Bonneagar Iompair Éireann
Transport Infrastructure Ireland

TII Publications

GE PE DN CC OP AM RE

Project Appraisal Guidelines Unit 5.0 – Scoping of Transport Modelling

PE-PAG-02014
December 2023

PE Planning & Evaluation

Technical

About TII

Transport Infrastructure Ireland (TII) is responsible for managing and improving the country's national road and light rail networks.

About TII Publications

TII maintains an online suite of technical publications, which is managed through the TII Publications website. The contents of TII Publications is clearly split into 'Standards' and 'Technical' documentation. All documentation for implementation on TII schemes is collectively referred to as TII Publications (Standards), and all other documentation within the system is collectively referred to as TII Publications (Technical).

Document Attributes

Each document within TII Publications has a range of attributes associated with it, which allows for efficient access and retrieval of the document from the website. These attributes are also contained on the inside cover of each current document, for reference.

TII Publication Title	*Project Appraisal Guidelines Unit 5.0 – Scoping of Transport Modelling*
TII Publication Number	*PE-PAG-02014*

Activity	*Planning & Evaluation (PE)*		**Document Set**	*Technical*
Stream	*Project Appraisal Guidelines (PAG)*		**Publication Date**	*December 2023*
Document Number	*02014*		**Historical Reference**	**PAG Unit 5.0**

TII Publications Website

This document is part of the TII publications system all of which is available free of charge at http://www.tiipublications.ie. For more information on the TII Publications system or to access further TII Publications documentation, please refer to the TII Publications website.

TII Authorisation and Contact Details

This document has been authorised by the Director of Professional Services, Transport Infrastructure Ireland. For any further guidance on the TII Publications system, please contact the following:

Contact: Standards and Research Section, Transport Infrastructure Ireland
Postal Address: Parkgate Business Centre, Parkgate Street, Dublin 8, D08 DK10
Telephone: +353 1 646 3600
Email: infoPUBS@tii.ie

TII Publications

Activity:	Planning & Evaluation (PE)
Stream:	Project Appraisal Guidelines (PAG)
TII Publication Title:	Project Appraisal Guidelines Unit 5.0 – Scoping of Transport Modelling
TII Publication Number:	PE-PAG-02014
Publication Date:	December 2023
Set:	Technical

Contents Table

Updates to TII Publications resulting in changes to

Project Appraisal Guidelines Unit 5.0 – Scoping of Transport Modelling PE-PAG-02014

Date: December 2023

Page No:

Section No:

Amendment Details:

Update to provide more guidance on the consideration of and approach to the development of Variable Demand Models. Text updates to align with the DoT Transport Appraisal Framework (June 2023).

Contents Table

1. Introduction

1.1 Overview

This PAG Unit specifies the process involved in the preparation of a transport model for use in the appraisal of transport infrastructure. It assumes the reader will be aware of transport modelling principles and will have an adequate level of professional expertise.

The guidance introduces the conceptual role of transport models and their application and outlines the underlying assumptions, software packages and data considerations involved in four classifications of transport model, namely:

- Simple Models
- Microsimulation Models
- Assignment Models
- Variable Demand Models

The importance of defining the scope of a modelling exercise in order to choose the correct model is highlighted. An overview of the remaining sub-units within PAG Unit 5 is also provided, allowing the reader to understand the role of each unit within the transport modelling process.

1.2 Transport Modelling Scoping

The requirement for modelling and the appropriate approach should be identified and set out in the appraisal plan section of the Project / Programme Outline Document (POD) developed as part of the Phase 0 (Scope & Pre-Appraisal) stage of the project. Further guidance on the development of a POD at Phase 0 is provided in *PAG Unit 2.1 – Project / Programme Outline Document.*

The requirements for modelling may evolve during the course of the project, as more data becomes available or as different questions need to be answered as the project moves closer to the design stage. Different types of models may be required at different stages or an existing model could be reused and refined. The full TII Project Lifecycle (comprising Phases 0 to 7) is shown in Figure 5.0.1, different types of models maybe required at different stages of the project lifecycle depending on scale, complexity and geographical location of the interventions that need to be considered.

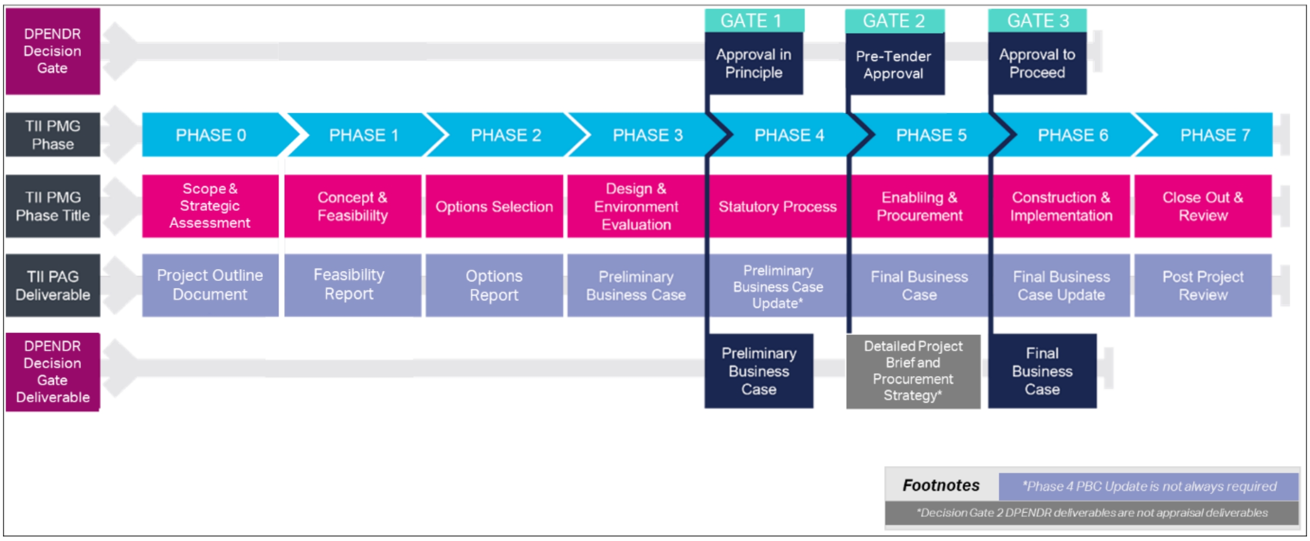

Figure 5.0.1 TII Project Lifecycle

1.3 Transport Modelling Hierarchy

A transport model is a computer-based representation of the movement of people and goods (trips) around a transport network potentially operating at various levels of detail and scale. Transport models can cover large geographical regions all the way down to single junctions. They are intended to provide an indication of how trips will respond, over time, to changes in that transport network. These changes may be due to growth in the number of trips or due to changes in the transport network itself: for instance large scale schemes such as the building of new roads or public transport infrastructure; to minor schemes such as junction improvements.

