overview

Project Aim

The aim of this Research Project was to develop a Methodology, which could potentially be applied throughout Great Britain, to identify potential Mobility Hub locations in the South West region of England, using geographical modelling techniques and a wide range of datasets.

However, during the research, as the Project Plan unfolded, the Project evolved somewhat in practise to become a study of what features would in practise determine where Mobility Hubs should go, and of whether a Methodology to identify and analyse these could be determined. Also considered was whether the development of such a Methodology was realistically possible under existing conditions of national datasets and, if not, then what changes might be needed to those datasets to facilitate such a development. The project ran out of time to complete the last element, namely the use of Multi-Criteria analysis to rank potential Mobility Hub locations.

Project Relationships

The project was carried out with the support of the University of Plymouth (and particularly from SOGEES – the School of Geography, Earth and Environmental Sciences there), through a Researcher / Working Partner arrangement at the University. This arrangement gave the author use of the University's research licences for ArcGIS Pro (desktop GIS software) and for Digimap (a web mapping and online data delivery service developed by the EDINA national data centre for UK academia). Support was also provided by Basemap Ltd., a supplier of digital mapping and transport data solutions, which granted access to and use of its TRACC Travel Time Analysis software. The author is very grateful to both those organisations: he also expresses particular thanks to Dr Andrew Seedhouse and Mr Shaun Lewin at the University of Plymouth.

Public Reporting of Project Findings

During the project, and in the period after, the author presented at the following Conferences and Webinars:

- Royal Geographical Society International Conference 2021, 2nd September 2021, London. '*Coworking spaces in relation to Public Transport location: experience from the UK and lessons for potential Mobility Hubs'*
- Landor Conferences: *Mobility Hubs 2023*, 17th May 2023, London. '*Data issues around a methodology for identifying where potential mobility hubs should be located'*
- Transport East: *Roundtable on Mobility Hubs*, organised by University of Hertfordshire, 26th September 2023. *'Data issues around a methodology for identifying where potential mobility hubs should be located'*

2. Foundation Stones – defining what a Mobility Hub is and what it is not

A considerable element of the early part of the Research consisted of laying down the foundation of what was meant by the term 'Mobility Hub' and considering what features a Mobility Hub might contain. That helped to determine the Research needed to identify potential Mobility Hub Locations.

What is a Mobility Hub

The concept of Mobility Hubs was first developed in the UK by Peter Warman and John Austin from 2003 until 2015, as 'MobiHubs'. An article by John Austin in *Local Transport Today* in July 2021 gives a brief outline of the history of the concept and its rationale[1]. A proposition in the concept as developed by Austin and Warman[2] is that Geography and Networks change only slowly over time, with an inherent stickiness, so that key individual travel corridors

[1] Mobility Hubs – a transport planning concept whose time has come, *Local Transport Today, issue 828, 27th July 2021*

[2] Unpublished research reports for Plymouth City Council and Watford Borough Council (2004 and 2008)

remain important and enable potential locations for Mobility Hubs to be identified. This concept was tested by referencing bus networks over time between the 1960s and the early 2000s.

By enhancing the 'sustainability-enabling' features of locations which already have a concentration of community facilities and services, and which are inherently the centre of geographic networks, Mobility Hubs can facilitate a lifestyle in which sustainable travel is a significant element.

A Mobility Hub is essentially a clearly visible, user-friendly and specifically-designed local point where different means of collective transport (public transport and shared transport) come together and which can be conveniently accessed by various means, including sustainable means such as walking and cycling. Mobility Hubs should be prominent enough for them to be seen by potential users as clear gateways to a wider public transport network.

The concept of Mobility Hubs is diverse in its features, but it is fundamentally geographic, relating to the concepts of proximity, access, location, and networks. The concept applies not only to Urban and Suburban locations, but also to Rural situations, although the emphasis is different in each. For instance, in an Urban setting Mobility Hubs relate to the 15-minute city concept which focuses on a concentration of local facilities, Mobility Hubs thereby enabling straightforward access onward to larger facilities further afield.

MaaS (Mobility as a Service) can be considered as the digital mirror of Mobility Hub networks as MaaS provides a multimodal payment and ticketing platform for accessing travel across such networks.

What are the characteristics of a Mobility Hub, what does it do?

