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Moving Forwards: Improving Strategic Transport Planning in Wales

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Moving Forwards: Improving Strategic Transport Planning in Wales

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Summary

- This report considers what the Welsh Government might learn from the theory and practice of strategic transport planning internationally. The focus is on four key questions:
    - What are the key issues that need to be taken into account in order to provide effective strategic transport planning?
    - Are there comparator countries or regions that Wales might learn from?
    - Are there models or assessment tools that Wales could consider adopting?
    - What scope is there for making use of new technology and new data sources?

- Traditionally transport planning has been reactive or 'problem-oriented'. More recently pro-active, 'objectives-led' approaches have emerged. Both can help frame strategic transport planning, but successful plans are those which: have a clear vision of what the plan is trying to achieve; are capable of being both proactive and reactive; contain a mix of policy instruments; and make appropriate use of forecasting models and options appraisal.

- International examples of best practice appear where a government is able to coordinate transport planning with other aspect of planning such as infrastructure, land use, environment, health, education and social services; and where there is a consistent approach to funding and a broad range of finance, often from devolved sources. The most useful comparators are likely to be at the city-region scale, particularly for the Cardiff/South East Wales City Region (e.g. Copenhagen, in terms of integrated public transport planning).

- Transport models and assessment tools are crucial in helping decision-makers to understand existing transport usage and to predict the impact of policy interventions. There is a range of transport models at the national scale, from relatively complex disaggregate approaches (which can cost several million pounds to set-up and run) to simpler aggregate approaches.

- Open data and open source software, in conjunction with new crowd sourced data and developments in cloud computing, are providing the materials to revolutionise analytical transport planning and to potentially reduce its costs. Although some in-roads have been made, this is a new area and the potential benefits are yet to be fully realised. Initiatives are underway to advance the state-of-the-art.

Introduction

The Minister for Economy, Science and Technology commissioned the Public Policy Institute of Wales to provide expert advice on approaches to strategic transport planning. The Minister asked for advice on four main questions:

1. What are the key issues that need to be taken into account in order to provide effective strategic transport planning in Wales?
2. What lessons can Wales learn from approaches to strategic transport planning in comparator countries?
3. What models and transport methods will be most useful to strategic transport planning in Wales?
4. How can Wales make best use of new technology (including GPS) and new data sources (including 'big data') to improve strategic transport planning?

The analysis in this report is based on a review of policy documents and the relevant academic and non-academic literature, with a focus on identifying best practice.

Key Issues in Effective Strategic Transport Planning

Effective strategic transport planning has a number of core features; it should:

- focus on strategy, and not let tactics dominate;
- be capable of being pro-active as well as re-active;
- be a circular rather than a linear process;
- identify the appropriate mix of policy instruments rather than having a predilection to a particular policy; and
- be supported by an appropriate evidence base and by analytical tools (such as forecasting models and assessment methods) that can support effective decision making.

These features are considered below, with the exception of forecasting models and assessment methods which are considered in the relevant section below.

Strategy, tactics and operations

It is important to distinguish initially between the strategic, tactical and operations aspects of transport planning (the STO model championed in transport by van de Velde (1999)). The

strategic (or long-term) function answers the question: what do we want to do? This involves outlining the overall vision for the transport plan and its high level objectives. The tactical (or medium-term) function answers the question: how do we do it? This focuses on determining the policy instruments that will deliver the transport plan. It is not unusual for this stage to dominate the plan – in essence the plan becomes about delivering the policy instruments. This is often the case where the plan is focussed on physical improvements such as building new roads, upgrading the rail network or introducing a new urban public transport system. The operations (or short-term) function is about marshalling the resources to deliver the plan (and can encourage a revisiting of the plan in light of resource constraints).

Pro-active and re-active planning

There are two broad approaches to transport planning: problem-oriented and objectives-led (May, 1997). It is worth noting that these are not mutually exclusive or competing and should be seen as inter-related. Indeed, recent transport planning in Wales has contained examples of both approaches.

Problem-oriented planning

Problem-oriented planning is typically re-active. It is the more traditional, bottom-up approach, often associated with local or devolved planning processes (Adams & Schmuecker, 2005). The problem-oriented approach is also usually associated with the promotion of mobility.

The starting point is the identification of 'problems' in the transport system that need to be addressed, around which the plan is then developed. It is typified by Thomson (1977) who, when reflecting on the London transport system in the 1970s, identified seven facets of the urban transportation problem: (1) Traffic movement, (2) Accidents, (3) Peak hour crowding on buses and trains, (4) Off-peak inadequacy of buses and trains, (5) Difficulties for pedestrians, (6) Environmental impact and (7) Parking difficulties.

