

Variable Demand Modelling – Overview

TAG Unit 2.9.1

June 2006

Department for Transport

Transport Analysis Guidance (TAG)

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1 Variable Demand Modelling – Advice Overview

1.1 Background

- 1.1.1 Any transport improvements that reduce journey times and costs will, in principle, affect the level of demand for travel. Schemes that improve travel conditions encourage travellers to make trips they did not make before the improvement, or to change to a different mode, or to travel further to different destinations. This additional demand for travel is sometimes masked by other phenomena, but mainly appears as “induced” traffic through or around the scheme.
- 1.1.2 In the past highway improvement schemes were primarily assessed by estimating the benefits on the basis of a fixed level of traffic on the network. However the extra traffic that can be induced by a scheme may add to congestion on the road network and reduce average speeds for all traffic, eroding some of the benefits of the scheme.
- 1.1.3 In congested areas, it is essential that scheme appraisal should consider the implications of this induced traffic and the complementary effect of the suppression of traffic, which arises mostly in the 'without scheme' scenario. Both effects should be considered relative to a reference case forecast of travel, which assumes that travel costs remain at the base year levels. That reference case represents the forecast growth in car travel through population and car ownership increases before allowing for the pressures on travellers to alter their travel patterns to avoid some of the increase in travel costs arising from those changes.
- 1.1.4 This TAG unit together with *An Introduction to Variable Demand Modelling* (TAG Unit 2.9.2) provide a basic understanding of variable demand modelling. More detailed advice is provided in *Variable Demand Modelling – Detailed Stages* (TAG Unit 3.10) for those undertaking appraisals. Where possible the advice develops simplified versions of current good practice. It assumes a familiarity with assignment modelling to forecast how traffic will be distributed across the road network, and describes how to estimate the likely changes in demand as travel times and costs change. Appraisal and general modelling issues are covered separately in other TAG units which describe the multi modal context in which all appraisals should now be conducted, see *Summary Advice on Modelling* (TAG Unit 2.4).
- 1.1.5 **The advice provided here reflects recent research results and suggests a minimum set of travel demand modelling requirements for road scheme appraisal in a multi-modal context.**
- 1.1.6 Any response in the demand for transport of *freight* is not considered here, as often it is sufficient to assume that total freight traffic is fixed, but susceptible to re-routing.

1.2 Scope of Advice

- 1.2.1 The advice is intended for use when assessing Trunk road schemes, local authority road schemes and the highway decongestion benefits of **major** public transport schemes. It represents a change in the Department for Transport's expectations of good practice.
- The advice replaces existing Departmental guidance on Induced Traffic Appraisal (in DMRB 12.2.2) and extends the types of scheme for which **the effects of variable demand on scheme benefits and the level of induced traffic MUST be estimated quantitatively**. The underlying principles of the advice are set out in *An Introduction to Variable Demand Modelling* (TAG Unit 2.9.2).

- The guidance defines criteria to enable analysts to decide whether the effects of variable demand seriously undermine the justification for a scheme. *VDM Preliminary Assessment Procedures* (TAG Unit 3.10.1) provides detailed guidance on those criteria.
- The **amount of detail** required in variable demand modelling should reflect the investment being assessed and the scale of its effects. *VDM Scope of the Model* (TAG Unit 3.10.2) gives details of the steps required to specify the scope of each variable demand model.
- Ensuring that the correct structure is adopted for variable demand modelling is important if the right policy conclusions are to be drawn from the model output. In order that model calculations are undertaken in a mathematically correct manner, the hierarchy of responses has to be constructed so that the sensitivity of the choices increases as the calculations proceed, with the least sensitive response placed first in the hierarchy and the most sensitive placed last. Thus, the order of the response hierarchy is governed either by knowledge of (through calibration against local data) or by assumptions about (made by drawing on previous models) the relative sensitivities of the individual responses. **In general, the choice hierarchy which the Department expects to see adopted is: change in trip frequency, choice of main mode and long time period, choice of destination, choice of short time period, and choice of route and public transport mode.** All those mechanisms and the circumstances when they are suitable are described in *VDM Key Processes* (TAG Unit 3.10.3). However, the advice does not rule out the adoption of a different choice hierarchy, providing that convincing evidence can be found from local data and circumstances.
- Most current large-scale transport demand models use a mathematical model (known as a hierarchical logit choice model) and this choice mechanism is described for mode choice, destination choice etc. and is recommended as current best practice. *VDM Key Processes* (TAG Unit 3.10.3) provides detail of those descriptions.
- Unless there are strong reasons for not doing so, the choice models should be **incremental**, predicting only the **relative** changes in trip numbers from the observed trip matrix, rather than fitted **absolute models**, which try to reflect the key details of the base trip pattern. *VDM Key Processes* (TAG Unit 3.10.3) gives more detail.
- Time of day choice (i.e. choosing whether to travel in the peak or off-peak, or at the height of the peak or in the shoulders) is potentially important. However, as its modelling is complicated and uncertain, it is recommended here only where strong differentials in cost are expected to arise between the time periods, or where peak congestion forecasts become unrealistically high. *VDM Key Processes* (TAG Unit 3.10.3) provides advice on those mechanisms.
- The sensitivity parameters that govern the strength of the choice mechanisms are difficult to calibrate to the local circumstances in the absence of extensive data. For many purposes it may be satisfactory to base them on the **illustrative values** provided in *VDM Key Processes* (TAG Unit 3.10.3), which were obtained from a review of current multi-stage demand models. **If relevant and robust locally-calibrated parameters are available** (from existing local models, for example), **they should be used**, provided the modeller is confident of their applicability and produces relevant documentation.