A feature of Mobility Hubs, as in the Public Transport focused research work of Austin and Warman, is that a strong sense of place and some economic activity are both needed in order to make Mobility Hubs viable. As the concept of Mobility Hubs has developed, the importance of certain particular community features within or adjacent to Mobility Hubs has also begun to be recognised. These features could not be described as mandatory for a Mobility Hub but have become more common: they include community social and service facilities, Work Hubs, and also Parcel Collection Points.

What is in a Mobility Hub

The term Mobility Hub is now also being used for urban locations and infrastructure which bring together different facilities that are focused primarily on the needs of car drivers (e.g. car parking and EV charging): as used by the Car Park provider APCOA in its 'Urban Hub' or 'Urban Mobility Hub' concept: see https://www.urban-hubs.com/uk/. However, in this FIT research project the 'Mobility Hub' concept is linked closely to public transport[3], Although not forming part of this project research as such it is envisioned in the research that Mobility Hubs and networks of such would have the following features:

- **The design of the Mobility Hub network uses Geographical features and methods.** Connectivity, the Spatial Distribution of Population and Services, and Graph Theory - relating to Nodes and Links - are at the core of the Location-determinants of Mobility Hubs
- **The network of Mobility Hubs is hierarchical**, and one which matches / represents a Transport Hierarchy
- Mobility Hubs are located on **Trunk Public Transport Corridors**
- Mobility Hubs have well-designed **Printed / Fixed Information** as a key Characteristic, and this information extends out to the immediate surrounding area and to the links between modes
- **When implemented the Mobility Hub network would feature Digitalisation heavily:** not only the digitalisation of Information, but also Purchase, Choice-Selection, and (where available) Operational Control
- The Mobility Hub network **integrates with both walking and cycling modes**
- The Mobility Hub network includes **other supporting place-based infrastructure**
- The Mobility Hub network would have **a sense of community 'ownership'**, with some measure of local control and governance
- The Mobility Hub network would allow for **flexible transport services.** However, these may be shared occupancy services, e.g. taxibuses

[3] As does the related Future Mobility Hubs concept developed by ARUP and Go-Ahead Group: see https://issuu.com/news-across-the-group/docs/mobility_hubs_-_final_report_2021

- Mobility Hubs should be designed to **ease transfer from the 'First Mile' and to the 'Last Mile'**
- Mobility Hubs are consistent with the **Link & Ride concept** of out-of-town access points which enable linkage between private cars or active travel modes to and from longer-distance or inter-urban public transport[4]
- Mobility Hubs can be planned in connection with the **development of Garden Villages, Garden Towns and New Communities**

3. Defining the Dataset of potential Mobility Hub locations

The first part of the Research was to define the dataset of potential Mobility Hub locations, from which actual locations for Mobility Hubs might be chosen. It was decided that Mobility Hubs had to be within the boundary of a concentration of buildings, so it was considered that the best way of defining this was to say that Mobility Hubs should be within Built-up Areas (BUAs).

The definition of a Built-up Area

This is an official geospatial concept used in England – other concepts exist for other parts of the UK. It has tight definitions: just because a group of adjacent buildings exists it does not mean that government statistics regard this as a Built-up Area.

The key characteristics of Mobility Hubs implied by the Public Transport-focussed definition

Another determinant of potential locations for a Mobility Hub related to the features that a Mobility Hub might have. The features listed above imply that Mobility Hubs would or could have the following characteristics:

Essential:

- Mobility Hubs must be close to or at a NaPTAN (National Public Transport Access Node). A NaPTAN is any point at which the public transport network is accessed by a passenger, and therefore includes not only bus stops but also railway stations and ferry terminals.

Preferable

- The Mobility Hub would be on a trunk Public Transport corridor
- The Mobility Hub would have good walking access
- The Mobility Hub would have good cycling Access

Optional

- The Mobility Hub could also be a co-working space. See Cost Action CA18214 '*The geography of New Working Spaces and the impact on the periphery*' at https://new-working-spaces.eu/ for European research relating to the location of Co-Working spaces.
- The Mobility Hub might have parcel collection / delivery, so its location would have geographical characteristics that make it attractive for Parcel Locker companies

4. The study area and definition of Datasets used

The study area for the project was the South-West Region of England. This is defined as the Local Transport Authority (County Council or Unitary Authority) areas of Cornwall, Devon, Plymouth, Torbay, BCP (Bournemouth Christchurch and Poole), Dorset, Somerset, Bath & North East Somerset, North Somerset, Bristol, South Gloucestershire, Gloucestershire, Wiltshire and Swindon.[5]

The base data consisted of 45,337 NaPTAN points. These would be grouped so as to permit a (smaller) database of potential Mobility Hub locations. These NaPTANs were downloaded from the publicly-available NaPTAN database provided by the DfT. They were then uploaded into TRACC (a commercially-available software programme developed and owned by Basemap), using Basemap's DataCutter tool, and into ArcGIS Pro.