Therefore, there is a wide variety of scheme types that may be subject to assessment. It is not appropriate to adopt a ‘one size fits all’ approach when it comes to developing transport models to assess this range of schemes. Furthermore the geographical location of the scheme will also impact on the decision on the type of modelling that is appropriate.

A range of bespoke transport modelling software tools are available. The model types considered fall into four levels of transport modelling functionality, and are as follows:

- **Simple Models** - which reflect traffic volumes on the basis of link flows. Such models do not attempt any route assignment, and hence are only applicable for small networks where no change in the distribution (re-routing) of traffic flows will result from a proposed intervention. Simple models tend to comprise isolated junction models or linked junction models. They can also comprise micro-simulation models where there are no route choice algorithms built into the model.
- **Microsimulation Models** - which simulate individual driver behaviour. Such models are suitable for complex interchanges and congested urban areas where the interaction of vehicles and their individual behaviour is an important part of the modelling assessment.
- **Assignment Models** - which allocate demand (trip) matrices through traffic and public transport networks, thereby replicating route choice by vehicles and service choice by passenger for each origin-destination pair. The assignment models referred to in this guidance are of the static type whereby the trip matrix is assumed to remain constant (in terms of level and pattern) throughout the modelled period. Dynamic assignment models permit the trip matrix to vary in terms of both level and pattern of flow during the modelled period.

- **Variable Demand Models** - which replicate demand responses where they might be expected as a result of an intervention. The demand responses considered here comprise changes in trip rates, choice of destination and travel mode. Major interventions within dense urban areas which have competing modes of transport, (e.g. on the approach to or within Metropolitan areas), are likely to warrant a variable demand modelling approach.

Figure 5.0.2 provides a reflection of the hierarchy of transport modelling. Data exchange should operate between different levels of modelling to promote analytical consistency.

For the most part, transport models developed in support of major transport infrastructure schemes either form tests within a Variable Demand Model or involve the development of a bespoke Assignment Model. Therefore, the focus of this guidance is on Variable Demand Models and Assignment Models. Microsimulation modelling is not referred to explicitly within this Unit, however many of the principles of the Unit are equally applicable irrespective of model type.

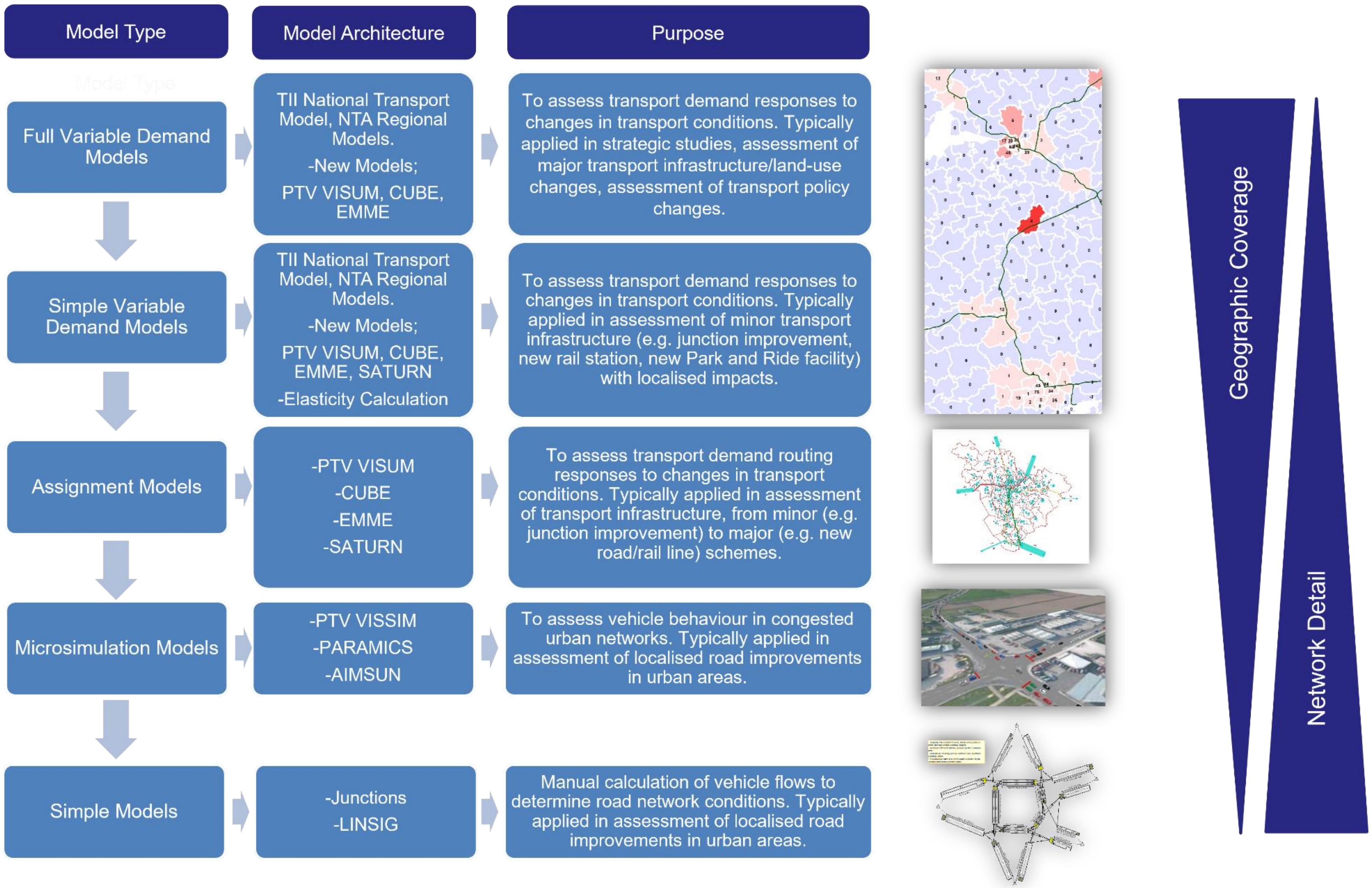

Figure 5.0.2 **Modelling Hierarchy**

1.4 The Role of Transport Models

1.4.1 Use of Transport Models

A transport model can serve several functions. It can help determine what the most appropriate option for a scheme is, aid the design of a scheme, and it can provide the necessary outputs for the economic, financial, social, safety and environmental appraisal of a scheme. As such, a transport model can provide the evidence base enabling a project to be appraised in accordance with the criteria set out in the Department of Transport's (DoT) Transport Appraisal Framework (TAF) for Transport Projects and Programmes, as set out in Table 5.0.1.