- Detailed justification for the parameters should be assembled particularly where they differ significantly from the relative strengths of the illustrative values. *VDM Key Processes* (TAG Unit 3.10.3) provides the appropriate detail.
 - It is essential that the demand model be subjected to “*realism tests*” to ensure that its response to changes in travel times and costs is plausible. If the responses differ from the accepted norms the advice explains how the model should be adjusted until an acceptable performance is achieved. The sensitivity of the result to the more uncertain parameter values should also be tested. *VDM Convergence Realism and Sensitivity* (TAG Unit 3.10.4) provides details of such tests.
 - Generally, more optional trips such as shopping, which tend to be off-peak, are more likely to redistribute to alternative destinations and are more sensitive to total travel costs than more obligatory peak purposes such as the journey to work.
 - The calculation must be iterated cyclically between the traffic assignment and the travel demand model(s) to obtain a stable solution. The **degree of convergence** of this iteration is very important, and needs to be stringently monitored to ensure that any uncertainty in the final result is acceptably small. *VDM Convergence Realism and Sensitivity* (TAG Unit 3.10.4) sets out appropriate convergence standards.
- 1.2.2 It is important to emphasise that this guidance is not intended as a textbook on demand modelling generally. It aims to provide the basic understanding necessary to ensure that highway scheme appraisal and strategic studies are robust against the effects of variable demand and induced traffic. **This guidance is not aimed at those who wish to construct a state-of-the-art model from scratch**, but aims to help assessors who will use appropriate modelling packages to estimate the effects of variable demand, and project managers who wish to understand the issues involved when seeking experienced expert support. Where the necessary expertise exists, this advice should not be interpreted as discouraging the adoption of more sophisticated or more detailed modelling techniques.
- 1.2.3 The TAG units that make up the new advice on variable demand do not replace Traffic Appraisal in Urban Areas (DMRB 12.2.1) nor the Traffic Appraisal Manual (DMRB 12.1.1) in the Design Manual for Roads and Bridges. Both provide relevant advice on detailed techniques and the need to relate the modelling approach to the objectives of the schemes to be assessed.
- 1.2.4 Reporting must demonstrate in a clear, consistent and balanced way that the reported models make effective use of data, are fit for purpose, and provide a sound basis for the estimation of the key economic, environmental and social impacts of projects. In particular, reporting must give details of: the source of the demand model parameters; the extent of local demand modelling calibration and validation; and results of the sensitivity and realism tests undertaken. In most cases, reporting on variable demand modelling should be integrated with the reporting requirements for assignment, as set out in Appendices A to C of DMRB 12.2.1.

1.3 Implementation

- 1.3.1 The advice should be used forthwith on all trunk road schemes unless a stage has been reached at which in the opinion of the overseeing organisation, its use would result in an unacceptable delay to progress. It is recommended for use for other types of scheme, and will be required for these schemes where public finance is sought and the application will be considered after the 1st June 2007.

2 Further Information

The following documents provide information that follows on directly from the key topics covered in this TAG Unit.

For information on:	See:	Link:
An overview of modelling issues	<i>Summary Advice on Modelling</i>	TAG Unit 2.4
Detailed advice on transport modelling	<i>Modelling</i>	TAG Unit 3.1
Detailed advice on variable demand modelling	<i>Variable Demand Modelling - Detailed Stages</i>	TAG Unit 3.10

3 References

Department of Environment Transport and the Regions *Design Manual For Roads and Bridges, Volume 12.*

4 Document Provenance

This Transport Analysis Guidance (TAG) Unit reflects the consultation comments received on the Executive overview of the draft Variable Demand Modelling Advice produced by TRL in June 2003.

Technical queries and comments on this TAG Unit should be referred to:

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