The risk with this approach is that, in developing a plan around addressing problems, piecemeal or short-term 'solutions' emerge. Some argue that the focus on increasing mobility is an example of this. Although in modern history increased mobility (defined as the ease of moving) has usually been correlated with increasing prosperity, this does not have to be the case[1] and there is an argument that greater weight should be placed on accessibility

1 To illustrate this issue an interesting (but somewhat extreme) parallel might be drawn between Wales and Singapore, with Wales having substantially higher mobility per person but Singapore having substantially higher GDP per person, although given its island state nature there are clearly greater physical barriers to internal mobility in Singapore than Wales, whilst there are also factors in Singapore's economic success (including the

(defined as the ease of reaching); although this is contested (Ferreira et al., 2012). There can be a 'mobility transition' where increased movements lead to congestion and hence reduced accessibility (Preston, 2007; Zelinsky, 1971). One solution to such a situation would be to provide more transport capacity to reduce congestion – the so called predict and provide approach. However, the problem with such an approach as that induced traffic will lead to the capacity quickly filling-up again. Where the investment is in roads/private transport, reductions in public transport demand and services can make the situation worse – the so-called Downs-Thomson paradox (see also Mogridge, 1990).

Objectives-led planning

Objectives-led planning is a more recent approach and is often seen as being pro-active. It is based around a vision statement and a series of high level objectives. An example is the 1998 New Approach to Appraisal (NATA) and its so called EASIE objectives: (1) Economy, (2) Accessibility, (3) Safety, (4) Integration and (5) Environment (Price, 1997). This approach is identified with top-down planning and high-level jurisdictions (national or supra-national such as the European Commission). It is often associated with an emphasis on accessibility, and more naturally lends itself to integration with other policy areas, with transport seen as facilitating sustainable access to, for example, healthcare, employment, the countryside and tourist sites. This is consistent with the view of transport as a derived demand – in the main people travel in order to engage in various forms of socio-economic activity[2].

Planning as a circular process

Effective long-term transport planning is a circular process in which monitoring is undertaken to determine how the system is operating with respect to key success indicators relating to the economy, society and the environment. In combination with public consultation and changing budgetary constraints, the outcomes in terms of system performance are fed back to inform the vision and objectives and the appraisal process of the instruments used to deliver the plan. Albeit with slightly different terminology, this is the approach to long-term transportation planning adopted by the US Department of Transportation (Weiner & Rikin, 2005) and the ROAMEF (Rationale, Objectives, Appraisal, Monitoring, Evaluation, Feedback) advocated by the HM Treasury Green and Magenta Books.

tax regime) which would be difficult to replicate elsewhere. Nonetheless, it is clear that high levels of mobility do not necessarily correlate with economic success.

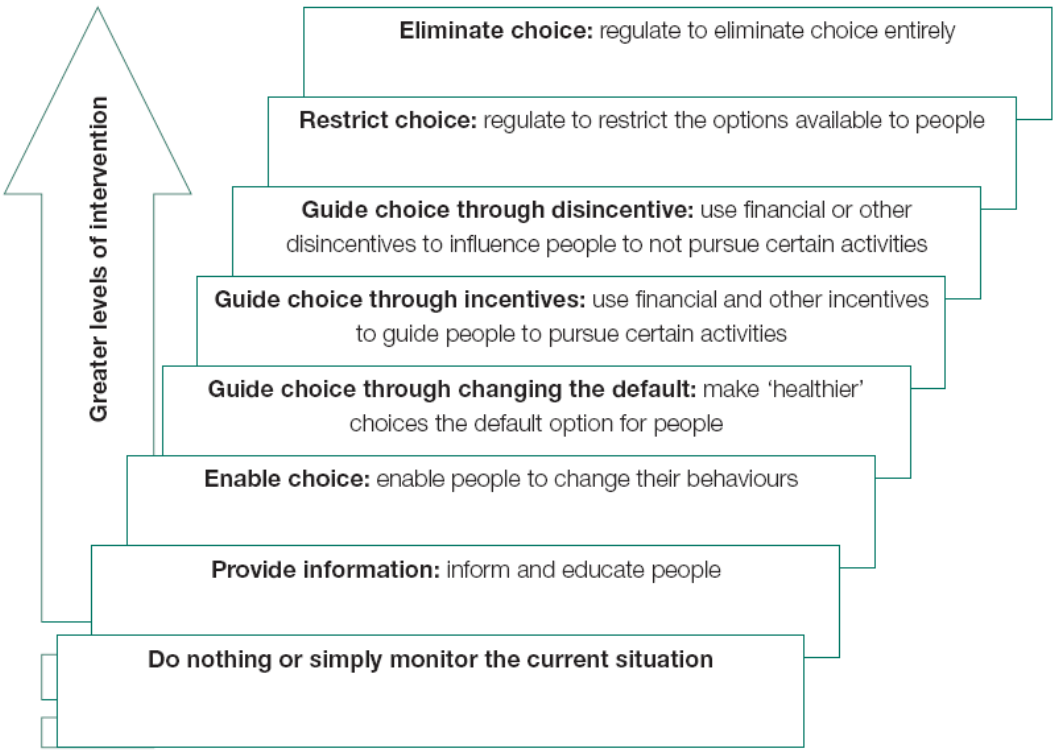
2 This is contested by proponents of the new mobility paradigm who argue that a significant element of travel is for travel' sake (Sheller and Urry, 2006).