In addition to the criteria and description of those criteria set out in TAF, a further column has been added to describe how a transport model could be used to inform each criterion.

Table 5.0.1 Transport Appraisal Framework – Project Appraisal Criteria

Criteria	TAF Description	Transport Model Application
Transport User Benefits and Other Economic Impacts	User benefits, such as reduced journey times or improved journey quality, but may include wider impacts on the local or national economy ,e.g., from better connectivity.	Models can provide journey time and cost saving estimates by each zone pair which can then be converted to monetary savings over long-term using TUBA and also be used in calculating wider economic benefits when used in combination with land-use models or agglomeration tools.
Accessibility	A scheme may have a positive or negative impact on the ability of individuals or households to access key services in the areas of education, healthcare, or employment, or may have other accessibility-related impacts such as facilitating international connectivity or enabling access of freight traffic to industrial locations in a more efficient or effective manner.	Models can provide estimates of changes in accessibility between different land-uses and key services for different modes of transport. The impact upon different cohorts of people can then be assessed to understand the social impacts of proposed transport interventions.
Social	The impacts of an intervention may have important distributional consequences. Impacts can specifically affect the wellbeing of those in designated cohorts of society or those living in geographically remote areas.	
Land Use	Scheme impacts may relate to the quality of the public realm, or may critically relate to spatial planning objectives, for example by facilitating land-use plans through transport connections to lands zoned for a specific purpose. This criterion also relates to the integration of a scheme proposal with other existing or forthcoming transport infrastructure or services.	Models can be used to assess a wide range of different land-use proposals to understand and inform the interaction with transport proposal. Various different scenario and sensitivity tests can be undertaken to help understand the impact/interaction with other committed or planned transport proposal.

Criteria	TAF Description	Transport Model Application
Safety	The project or programme may have an impact on the number of transport-related injuries or fatalities within the study area or have an impact on other safety considerations, e.g. by creating a safer setting for transport network users.	Models can provide forecast traffic volumes on a highway network arising from a transport intervention which can then be used in combination with other inputs to the COBALT – Ireland software programme to quantity the change in collisions and derive monetised safety impacts of schemes.
Climate Change	Emissions from the transport sector are one of the most significant contributors to Irish emissions of Greenhouse Gases (GHGs) and Greenhouse Gas equivalents (GHGes). Furthermore, transport infrastructure can be vulnerable to the impacts of climate change and may require investment to mitigate against those impacts.	Models can provide forecast traffic volumes on a highway network to be used in combination with other data to calculate impacts on the changes in emissions (e.g. in combination with vehicle fleet data and emissions rates to calculate road-sourced emission using TII's Road Emissions Model).
Local Environment	The transport system significantly impacts the local environment. Transport activity produces harmful pollutants, generates noise and vibrations that disturb communities and that can cause damage to local infrastructure and buildings. An intervention may seek to mitigate these impacts through changing transport modes or moving activity further from communities or infrastructure	Models can provide forecast traffic volumes on a highway network to be used in combination with other data to calculate impacts on air quality, noise and vibration, visual impacts etc.

In order to forecast what will happen over time, it is necessary for the transport model to make assumptions about how people will react to growth and/or network changes. A transport model can therefore never be precise about the future and should never be presented as such.

One of the benefits of using a transport model is that it can ensure that a variety of schemes, or scheme options, are considered on a consistent basis. An objective of these guidelines is to ensure that all transport scheme evaluations and appraisals follow the principles discussed herein and therefore enable TII to consider schemes on a like for like basis.

1.4.2 Proportionality

The creation of a transport model can be costly and time consuming process particularly in terms of the collection and processing of the necessary data. Thus, it is sensible to consider what form or scale that model should take at an early stage and to make sure that the level of investment in the transport model is proportionate.

Furthermore, it is important that the scope for using existing models and data is carefully considered. Careful consideration should be given, before resources are committed to data collection and model building, to the nature of the options that are likely to be tested and the required level of detail of the analyses. In short, the model must be appropriate and unnecessary complexity should be avoided.

Finally, evidence should be of suitable quality to inform the decision making process, compiled using proportionate resources. The risks of using disproportionate time and resources can be minimised by specifying the model scope correctly from the outset. This should be explored and considered via the appraisal plan section of the Phase 0 POD deliverable.

2. Requirements of a Transport Model

A transport model needs to be capable of reflecting, to an acceptable degree, the existing transport situation as observed on the ground.

Additionally, the model needs to have a mechanism whereby it can reflect projected growth in the numbers of trips being made and also planned changes in transport infrastructure which occur over time.

In considering the scope of the transport model, the following basic questions need to be addressed:

- What is the nature of the scheme to be assessed?
- Where is the scheme located and in what sort of environment?
- What is the likely area of influence of the scheme?
- What modes of transport are likely to be affected by the scheme?
- What outputs are required from the modelling process?
- What are the main modelling risks (for example, the risk of errors in inputs) and how can these risks be mitigated?

The answers to these questions should lead towards a decision as to whether a model is required and, if so, what form it should take.

3. Defining the Scope of a Modelling Exercise

3.1 Type of Model

The nature of the scheme and the type of options that may need to be considered, (e.g. junction improvement versus multi-modal transport solution) will provide the first indication of what type of modelling is required, although it will also be important to consider the location and the prevailing environment. As an example, a major junction improvement in a rural area with a sparse road network is likely to only require an isolated junction model. The same kind of scheme in a dense urban environment may cause significant rerouting effects and potentially, impact on other modes.