[4] See G Parkhurst's work at https://uwe-repository.worktribe.com/output/1095774/a-longer-range-strategy-for-car-bus-interchange-the-link-and-ride-concept

[5] These were the CCs/UAs at the time the project was undertaken. CCs/UAs for the South West region have changed since.

A considerable amount of screening had to be undertaken on the NaPTANs (e.g. removing NaPTANs that represented an 'Area' - e.g. a Demand Responsive Transport area - rather than a Point).

Public Transport routes and their timetables were obtained for 2021 Q4, from Basemap's TRACC system but although their use in the research was mapped out the project ran out of time for them to actually be applied to individual Potential Mobility Hub locations.

Digimap data was also used to establish what economic activity features were within the vicinity of potential Mobility Hub locations.

For all three software programmes the process of defining which datasets to download and then analyse was quite detailed and time-consuming.

5. Location Methodology

Overview

The (screened) NaPTANs were imported into ArcGIS Pro and then they were filtered against BUAs to produce a dataset of NaPTANs that were the elements of potential Mobility Hub locations.

This section of the Report goes into quite a lot of detail in places to illustrate the importance both of having a very systematic approach if one is going to be able to develop a methodology that can be applied universally, and also the difficulties in developing that approach.

Importing data into ArcGIS Pro – NaPTANs

- Overview of the data

  NaPTAN data can be obtained either from the DfT / BODS data system, which is publicly available (without charge) or from a supplier who uses the data in its proprietary packages (e.g. Basemap which supplies NaPTAN data for use in its TRACC package). NaPTAN data has lots of errors in it and therefore to aid error checking it made sense to have the data in as rich a form as possible (a maximum number of fields) in order to be able to more easily spot errors: the DfT / BODS format meets this requirement while the Basemap data has many fields omitted. However, I needed to have the data in a form that Basemap supplies as I wanted to be able to use it in the TRACC package to analyse schedules: I also needed to ensure that I had the NaPTAN records as used by Basemap in order to run TRACC.

- Cleaning the data

  The NaPTAN data first had to be cleaned before it could be imported. Part of this process involved the removal of 'DRT area' NaPTANs. I considered it unlikely that DRT (Demand-Responsive Transport) areas would be the location of Mobility Hubs: if an area that has a Built-up Area within it ended up at some point being served only by 'DRT' bus services I would expect that there would be at least one fixed-point NaPTAN within the BUA. So these 'DRT area' NaPTANs were removed from the list of NaPTANs before NaPTANs were loaded into ArcGIS Pro.

- Ordering the data prior to importing it.

  I decided that NaPTANs should be arranged in Alphabetical Order {of Locality Name (including Qualifier, if it exists) + : + Common Name} so that it would be easy to spot discrepancies or errors before loading into ArCGIS Pro. There were **45, 243 NaPTANs** loaded for all Local Authorities in the South-West (excluding 'DRT area' NapTANs) plus National NaPTANS (rail, air, ferry, light rail, metro / Preserved Railways) that I judged to be in South -West (I made a first attempt and then checked these against Eastings / Northings).

- Importing the data

  I imported the NaPTAN data as Points: I needed to ensure that all the NaPTANs that I was using were capable of being analysed by TRACC: therefore they must be held by TRACC also (though not necessarily in the form that ArcGIS Pro uses)

  Sub-Steps involved the process of adding the CSV files of NaPTANs to the Map, which then created 'Standalone Tables', 'Display XY Data', changing X Field to 'Easting', changing Y Field to 'Northing', changing the 'Co-ordinate System' to 'British_National_Grid' and creating an 'Output Feature Class'.