Appropriate mix of policy instruments

It can often be the case that transport plans are dominated by infrastructure projects. In fact the range of policy instruments available is much broader. The Institute for Transport Studies at Leeds University have developed the Knowledgebase on Sustainable Urban Land-Use and Transportation (KONSULT[3]), which catalogues the range of interventions available. Infrastructure measures are one of six broad groupings, with 64 sub-categories in total. The other five measures are land use measures (6 sub-categories), attitudinal and behavioural measures (7 sub-categories), infrastructure management (18 sub-categories), information provision (10 sub-categories) and pricing (8 sub-categories). Given the large number of potential policy instruments, the challenge is to design an 'optimal' package, in which measures reinforce each other and help overcome constraints related to public acceptability and funding (May et al., 2005).

Overall, strategic planning might be seen as focusing on achieving the 'holy grail' of integrated and sustainable transport by progressing up the ladder of integration (Preston, 2012) and by using the ladder of interventions to achieve this – see Figures 1 and 2 below.

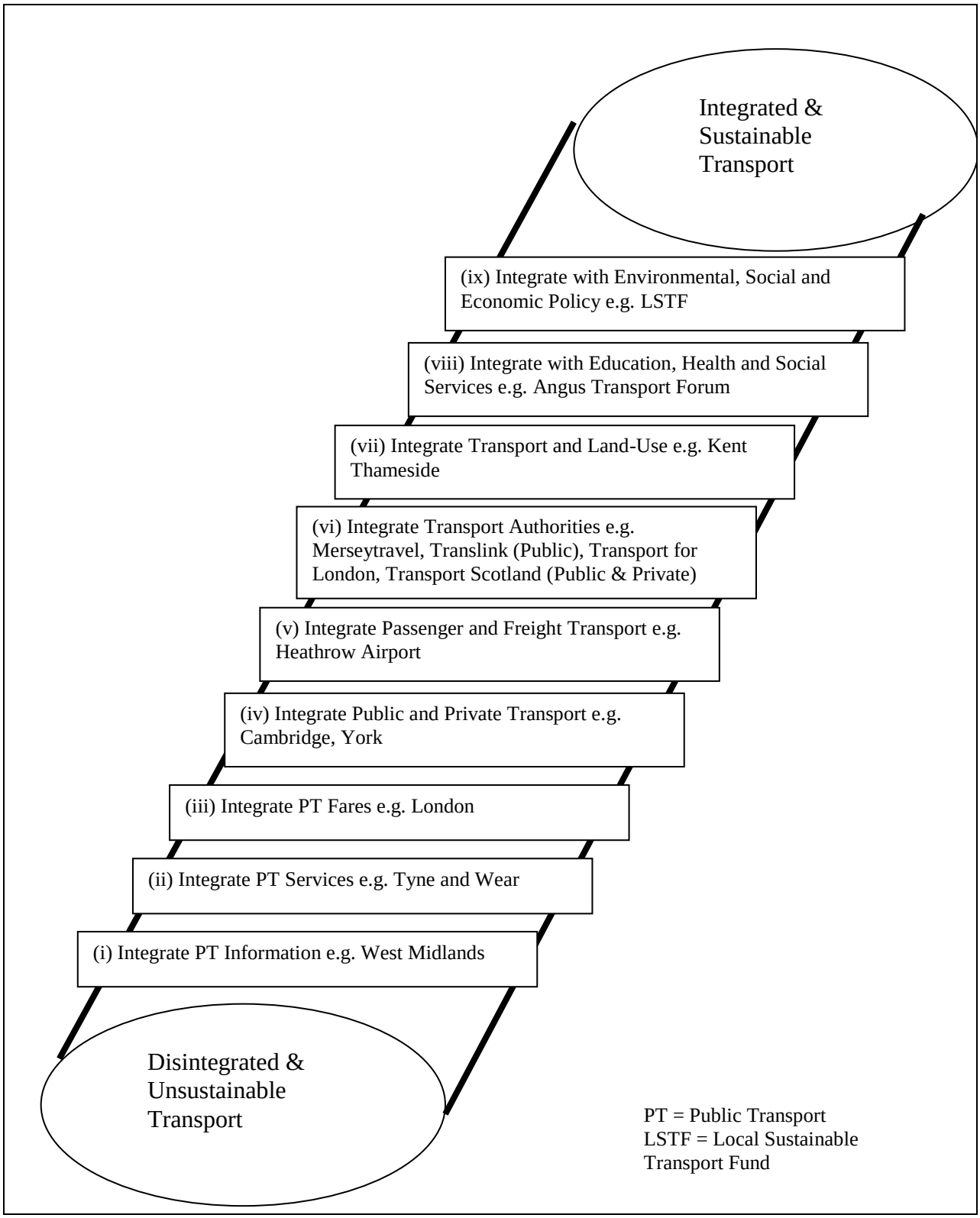
Figure 1: The Ladder of Interventions



Source: DfT, 2011, in Preston, 2012.