As a consequence, a variable demand model and/or assignment model test may be required. If the appraisal is only required to capture rerouting, then an assignment model is sufficient. However, if the appraisal also requires the capture of newly generated trips or changes in mode share and trip distribution, then a variable demand model may be required.

Induced demand refers to increased travel which is undertaken in response to an improvement in the transport network and is usually measured by the change in distance travelled. If induced demand effects are relevant to a particular scheme, the type of model which should be adopted will depend on whether the increase in travel demand is related to rerouting (in which case an assignment model is most appropriate) or a change in trip levels (in which case a variable demand model is most appropriate).

Table 5.0.2 in Appendix A summarises the scope of the four levels of models identified. Table 5.0.3 in Appendix A focuses on Variable Demand Modelling in greater detail and scopes four alternative approaches for undertaking a Variable Demand Modelling assessment. The intention is for both tables to assist the practitioner with adopting an assessment method which is in proportion to the scheme or test being appraised.

3.2 Variable Demand Modelling Approaches

There are two critical considerations to be taken into account in relation to Variable Demand Modelling (VDM); firstly establishing the need for VDM and secondly, if it is required, which VDM approach should be adopted. As a minimum, scheme promoters should provide evidence that the need for VDM has been assessed.

3.2.1 Establishing the need for a VDM

There are three important conditions which should be considered when determining if a Variable Demand Model should be adopted;

1. Whether the scheme has significant impacts spatially and on travel costs
2. Whether congestion or crowding exist on the network in the forecast years in the absence of the scheme (without congestion or crowding there will no peak spreading or suppressed demand effects)
3. Whether the scheme will have an appreciable effect on inducing demand, either through the generation of new trips, trip redistribution, mode shift or time shift, in the corridor(s) containing the scheme. Care should be taken in this regard, as whilst induced demand may have little impact on the operating conditions of a new scheme there could be substantial changes in operating conditions on transport links leading to and from the scheme.

Prior application of the model will inform whether the second condition is met. Potential approaches for determining if the first and third conditions are met include (note this is not an exhaustive list - a bespoke approach could be applied for each project to reflects local/unique issues);

- Undertaking an initial test in an existing Variable Demand Model;
- Undertaking initial tests using both a fixed matrix assignment approach and a VDM approach and comparing impacts;
- Undertaking a non-modelling exercise to determine impacts (e.g. GIS assessment to determine affected catchments or use of Census/Spatial data to determine travel patterns and how these might be logically affected by a scheme)

Having determined which of the three conditions exist, the following potential approaches are recommended;

- If none of the conditions apply, a Variable Demand Model is not required and an Assignment model approach will suffice
- If the scheme has an appreciable impact on induced demand but does not meet the other conditions, then a simplistic application of variable demand modelling will suffice (see guidance on Elasticity Approach and Simple VDM in Section 3.2.2)
- If the scheme has significant impacts spatially and on travel costs and/or congestion or crowding exist on the network in the forecast years in the absence of the scheme (the scheme may or may not additionally have an appreciable impact on induced demand), then a full Variable Demand Model approach should be adopted (see guidance on Existing National/Regional VDM (e.g. TII NTpM / NTA RMS) and New Local VDM in Section 3.2.2)

It should also be considered whether a VDM approach is capable of simulating the full range of effects of a scheme on demand. A transport modelling approach will only be able to forecast changes in demand resulting from peoples' rational choices based on economic considerations of travel time and cost.

It will not be able to account for peoples' changing perceptions in relation to travel and their awareness of new schemes (and their perceived advantages and disadvantages relative to other travel choices) gained through local knowledge and marketing. In this situation, the VDM exercise could be used to forecast changes in demand based on rational economic responses with a separate exercise undertaken to account for the impact of other factors.

3.2.2 Establishing which VDM Approach should be Adopted

If it is determined that a VDM is required, there are a number of alternative approaches which could be adopted. These are described in detail in Table 5.0.3 in Appendix A but can be summarised as follows;

- **Elasticity Approach –** use of published elasticities to forecast the change in demand on a particular transport link resulting from an improvement on that link. This is the simplest approach and offers a quick turnaround. However it is only suitable for small schemes where the existing demand is known, e.g. widening of a section of road from single to dual carriageway. Further guidance on the application of this approach is provided in Section 6.2 of *PAG Unit 5.1 – Construction of Transport Models*.
- **Simple VDM –** use of published elasticities and other sources to forecast the change in demand resulting from a transport improvement, at an O-D cell level using a transport model.

Also offers a simple approach and quick turnaround relative to a full VDM, however compared with elasticity approach allows for impacts to be better defined geographically. In addition to being suitable for small schemes, could also be applied for larger schemes (e.g. widening of an entire road from single to dual carriageway) where the geographical impacts can be easily implied. Can also make use of demand segmentation within transport model to estimate impacts selectively for particular demand segments (e.g. commuter trips versus business trips) Further guidance on the application of this approach is provided in Section 6.3 of *PAG Unit 5.1 – Construction of Transport Models*.

- **Existing National/Regional VDM (e.g. TII NTpM / NTA RMS)** – use of existing full VDM to forecast change in demand resulting from a major transport improvement. Has the advantage of using existing transport models which are validated and therefore form a robust basis for future year forecasting. These models forecast changes in travel cost and demand responses in each individual O-D cell therefore offer a detailed and comprehensive approach. Also offer the advantage of being sufficiently detailed within the urban centres of Dublin, Cork, Waterford, Limerick and Galway to be used for major scheme assessment within those areas. However, these national/regional models by their very nature are strategic tools and may not have the required level of network or demand detail at a local level to assess the impact of a specific transport proposal Further guidance on the application of this approach is provided in Section 6.4 of *PAG Unit 5.1 – Construction of Transport Models*.
- **New Local VDM** – use of full VDM to forecast change in demand resulting from a major transport improvement outside the urban centres of Dublin, Cork, Waterford, Limerick and Galway. By far the costliest approach as involves development of a new model from scratch. Should only be applied if the above methods are not suitable. In the case of major transport improvements, use of the TII NTpM and NTA RMS should be considered first; if the level of detail is not sufficient consideration should be given to enhancing the detail of those models. The development of a new local VDM would enable changes in travel cost and demand responses in each individual O-D cell to be forecast therefore offering a detailed and comprehensive approach. It is considered unlikely that such a new model will be required in most instances outside the main urban centres, as the level of detail within either the TII NTpM or NTA RMS should be sufficient to broadly reflect the magnitude of demand impacts generated by new schemes. Further guidance on the application of this approach is provided in Section 6.4 of *PAG Unit 5.1 – Construction of Transport Models*.