Importing data into ArcGIS Pro – Built-up Areas

The Built-up Area (BUA) concept has been described above. However, some NaPTANs that were outside BUAs had to be allowed as potential Mobility Hub locations because in practise their specific features made them suitable as Mobility Hubs. All of the following types of sites might in theory be able to function as Mobility Hubs, but might be outside a BUA. Railway Stations, Park & Ride sites, Superstores, large school sites and Business Parks are all types of locations which might well be outside a BUA. [6]

While these Built-up Area boundaries can be downloaded from **Living Atlas** for viewing on a map in ArcGIS PRO this is just as an Image File which can be displayed on a Map. It cannot be analysed (e.g. for comparing with NaPTANs**).** Instead, it must be downloaded as a full SHAPE file (going to another source for this data).

I had problems downloading the file from https://data.gov.uk (and instead ended up using https://geoportal.statistics.gov.uk/datasets/built-up-areas-december-2011-boundaries-v2/explore?location=52.950000%2C-2.000000%2C6.60/ downloaded as a SHAPE file

Use of Spatial Join

- ArcGIS Pro's Spatial Join process was used in accounting for potential Mobility Hub locations that aren't in Built up Areas
- I also realised that NaPTANS can be JUST OUTSIDE the boundary of the BUA, so I needed to fix a level of distance which is the maximum distance outside the BUA Boundary that was acceptable: 100 metres seemed appropriate.
- I also had to develop a process for calculating whether or not a Point (e.g. a NAPTAN) is within an Area (e.g. any BUA)

  Having downloaded the BUA data (as a ZIP file of c. 8 different files), I put that into a Folder there called Built-up_Areas_(December_2011)_Boundaries_V2 (1). But in order to use this in an ArcGIS Pro Workflow ArcGIS Pro had to recognise where it is. So I had to create that Folder in the Catalog View, under Project/Folders

  After I had done that I could run the ArcGIS Pro Tool called **Spatial Join** (accessed from Analysis / Tools)

  I set a distance factor as 100 metres (to allow points to fall up to 100 metres outside the BUA and still be regarded as valid). It worked, and resulted in BUAs coloured in (indicating that they were real data and not just images) and a set of points that met the 'within a BUA' criterion (I had to turn off the display of 'All Points' in order to see this second set).

  Out of the **45,243** NaPTANs loaded it gave **32,555** as within BUAs,

- I downloaded the 'within BUA' set of NaPTANs and added in legitimate 'other' NapTANs, such as Pilning Rail Station (which is outside a BUA)

  I used the Table to Excel conversion tool within ArcGIS Pro. "How to Export and attribute table from ArcGIS Pro to Microsoft Excel" is described in https://support.esri.com/en/technical-article/000021825

  By following the instructions given there (and running the Tool) I created a file called NaPTANGroupsnoDRTareas08_XYT_InBUA_TableToExcel.xlsx, that was in the folder 'OneDrive/Documents/ArcGIS/Projects/FIT – Mobility Hubs in South West – NEW"

  This showed only the NaPTANs that have been included, but showed their record number according to the original loading of NaPTANs. I was able to identify those NaPTANs which hadn't been included.

  To locate legitimate 'Other' NapTANs I located any NaPTAN that was outside a BUA that had the following words in its name:
  - Morrisons
  - Asda

[6] Note that BUAs appear to be rather subjective (e.g. why is the area around Severn View Services (M48) shown as a BUA but the areas round Sedgemoor Services and Membury Services are not?)

- Aldi
- Lidl
- Tesco
- Sainsburys
- Waitrose
- Superstore
- Business Park
- Enterprise Park
- Technology Park
- Technology Centre
- Research Park
- Science Park
- Park & Ride (or P&R, Park and Ride)
- Trago Mills (**this required some local knowledge**)

In addition, all National Rail Stations were included. Airports are already treated by OPCS as Built-up Areas

And I also watched for large schools in sizeable towns that were outside the BUA (including Bath Spa University) that had the potential to be Community Hubs. Again, this **required some local knowledge.**

It was noted that **Information on Park & Ride sites on the web is not maintained** (Poorly maintained) websites (at the time the project was done) were at http://www.parkandride.net/ and https://en.wikipedia.org/wiki/Park_and_ride_bus_services_in_the_United_Kingdom

And any NAPTAN that was the 'pair' of an already-included NAPTAN was also included.