[3] http://www.konsult.leeds.ac.uk/

F**igure 2: The Ladders of Integration.** Note this indicates possible exemplars in the UK.



Source: Preston, 2012.

Lessons from Strategic Planning in Other Countries

International comparisons of transport planning can be usefully grouped under three main headings: infrastructure planning, national transport planning and urban transport planning. In what follows, the literature on each is considered in turn, with an emphasis on the works of leading experts in these three domains.

Marshall (2012, 2013) has undertaken comprehensive reviews of infrastructure planning, particularly with reference to Europe. His analysis suggests that spatial approaches, like the evidence-based Spatial Planning Reports (Raumordnungsverfahren - RoV) in Germany, used to offer good examples of best practice, but have lost their value as infrastructure utilities have been privatised[4]. He contrasts England's National Policy Statements, which are sectoral-based, unfavourably with Scotland's National Planning Framework, which is spatially based; and he posits that Wales is positioned between the two extremes. The Netherlands is highlighted as representing best practice in terms of National Key Decisions, with this planning approach enabling the strategic development of Schiphol Airport and Europort, Rotterdam as international transport hubs.

In terms of national transport planning, Banister (2002) compares the UK with France, Germany, the Netherlands and the US. He notes a dominant engineering led approach, with the US and UK the most market-led. The most successful national transport plans are those that are integrated with other areas of planning. For example, the Netherlands is seen as having the clearest integration of transport, land-use and environmental policy and planning. This is exemplified by the ABC planning schema which prioritises land-use developments at public transport hubs, although the success of this policy has been questioned by some (Schwanen et al., 2004).

Hull (2011) compares the UK (and London) with Denmark (Copenhagen), Germany (Freiburg), the Netherlands (Amsterdam) and Sweden (Malmo). She highlights the importance of the clarity (and integration) of national rules, the need for structures (and funding sources) to support integrated problem solving at the local level, the coordination of public and private interaction, the engagement with civil society and the monitoring of the effectiveness of interventions. It might be argued that many of these are currently missing in strategic transport planning in Wales.

[4] Marshall sees this as part of a neo-liberal process of hollowing-out of the state as evidenced by the weakening of national spatial strategies in Denmark, France and the Netherlands. He notes that there has been some subsequent filling-in such as the UK's National Infrastructure Plan (2010), the Wales Infrastructure Investment Plan (2012) and its Project Pipeline update (2014). This process of filling-in has also been associated with devolution (Smyth, 2003).

Evidence with respect to urban transport planning is provided by the work of Rye (2004). As shown by Table 1, he compares Edinburgh with 11 other cities, all but one of which are in Europe. By qualitative assessment (the summation of the pluses and minuses given in the final column of Table 2) he concludes that best practice is best exemplified by Stockholm, followed by Copenhagen and Zurich. He identifies four key success factors: integrated ticketing; funding; existence of a regional body and the comprehensive tendering of public transport operations.

Table 1: Comparative Assessment of Urban Transport

	Madrid	Barcelona	Jonkoping/ Sunsdsvall	Berlin-Brandenburg	Copenhagen	Helsinki	Stockholm	London	Munich	Zurich	Vancouver	NET +
Regional Body	+++	++	+++	+++	++	+++	+++	+++	++	++	++	28
Political Consensus		--	+++	+++		+++	+++	--		+++	--	9
Public Support			+	++			++	++		++		9
Political Champion		++					++	+++				7
Central Govt Steer					++	++						4
Policy in place for many years					++	++	++		++	++		10
Investment in services/ infrastructure	+++	+++	++	+	+++	+++	+++	++	+++	+++	+++	29
Tendering of operations	+	+	+++	++	+++	+++	+++	+++				19
Parking restraint policy					++		++		++	++	+	9
Land-use transport integration	+	+			+++		+++		+++	+++	++	16
Low Fares	+++	+++	++	++			++	+ (bus)				13
Integrated ticketing	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	++	32
NET +	14	13	17	16	20	19	28	15	15	20	8	185

+++ = very important factor ++ = moderately important factor + = slightly important factor -- = factor that works against success

Source: Rye, 2004.