3.3 The Four Stage Transport Modelling Process

In practice, Variable Demand Modelling is often undertaken in combination with assignment modelling, as scheme promoters usually need to forecast the impacts of a transport scheme on the routing of trips as well as changes in demand for travel. Together, this combined approach is often referred to as the ‘*Four Stage Transport Modelling Process*.’ The four stages are Trip Generation, Trip Distribution, Mode Choice (all performed within the Variable Demand Modelling process) and Assignment (performed within the Assignment modelling process).

An important feature of the four-stage modelling process is the iterative feedback of costs between the trip assignment and demand modelling stages. By iterating between these stages, it is possible to forecast the impacts of congestion and crowding on travel demand. This iterative process ensures a balance between the final trip pattern and the costs by which it is derived. Figure 5.0.3 illustrates the process.

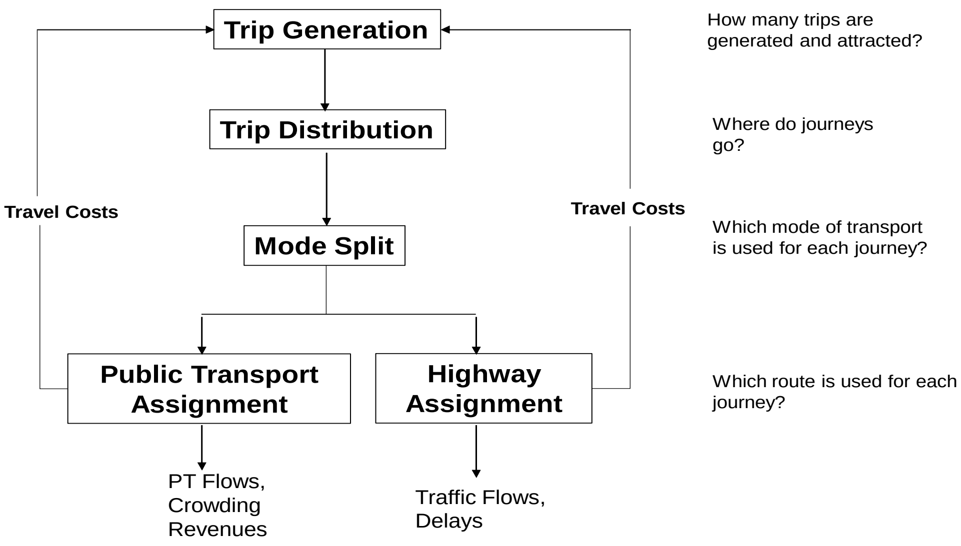

Figure 5.0.3 Four Stage Transport Modelling Process

In addition there may be a need to forecast the effect of changes in travel costs on *when* trips are made. As this is outside the 'traditional' four stage modelling process, it would require the addition of a fifth stage (refer to section 3.3.5).

3.3.1 Stage 1 – Trip Generation

Trip generation is the procedure whereby land use, population and economic forecasts are used to estimate how many person trips are produced within, and attracted to, each zone. Trip generation uses average trip rates for the study area to estimate the quantum of trips undertaken by various trip purposes such as:

- Home-based work trips (such as work trips that begin or end at home)
- Home-based shopping trips
- Home-based education trips (such as from home to primary, secondary and tertiary education)
- Home-based recreation trips
- Home-based other trips
- Non home-based trips (trips that neither begin nor end at home)
- Other non-home-based trips (such as service trips and business trips)

The four-stage modelling process can forecast the effects of changes in travel costs on the amount of travel demand (i.e. an improvement in travel conditions may generate new trips).

3.3.2 Stage 2 – Trip Distribution

Trip distribution forecasts where the trip ends – developed in Trip Generation (Step 1) – will go. These trip ends are linked to/from an origin–destination pattern of trips through the process of trip distribution. The logic behind trip distribution is that a person is more likely to travel to a nearby model zone with a high level of activity (such as employment, shopping or recreation) than to a more distant zone with a low level of activity.

There are several approaches for trip distribution such as growth factor, gravity model, entropy-maximising approach and intervening opportunities. Recent developments in trip distribution have seen the implementation of logit based destination choice models.

Trip distribution is often determined on the basis of the calculation of impedance between zones. Impedance can be measured in several ways. The simplest way is to use either actual travel distance (km) or travel times (minutes) between zones as the measurement of 'impedance'. Alternatively, by ascribing a value of time and a cost rate to travel time and travel distance respectively, together with any tolls or fares paid, a 'generalised cost of travel' can be used as the 'impedance'.

The outcome of the trip distribution step is a matrix of trips from each model zone to all other model zones.

3.3.3 Stage 3 – Mode Choice

Mode choice allocates the origin–destination trips derived from Trip Distribution (Step 2) to the available travel modes, by trip purpose. This step estimates the choice between travel modes based on the characteristics of the trip maker (income, car ownership, age), the trip itself (trip purpose, the origin and destination) and the characteristics of the travel mode (fares, vehicle operating costs, travel time, parking availability and cost, reliability). The outcome of this step is an estimate of travel by all available travel modes between all transport zones, by the separate trip purposes.

Mode choice can be performed before trip distribution (trip-end mode choice model) or after trip distribution (trip-interchange mode choice model). Alternatively, trip distribution and mode choice may be performed simultaneously using a composite cost function.

Trip-end mode choice models split the total demand for travel for each transport zone by the available travel modes. The mode choice in this case is based on the attributes of the trip origin (that is, ease of access to each mode and the ability or inclination to use a particular mode). The trip-interchange mode choice models split the origin–destination travel (including intra-zonal travel) between the available travel modes by responding to the specific service characteristics of the available travel modes. In this approach, the number of trips by travel mode is estimated on the basis of the relative utility (or disutility) of travel by different modes, as perceived by the trip maker.

3.3.4 Stage 4 – Trip Assignment

Trip assignment assigns the various mode-specific trip matrices, by trip purpose, to the alternative routes or paths available across the transport network. Public transport trips can be assigned to the public transport network (in which case path choice includes all public transport modes) or trips using public transport sub-modes (e.g. bus, rail) can be assigned separately to their respective networks. Private vehicle trips are assigned to the highway network. This step forecasts the distribution of travel across the available transport network.