In addition, the following new communities exist, which were not yet designated BUAs at the time of the Research Project, but where there are NaPTANs

- Cranbrook (Devon) – identified as Cranbrook (Devon) **Locality** in NaPTAN
- Newcourt (Devon) – identified by **Manual examination**. Within Countess Wear Locality

Further planned or partially-open **new communities**, some of which will already have NaPTANs, but some of which may not yet have NaPTANs identified, will exist in the South West. In a fully operating PMHL system these must be identified in conjunction with the relevant Sub-National Transport Bodies – i.e. **Peninsula Transport** and **Western Gateway.**

This process resulted in an increase of **292** from **32,555** ***'Inside BUA'*** NaPTANs to **32,847** ***'Legitimate'*** NaPTANs (see above)

Clustering of NaPTANs to produce PMHLs

The process was to then form Clusters of NaPTANs, and also identify NaPTANs not clustered. This produced a total of 'Potential Mobility Hub' locations (PMHLs) (centre of clusters + isolated NaPTANs inside BUAs).

There were various (and alternative) ArcGIS Pro procedures that were used to perform this clustering

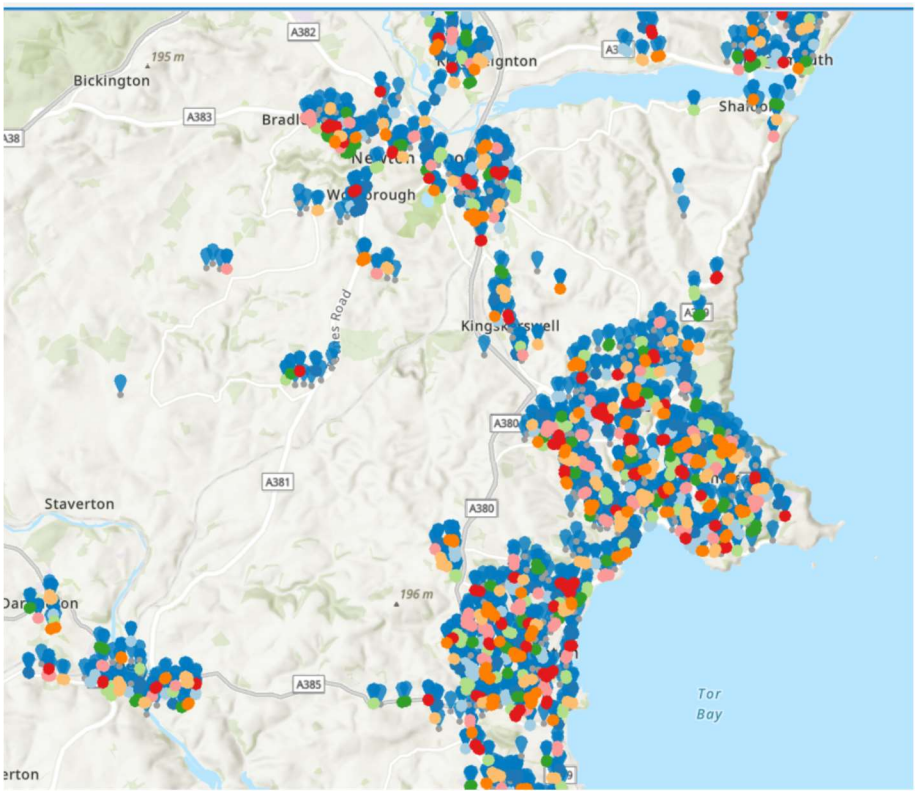
Self-adjusting and **Multi-scale** produced very strange results (huge, spread-out clusters in urban areas).

I had to use DBSCAN (Defined distance) based on a distance of 50 metres: using 100 metres gave clusters in town centres that were too large. However, using 50 metres also produced a lot of 'Noise' (i.e. Points that were excluded: perhaps bus stops on opposite sides of road were too far away from each other). I tried both 60 metres and 75 metres and these had the effect of stretching out a bus station to stops quite a way outside the bus station boundary (e.g. Breton Side Bus Station in Plymouth 'stretched' to north of Breton Side road). HOWEVER, with a Mean Centre weighted by the number of stops in a particular area this 'pulled' the CENTRE of the cluster very much closer to the Bus Station.