Rye argues that Edinburgh would require a doubling of capital funding and a 20% increase in revenue funding if it was to match European best practice. He also notes that network ticketing prices in the best practice cities were at below half the then current levels in Edinburgh. The most successful systems were based on some form of quality contract for integrated public transport plus parking restraint and reallocation of road space. In marked contrast to Edinburgh, 10 cities had seen increasing Public Transport volumes but only three had seen mode shift. Subsequent work on policy transfer has highlighted England and Switzerland as representing best practice with respect to behavioural change instruments

(Rye et al., 2011), particularly instruments associated with the smarter choices agenda (Cairns et al., 2008)[5].

One common thread to these comparative reviews is the importance of finance and funding, with the ability to raise funds at the local level a critical success factor. There are a number of routes by which this can be done. Hull (op cit.) notes the role of local income and sales taxes, whilst Banister (op cit.) highlights the role of an employer tax in France (Versement Transport), hypothecated fuel taxes in German and land value/development gains taxes in the US. However, any of these fiscal measures would require primary legislation for Wales. On the other hand there are some measures available that can already be used including road user charges, workplace parking levies, community infrastructure levies and developer contributions.

The world leaders in transport planning are those that best integrate transport with infrastructure planning and other connected policy areas (land-use, environment, education, health, social services). This requires Government, at all levels, to provide an important co-ordinating role. There is no obvious single exemplar for Wales at the nation level – instead the emphasis might be on picking and mixing from the range of best practice identified. At the city level, Copenhagen might provide a useful comparator for Cardiff and South East Wales. Copenhagen's five finger suburban rail network has some parallels with the Valleys rail network. Copenhagen's expansion across the Oresund to increase interconnections with Malmo could also provide lessons for the impact of improvements to the Severn Crossings and increased interconnections with the Bristol City Region. Copenhagen's comprehensively tendered bus system, integrated public transport system and transit oriented development might also be beneficially replicated in the Cardiff City Region (Knowles, 2012).

Models and Methods for Strategic Transport Planning

The key methodological tools underpinning the strategic transport planning process are demand forecasting models. These are mathematical models that are used to forecast the impact of transport strategies, and assess the extent to which different strategies meet policy objectives and solve transport problems. Our emphasis here is on demand forecasting models but we will also briefly discuss assessment methods.

[5] Such measures include personal, workplace, school and station travel plans and marketing measures to encourage active travel (walking and cycling), public transport and carsharing/liftsharing.

Demand forecasting models

Strategic forecasting models may be developed at a variety of spatial scales but for the purposes of this paper we focus on national transport models. As Banister (op cit.) observes these models may be developed at varying degrees of sophistication ranging from complex models, based on a family of behavioural models calibrated, validated and applied using disaggregate (individual or household level) data, to sketch planning tools, based on extrapolation and elasticities and aggregate zonal data, as widely used, for example, in France.

The more sophisticated modes can provide more accurate forecasts, but as models become more complex they also become more costly, with the result that there is a trade-off between the increased accuracy of the forecasts and the increases in cost. The set-up costs of the most complex models would run into several million pounds, with the on-going operating and maintenance costs also being substantial. If use is made of existing data, the operating and maintenance costs can be much lower. For all types of models, increasing availability of big data and open innovation offer the prospect of reducing costs.[6]

For the purposes of this review, three models have been considered:

1) the Dutch National Transport Model, which is at the most complex end of the spectrum,
2) the UK's National Transport Model, which is significantly simpler, but still reasonably sophisticated, and
3) the Infrastructure Transitions Research Consortium's Transport Demand and Capacity Assessment model, which is at the least complex end of the spectrum.

Dutch National Transport Model

The Dutch National Transport Model (Landelijk Model Systeem – LMS) has been established since 1986 (see Daly & Sillaparcharn, 2008; Van der Hoorn & Van Wee, 2013), and is owned by the Centre for Transport and Navigation which is part of Rijkwaterstaat (Public Works Department). The LMS is based on an annual travel survey of around 50,000 individuals and is supplemented by four regional models. It has been used extensively to

[6] It is worth noting that strategic transport models can assist in attracting funding for transport projects. For example, Transport for South Hampshire (now Solent Transport) commissioned consultants MVA (now Systra) to develop a Sub-Regional Transport Model (SRTM) to cover a conurbation with a population in excess of 1.1 million. Development and operating costs to date have been almost £2 million but the SRTM was used to successfully bid for funding from the Local Sustainable Transport Fund and the Better Bus Area Fund to a value of £22.3 million and has been viewed as a highly cost effective investment by the Local Authorities involved.

examine infrastructure provision (particularly new roads), infrastructure management and road pricing. Some of its key features are that it:

- Models travel behaviour in 1,500 zones, based on individual socio-economic characteristics and accessibility measures;
- Splits the population into 18 age, 2 gender, 6 activity, 10 income, 6 education and 2 student groups giving 25,920 sub-groups overall;
- Accounts for demographic and social change; and
- Incorporates modelling of car purchase and scrappage rates as a function of technological developments and other changes in supply and demand characteristics.