3.3.5 The Five Step Transport Modelling Process

Four step transport models typically require the application of fixed factors in order to derive demand and supply assumptions by time period. The disadvantage of this approach is that it might overestimate the level of traffic congestion during the peak periods by not taking into consideration trips which change their time of departure in order to avoid traffic congestion or crowding. A five step transport model incorporates an additional step called *time period model* which models this response.

3.4 Extent and Level of Detail of the Transport Network

Irrespective of the model type, the extent of the transport network (area of influence) to be captured within the model is a significant factor in determining the overall resources required to undertake the modelling work. The modelled transport network should be the area of influence within which impacts are expected and no larger.

For instance, one of the main purposes of an assignment model is to investigate the extent and impact of changes of route as a consequence of a scheme. Therefore it must be of sufficient extent to allow all reasonable and significant reassignment movements to occur.

The study boundary should also be carefully chosen to ensure that any potential competition between route corridors can be captured, as this can significantly affect the appraisal.

For National Road schemes, the TII National Transport Model is the primary tool to assist in determining the model study area. Model runs of the National Transport Model with and without indicative proposed schemes in place can be used to provide an initial indication of the area of influence of a scheme and hence the potential geographical boundary of the study area.

Alternatively, it may be possible to use other existing regional transport models (such as those developed by the National Transport Authority) to determine the modelled study area.

If an existing Local Area Model is available from a previous study, even if it is quite old or of a coarse nature, then it should be possible to code in a representation of an indicative improvement scheme to identify the extent of any reassignment effects and thereby the area of influence. The magnitude of the effects from an older model may not fully reflect the degree of impact but the routes themselves are likely to be reasonable.

The level of detail required will generally vary across the network. In close proximity to the scheme, it will be necessary to include all main roads and / or public transport routes, as well as those minor routes, or roads in residential areas, (including ‘rat-runs’) that are likely to carry critical traffic movements, either in the base year or in future years.

Local authorities will normally be aware of the common ‘rat-runs’, but some independent assessment may also be required. Junction modelling will also be required in those areas close to the scheme where junction capacities have a significant impact on drivers’ route choice, and where delays are not adequately included in the speed-flow relationships applied to network links.

However, the network will often be sparser towards the boundary of the area and only needs to be capable of ensuring that traffic and/or passenger demand is using the correct main routes on the approaches to the scheme. Junction modelling is unlikely to be required in these areas unless there are particular key junctions where route choices are made and where the junction capacity is critical.

3.5 Zone Systems

The size and number of model zones is a critical factor in determining the realism and accuracy of the transport model, particularly assignment models, and also how long the model takes to run. If zones are too large, the model will be unable to estimate traffic flows to the required level of accuracy, however good the quality of the trip matrix data. On the other hand, if the zones are too small, the sample sizes in the cells of the matrix will be small also, affecting the accuracy of the trip and flow estimates.

It should also be noted that intra-zonal trips (i.e. those taking place entirely within the same zone) are not assigned to the model network since they are modelled as starting and ending at the same point. If zones are too large, this may lead to a significant underestimation of traffic flows, both on links and at junctions, and this in turn could alter the pattern of flows and delays given by the assignment model.

This is a particular problem in urban transport models that use for example detailed junction modelling techniques.

Similar distortions, particularly in the modelling of junction turning movements, can also occur if zone sizes are not compatible with the level of network detail included in the model. Reducing zone size will minimise these problems but will increase the complexity of the model and will increase run times.

In a similar fashion to the network, zones sizes should generally be smallest towards the centre or focus of the model area and increase in size towards the extremities of the model. They should also seek to follow, or be capable of being aggregated to, administrative boundaries, such as CSO Small Areas and Electoral Divisions, as this can prove useful when using other data such as population or household information. Within the constraint of the administrative boundaries, natural barriers to movement (rivers, railways, motorways and other roads) should be taken into account. Zones should also comprise areas of similar land use and should also be designed to minimise the number of zone connectors necessary for each. Care is required to ensure that the average zone size increases gradually and it is important that sudden changes in zone size are avoided.

It is also important to ensure that the resultant number of trips to and from individual zones near the centre or focus of the model should be approximately the same for most zones; and that the number of trips to and from each zone be some relatively small quantity to avoid unrealistically high loads appearing at some points in the network.

Within highway assignment models, zone systems typically provide access to key loading points on the highway network, that is points on the highway network where significant levels of traffic join the main network from feeder roads. Within public transport assignment models, zone systems typically provide access to stations (i.e. the main points at which trips access the public transport network).

3.6 User Classes

It is only necessary to provide sufficient disaggregation of matrices to ensure the model can accurately reflect route choice and provide whatever additional output may be required for operational or other analyses. In that context, it is generally acceptable to model light vehicle and heavy goods vehicle matrices. The route choice of these two users can be very different and details of heavy goods vehicle patterns may be required for other environmental purposes.

Where schemes involve tolling, disaggregation of demand into travel purpose and income segments may also be warranted. However, it is important to note that, as a rule of thumb, doubling the number of user classes will approximately double model run times. Therefore, the value of adding additional user classes should be considered carefully.

3.7 Time Periods

In order to facilitate an accurate cost benefit appraisal, the model needs to provide as accurate an estimate as possible of peak hour traffic flows on the network. In most instances, traffic and passenger demand patterns will be significantly different for the morning and evening peaks and different again for the inter peak period. It is recommended that most models, irrespective of type, should therefore include:

- An AM Peak Hour (neutral average weekday)
- An average Inter Peak Hour (neutral average weekday)
- A PM Peak Hour (neutral average weekday)

In certain circumstances an off peak or weekend peak model may be required. This is due to the fact that the appraisal software of choice, TUBA, cannot calculate benefits for periods which are not modelled.

The choice of which hour(s) to use in each case will be informed by an analysis of traffic and passenger flow data in the form of Automatic Traffic Counts and TII Traffic Monitoring Units within the study area, particularly those in close proximity to the scheme. This analysis should designate the periods, generally AM and PM peaks where aggregate traffic and passenger flows clearly indicate a peak period with the Inter peak being a period between the two peaks during which the flows are almost constant.

In those areas where the AM and PM peak lasts longer than one hour, it is best practice to use multiples of the peak hour to calculate the peak period flow and combine this with the inter peak to produce 12 hour and then daily flow estimates. An example of a daily traffic profile and its 'peak periods' is illustrated in Figure 5.0.4.