75 metres produced:

- **11,642** Clusters using Self-adjusting (DBSCAN – minimum size of Cluster: 2, Distance: **75 metres**)
    - **HOWEVER, Note that 'places' that have only one NaPTAN will be EXCLUDED since the minimum number of features in a Cluster is 1.**
    - **Therefore I want both the CLUSTERS and the NOISE (individual points not in a Cluster)**
- With **6,541** Points that were not in a Cluster.
- i.e. **18,183** points on which to perform Multi-Criteria Analysis

Clusters of NaPTANS, and unclustered individual NaPTANs, within Built-Up Areas, in the Torbay area. Clustered using ArcGIS Pro's DBSCAN Algorithm with Defined Distance of 75 metres



Data and map produced using ArcGISPro, licence of University of Plymouth

A note on Importing data into ArcGIS Pro – general procedures discovered and adopted

The following basic concepts were discovered and adopted during the process of importing data into ArcGIS Pro.

- Projection of data:

    Latitude and Longitude is not good for working out distances (because of the earth's curvature). So 'Projecting' means using Eastings / Northings (or the equivalent national standard in whatever country whose data I am using). Such systems pretend that the earth is flat. *Use Eastings & Northings (and British National Grid) rather than Latitude and Longitude) – this prevents distortion from Curvature of the Earth and allows distances to be measured*

- Use data built into ArcGIS Pro

    A considerable amount of data is already built into ArcGIS through its **Living Atlas** tool included within the Portal. Useful data for this project included the following:

Data	Where in Living Atlas? (i.e. Category)	Coverage
*Built-up Areas (December 2011) Boundaries V2	Administrative	All England and Wales (BUAs do not exist in Scotland)
Ward Boundaries	Administrative	

Scoring of PMHLs: Importing other data to do Multi-Criteria Analysis on PMHLs

The next step was to analyse and score the PMHLs by Key Features.

However, this was not actually undertaken because the project ran out of time.

The Key Features which would have been used to score PMHLs are as follows:

- Public Transport service level. There are various ways of defining, e.g.
    - Frequency / Number of departures within a time-band
    - Number of large communities directly served from the PMHL. This might be particularly relevant for railway stations, including railway stations that are some distance away from much economic activity.
- Resident Population
- Features of Economic Activity
    - Note that some places exhibiting features of economic activity have particular potential for 'Community Hubs' (which could feature Co-Working spaces and / or Parcel Delivery Points). Such places include:
        - Grocery Stores
        - Schools
        - Leisure / Sport Centres
        - Health facilities
        - Office / Business Parks
        - Motorway Service Areas
        - Existing major transport hubs (e.g. Railway Stations).

Calculate PT characteristics for each PMHL. Assign a SCORE to each PMHL based on these PT Characteristics

Various methodologies were constructed to do this, but the project ran out of time to actually test and implement them. These methodologies considered the relative advantages of alternative software tools, e.g. regarding processing speed.

6. Taking Forward in the South West

The Research has the potential to be taken forward to incorporate insights from Bus Service Improvement Plans for Local Transport Authorities in the South West. Mobility Hubs are currently mentioned in several Bus Service Improvement Plans for Local Transport Authorities in the South West region.

7. Lessons Learned

It Is unfortunate thar the project ran out of time before all the stages of the work could be completed. However, some key lessons from the Projects are the following:

Research Approach

The Researcher must have a very good understanding of the various software to be used in the Project before the Project commences. This must include not only the processes that the software uses but the elements and quality of the data used in those processes.

Sufficient time must be allowed in the Project Plan to try alternative Procedures within the Research and to allow for Procedures not working as expected.

Official Data used in the Analysis

Data for many Economic Activity features is not consistent or comprehensive, and may be misleading. The standards and processes for collecting such national data for local Economic Activity features should be reviewed.

Car Park Data (where collected well) appears a good proxy for several Economic Activity features. However, there is no such reliable database of Car Park locations that is freely available without charge. The DfT should take a lead in reviewing this.

Certain aspects of NaPTAN data, which is an essential element for identifying potential Mobility Hub locations, are unreliable. The DfT should consider where it should focus efforts in getting and keeping NaPTAN data correct.

Exploitation of locations as potential Mobility Hubs

Potential Interchange nodes (e.g. Car Parking at rail stations and at Motorway Service Areas) have inconsistent pricing and time-length rules that act against interchange. These commercial operating features should be reviewed in the light of a possible national strategy for developing Mobility Hubs.