As Daly and Sillaparcharn (op cit.) note, the Dutch National Transport Model has inspired a number of imitators (most notably in Norway, Italy and Sweden). They also note that successfully developing such National Transport Models requires initial momentum, validation (through backcasting), adaptibility/extendibility and a firm behavioural basis for the underlying model(s).

UK National Transport Model

The history of National Transport Modelling has been more problematic in the UK than the Netherlands. There has been a long, and relatively successful, history of modelling car ownership and vehicle use. However, attempts to build modelling capacity that covered all modes and gave spatial detail in terms of travel destinations and routes chosen initially faltered[7]. It was only in the late 1990s that the UK Government decided to develop a National Transport Model (NTM) based on existing data such as the National Travel Survey (NTS). However, the sample size of the NTS was (and still is) insufficient to provide detailed spatial forecasts[8]. As a result a largely aggregate approach was developed based on 'artificial' geography.

Given the lack of spatiality in the NTM, specific spatial models have been developed to examine long distance traffic, with a specific focus on new high speed lines and motorway upgrades (see Fox et al., 2012); such models have been developed for HS2 and were used to forecast usage of the Channel Tunnel.

[7] The Regional Highway Traffic Model (RHTM) was developed to overcome these spatial shortcomings around 1978. However, validation found that it failed to accurately predict traffic changes, in part because intra-zonal travel (which it was not designed to forecast) dominated inter-zonal but also because of data mismatches, particularly between roadside interviews and household interviews.

[8] From 2013, the NTS applied to England only and involved approximately 16,000 individuals in 7,000 households.

ITRC Transport Capacity and Demand Assessment Model

Although the NTM has some simplifying features it still requires overnight computer runs to generate outputs. As a result, as part of the Infrastructure Transitions Research Consortium (ITRC)[9], the University of Southampton has developed a Transport Capacity and Demand Assessment Model (TCDAM) that covers the whole of Great Britain (including representation of the 22 Local Authorities in Wales). It is multimodal, covering road, rail, seaports and airport, and provides annual forecasts from 2011 to 2100. It has short run times, is based on open source data and is compatible with a system of systems approach.

A feature of the ITRC modelling suite is the distinction between external factors (scenarios) and internal factors (strategies), Scenarios are related to energy prices (from the Department of Energy and Climate Change), demographics (provided by the University of Leeds, with Welsh growth forecast to be broadly in line with Great Britain, but with losses in some areas such as Flintshire) and macro-economic forecasts (provided by the University of Cambridge). Strategies are related to three main policy areas: demand management, capacity provision and technological provision.

Some examples of the outputs from the ITRC model are annexed.

Assessment methods

In this section we have focused on a range of transport models but it should be recognised that these are not ends in themselves but are used to assess different planning interventions. There are two broad approaches to assessment. Cost-benefit analysis, widely applied in the UK (typically using the Department for Transport's web based Transport Analysis Guidance (WebTAG[10])), is a quantitative approach in which the impacts (positive and negative) of different interventions are monetised and a benefit:cost ratio is generated. Multi-criteria analysis (MCA) can be a more qualitative approach (of which the Welsh Government's WelTAG could be seen as a version) which uses a mixture of monetary, physical and semantic units of account. Banister (op cit.) notes that MCA is widely used in countries such as the Netherlands and Germany (see also Grant-Muller et al., 2001). There have been a number of international reviews of transport appraisal (e.g. Morisugi and Hayashi (2000), DfT (2007), International Transport Forum (2001)), with the WebTAG system widely acknowledged as being world leading. By contrast, WelTAG seems light on quantification and does not provide value for money assessments. It seems to lack both a sound scientific basis and an underlying evidence base.

[9] http://www.itrc.org.uk/
[10] https://www.gov.uk/transport-analysis-guidance-webtag

The Use of New Technology and Data Sources

Data has been a major constraint in strategic transport planning and has been a point of failure in some attempts to make advances (such as the RHTM in the 1970s). However, there have been a number of recent advances, under the banner of big data, that offer the promise of richer transport data sets in the future (see also POST, 2014). Traditional/static sources of data include inductive loops, Automatic Number Plate Recognition (ANPR) cameras and microwave sensors, whilst bluetooth sensors have also been used in recent work (Lees-Miller et al., 2013). New probe (also referred to as mobile) data are provided by enabled wireless networks, GPS and smart phones.

Data fusion and filtering techniques, used in conjunction with microsimulation traffic model, can provide real time visualisation of traffic on arterials and at key junctions (see Box et al., 2014 for an application in Southampton). Visualisation of data (including in three dimensions) has been enhanced by developments in Geographical Information Systems, the take-up of which has been facilitated by open access source code and related developments in what has become known as neo-geography (Hudson-Smith et al., 2009). This includes the use of crowd sourced social media data (such as Twitter) to provide a rich picture of traffic conditions.