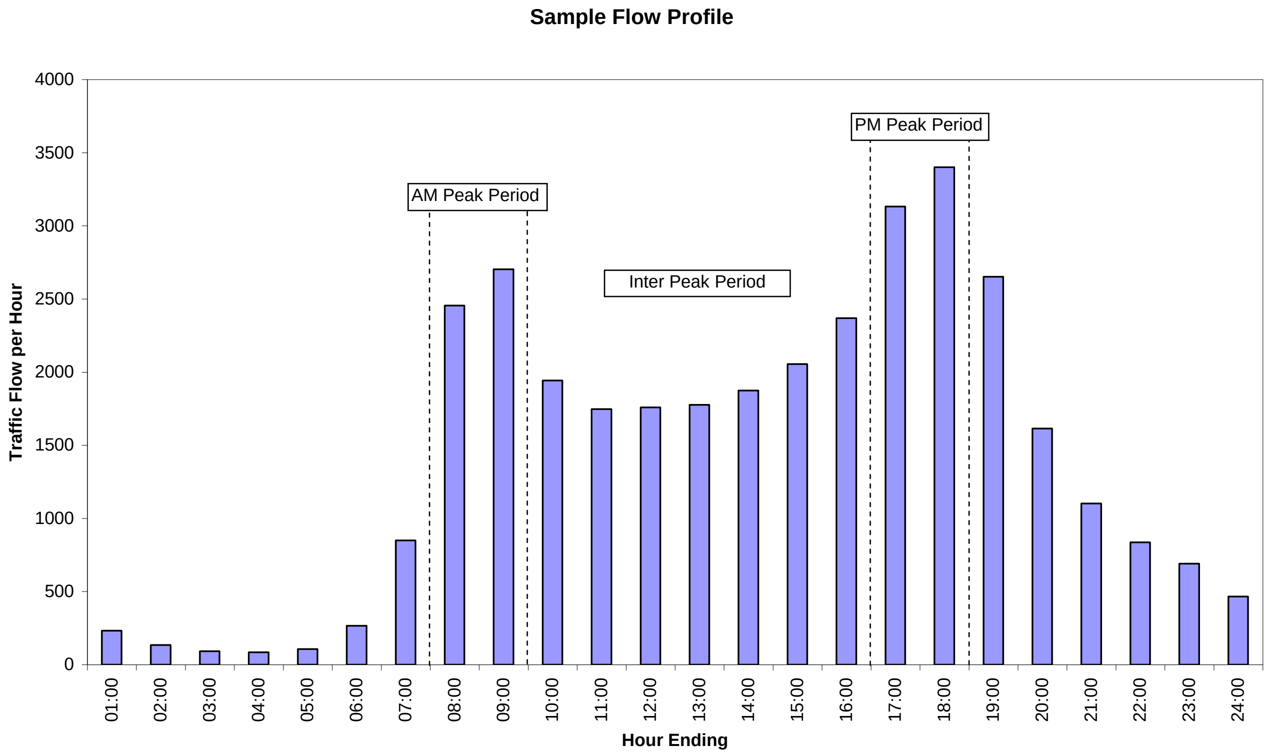

Figure 5.0.4 Example of Daily Flow Profile

3.8 Modelled Years

Irrespective of model type, the modelled years are dictated by both the design requirements and by the necessary inputs to appraisal. The transport model needs to include the following as a minimum:

- Base Year
- Opening Year
- Design Year (Opening Year + 15 Years)
- Forecast Year (Opening Year + 30 Years)

Additional years may be required if there are significant changes to the network or trip patterns (e.g. as the result of a development nearby) in the intervening period.

3.9 Generalised Cost

Within assignment models, the demand for travel, represented by trip demand matrices are applied to the available transport network. The route choice of trips is based on the generalised cost of each route option.

3.9.1 Highway Generalised Cost

Within highway assignment models, generalised cost is typically calculated as a combination of time, distance and road user charges, as follows:

Generalised Cost = Value of Time * Time + Vehicle Operating Cost * Distance + Road User Charges

The values of time and vehicle operating costs should be calculated using the values available in PAG Unit 6.11: National Parameter Values Sheet.

3.9.2 Public Transport Generalised Cost

Within public transport assignment models, generalised cost is typically calculated as a combination of fares, in-vehicle times, walk times and wait times. In addition, crowding can be represented as a multiplicative time penalty applied to either in-vehicle or wait time and a boarding penalty is modelled to represent the perceived inconvenience of interchanging. The generalised cost can be represented as follows (in this case crowding is applied as a penalty to in-vehicle time):

$$GC = (IVT * WF * CP) + (AT * WF) + (ET * WF) + (WT * WF) + (OWT * WF) + (TWT * WF) + BP + F$$

where:

GC = Generalised Cost

IVT = In-Vehicle Time

WF = Weight Factor

CP = Crowding Penalty

AT = Access Time

ET = Egress Times

WT = Walk Time

OWT = Origin Wait Time

TWT = Transfer Wait Time

BP = Boarding Penalty

F = Fares

3.10 Capacity Restraint

Within assignment models, capacity restraint is the process utilised by which model travel times and generalised costs are adjusted so that they are consistent with the assigned traffic flows. Capacity restraint can be applied by the use of:

- Within highway assignment models
- Link based speed / flow relationships

  - Link based speed / flow relationships
  - Flow / delay modelling of junctions
  - A combination of both
- Within public transport assignment models, crowding curves which define the relationship between levels of crowding and a perceived time penalty

Junction modelling is required where junction capacities have a significant impact on route choice and where delays are not adequately represented by speed / flow relationships applied to network links.

Speed / flow relationships developed and used within the TII National Transport Model may also be used within standalone assignment models, these relationships allow for effects of road geometry and other attributes to be taken into account.

4. Overview

This section provides the reader with an outline summary of the remaining sub-units within PAG Unit 5 allowing the reader to understand the role of each unit within the transport modelling process.

4.1 PAG Unit 5.1: Construction of Transport Models

This Unit provides detailed guidance on the process of constructing a base year model to reflect transport demand and supply as well as guidance on subsequent model calibration and validation and future year forecasting.

4.2 PAG Unit 5.2: Data Collection

This Unit documents the data sources and survey approaches used to develop transport models. Particular attention is paid to finding a balance between costly data collection and the level of model accuracy required. Emphasis is placed on the need to review existing sources of information, including previous transport models, prior to survey commencement. The guidance highlights the importance of effective models to aid decision-making but also surmises that the quality and quantity of data collected will often reflect the scale of the project being assessed.