There are also possibilities of combining the automated data described above with manually collected data from traffic and travel surveys and counts, the Census Journey to Work data, MoT car usage data etc. An example is the work of Martin et al. (2009). Using Census data on night-time resident populations, in combination with data on employment, education, travel etc., they have developed a 24/7 representation of the population. The application to Southampton shows how the suburbs are most heavily populated at night but lose their population to major employment and education centres in the morning peak. A feature of the Southampton area is the relatively dispersed nature of the daytime population albeit with some concentrations in the city centre and the docks area, and around the major University and hospital sites.

Similar initiatives are being championed by bodies such as the Highways Agency and Transport for London. There was a time when the Welsh Office, in combination with the Highways Agency, was an important player in Intelligent Transport Systems, with the M4 a test bed for advanced traffic management. This comparative advantage appears to have been lost with devolution, with the Department for Transport concentrating its data collection and modelling on England. However, the Transport Systems Catapult, and its proposed

National Transport System Modelling Facility, offers an opportunity to revive work in this area, building on the modelling work (based on the macrosimulation model SATURN) used to examine routings for a relief road to the south of Newport. The University of Southampton is an academic partner of the Transport Systems Catapult, representing the South of England, although it is observed that the Catapult does not have regional partners for Wales or for the North West and South West of England.

Collaborations with Universities offer the prospect of advances in the areas of new technology and big data. For example, the Economic and Social Research Centre (ESRC) has established a big data network, and has initiatives on urban data (at Glasgow University) and consumer data (at the University of Leeds) that are doing work in the transport sector.

Overall, some in-roads have been made in maximising the benefits that 'big data' offer, although to date Wales has not been at the forefront of these endeavours, but this is a new area and initiatives are underway to advance the state-of-the-art. The prize is that 'big data' offer the prospect of cheaper and better transport planning models.

Conclusions

The development of strategic transport plans is necessarily an iterative process. Wales has had a first iteration of this process using a blend of problem-oriented and objectives-led approaches. A systematic application of an objectives-led approach (in which problems are defined in terms of the failure to meets outcomes) can help frame policy. However, experience from Scotland suggests that one should beware of 'objective fatigue', where successive Ministers have focused on fine-tuning the objective(s) rather than delivering the plan (Docherty et al., 2007).

Although there are few good comparators for Wales at the national level, there may be some at the City region scale (for example, Copenhagen). At both national and sub-national levels, Wales can learn from best practice in Europe and elsewhere, especially concerning funding, finance and policy integration.

Transport models, and related assessment methodologies, can assist in forecasting and appraising the outcomes of policy instruments and in designing the 'optimal' package of instruments that make up the strategic plan. Learning by doing can be an expensive way to implement a transport plan but conversely one should beware of 'paralysis by analysis' – having such an onerous assessment process that little is delivered on the ground. However, an approach that can assess, in broad terms, the value for money and other impacts of the

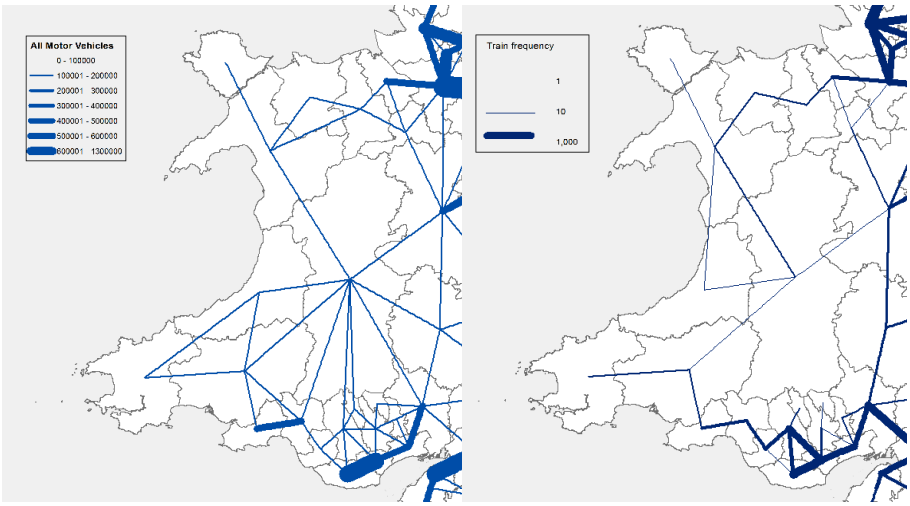
national transport systems is urgently needed, along with a more scientific approach to planning and the evidence base to underpin it.

We would argue that there are strategic modelling and appraisal tools that could be developed for Wales at relatively low cost and which could help justify the funding of transport projects. Developments in big data and open innovation can offer ways to enhance these tools. Partnerships between Government and Universities will be one way of delivering this, along with other collaborations including with the private sector and third parties such as the Transport Systems Catapult.

Annex: Sample Outputs from the ITRC TCDAM Model

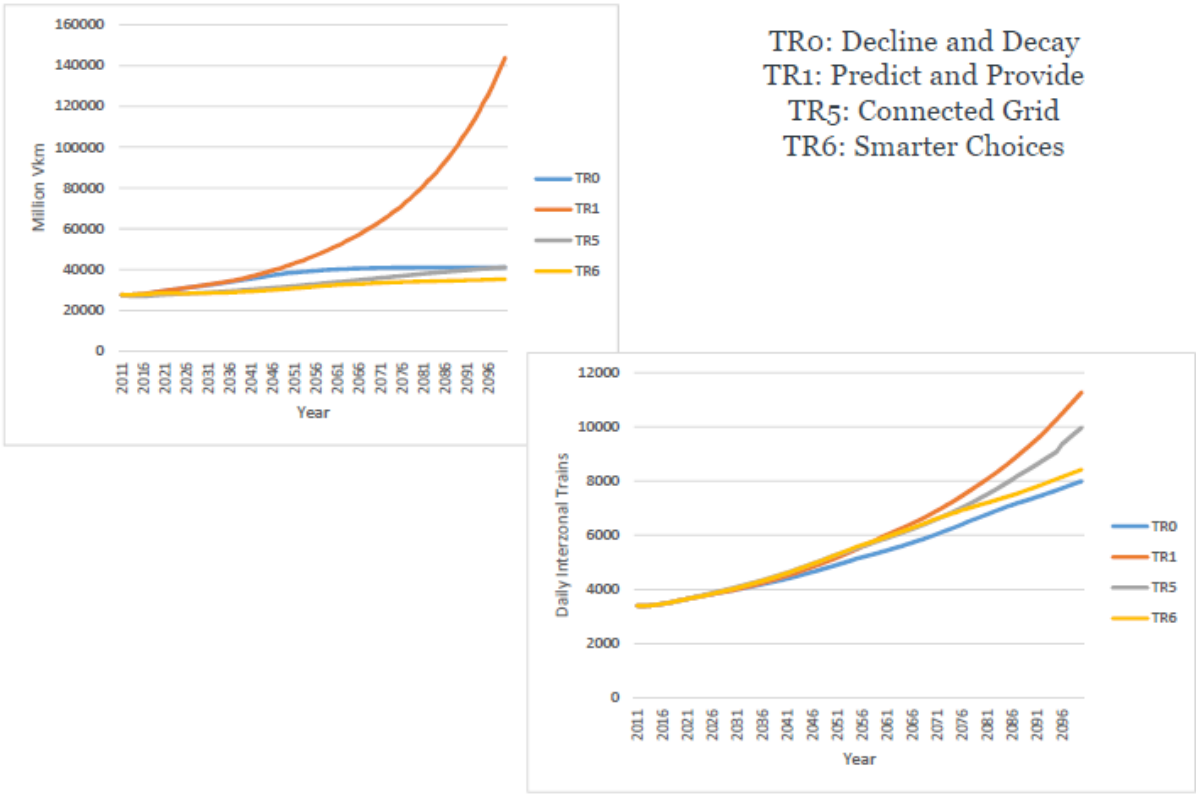
Outputs of the ITRC TCDAM

The Transport Capacity and Demand Assessment Model (TCDAM) is detailed in Blainey et al. (2012). Some of the baseline results for Wales are illustrated below. In terms of air travel, the usage of Cardiff Airport is dwarfed by Bristol (top left), whilst in terms of seaports the South Wales coast has a number of important terminals, but is dominated by Milford Haven (top right). For road transport, the network map (which is topologically transformed) highlights the greatest levels of demand in North East and South East Wales, although the Severn also appears as a major barrier to movement (bottom left). Rail movements are dominated by South East Wales but the Severn appears as less of a barrier (bottom right)



Demand Forecasts for Road and Rail Usage in Wales

Some runs of the TCDAM have been undertaken specifically for Wales and are illustrated below. For road (top left), infrastructure provision (TR1) leads to exponential growth suggesting Say's law is applying – supply is creating its own demand. Demand management (TR6) and technological promotion (TR5) can keep demand below a business as usual strategy (TR0), although there is some catch up by the end of the century. For rail (bottom right), all forms of intervention lead to higher usage than the business as usual approach, although in the second half of the century major infrastructure enhancement are required as capacity becomes fully utilised. Note for both roads and rail this analysis refers purely to Wales, demand could be constrained by bottlenecks existing over the border in England.



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