The reader will understand the key elements of a transport model, the range of existing data sources and the different methods of data collection utilised in the creation, calibration and validation of transport models.

4.3 PAG Unit 5.3: Travel Demand Projections

PAG Unit 5.3 provides guidance on the preparation of future travel demand projections for use in the appraisal of National Road projects. The unit outlines the role of national travel demand projections and the need for consistency in the appraisal of transport schemes.

The role of the TII National Transport Model in providing outputs to inform future projections is also discussed. Two methodologies for projecting travel demand for National Road projects are outlined and discussed:

- Link-Based Growth Rates (Simple Models)
- Zone-Based Growth Rates (Assignment and Variable Demand Models)

4.4 PAG Unit 5.4: Transport Modelling Report

PAG Unit 5.4 describes the structure and content of the information to be provided in the Transport Modelling Report (TMR). The TMR is a key deliverable of the appraisal process and documents the development, calibration and validation of the base year transport model alongside the data collected in order to construct the model.

The TMR clearly outlines the growth projections used and any assumptions in relation to the allocation of growth. The impact of the scheme is discussed and presented through graphical and tabular outputs. Guidance for completing the TMR is supplemented by visual examples and a detailed check-list to ensure the reader fully understands the reporting requirements.

Appendix A:

Criteria for Scoping of Transport Models

Table 5.0.2 Criteria for Scoping of Transport Models

Category	Simple Models	Microsimulation Models	Assignment Models	Variable Demand Models
Description	• Manual assignment calculations using fixed demand flows. Can comprise junction modelling or static microsimulation modelling.	• Models of complex intersections and arrangements, often in congested urban networks. Microsimulation models simulate the behaviour of individual vehicles.	• Models which use a fixed demand matrix and assess impacts of reassignment only. Assumes average conditions apply to all vehicles or passengers.	• Models which include consideration of demand responses occurring as a result of a change in transport conditions (e.g. trip generation, trip distribution, mode share and time of travel.
Example Modelling Packages	• Junctions (for simple priority or 'give way' junctions, roundabouts and signal controlled junctions) • RODEL (also for roundabouts) • TRANSYT (for signal controlled junctions and linked junctions) • LinSig (also for signal controlled junctions and linked junctions).	• PTV VISSIM • Paramics • AIMSUN	• PTV VISUM • SATURN • EMME.CUBE	• Model architecture available in the form of: - TII National Transport Model; - NTA Regional Models.
Nature of Scheme	• Minor schemes • Road safety schemes • Localised improvement	• Major schemes & Minor schemes in urban areas • New interchange or upgrade to interchange • Merging and weaving arrangements; • Lane closures • Localised improvements in urban areas.	• Major schemes • New roads • Significant upgrades to existing roads • Large inter urban networks • Rural areas • Small urban areas • Public transport schemes including new lines/routes, enhancements of existing lines/routes (e.g. frequency/ capacity enhancements) and new stations/stops	• Strategic studies • Major schemes • New roads • Significant upgrades to existing roads • Interventions / traffic management in major urban areas • Public transport schemes including new lines/routes and enhancements of existing lines/routes (e.g. frequency/ capacity enhancements)

Category	Simple Models	Microsimulation Models	Assignment Models	Variable Demand Models
				• Public transport fare changes • Intermodal impacts • Land use planning tests • Road pricing tests • Tests concerning infrastructure management (e.g. tolling and multi point tolling) • Tests concerning government transport policy, (e.g. fuel price changes)
Likely Impacts of Scheme	• Rural road networks with no route-switching • Single or multiple junctions in urban areas with no route-switching	• Model complex merging/shockwaves and incidents / closures • Areas with public transport • Schemes which will lead to changes in routing and behaviour • Incidents where there are interactions between junctions (e.g. blocking back of queues)	• Schemes which will lead to changes in routing • Areas where induction or suppression of traffic or passengers is not anticipated (e.g. rural road schemes and new public transport stations/stops improvements)	• Schemes which will generate new traffic/demand • Major urban areas where congestion/crowding will exist • Schemes which lead to large reductions in journey time/cost • Areas where induction or suppression of traffic/demand is anticipated • Schemes which will increase competition with other modes • Schemes which will impact trip origin and/or destination • Schemes which will impact time of travel • Mode choice is likely to be a significant issue • Changes in trip costs may be large

Category	Simple Models	Microsimulation Models	Assignment Models	Variable Demand Models
Demand Inputs	• Demand can be input by 15 minute segment in Passenger Car Units (PCU)	• Demand can be entered by time segment • Demand can be assigned dynamically • Requires 'warm up' and 'cool off' periods.	• Aggregated demand entered generally by hour • A number of user classes (e.g. Light vehicles and Heavy vehicles) and trip purposes (e.g. commuting, work, and leisure) can be modelled	• TII & NTA demand inputs for a variety of journey purposes and a variety of modes are based on demographic & economic models, car ownership models, trip attraction generation models, and trip distribution models • Incorporates projections for horizon years
Prior requirements	• Comprehensive junction geometry measurements • Junction Turning Counts • Queue lengths to complement traffic counts (which measure throughput rather than demand) • Details of signal control in place, staging and phasing data at existing signalised junctions	• Adequate 'warm up' and 'cool off' periods • Junction Turning Counts, origin-destination data and queue lengths • Detailed junction and link geometry • Details of signal control in place, staging and phasing data at existing signalised junctions • Detail on public transport network and stops • Detail on priority lanes • Scheme investment alternatives	• Extensive transport data, including Automatic Traffic or Passenger Counts, Junction Turning Counts, Origin-Destination data, queue lengths, and journey time surveys • Refined zone structure based on land use • Link lengths, link standard (cross section), speed • Public transport service times, frequencies and capacities • Demand matrix of trips by time period and user class • Major scheme investment alternatives • Land use proposals/scenarios to be tested	• Agreement with relevant authority concerning model access and usage • Agreed modelling plan with relevant authority • Major scheme investment alternatives • Land use proposals/scenarios to be tested
Main Indicators / Outputs	• Flow on each link • Delay on each link • Mean maximum queue length	• Visual representation of issues • Journey times / travel times • Queue lengths • Delay	• Demand and actual link flows by mode and user class per peak hour modelled • AADT flows and annualised public transport flows	• Demand responses (volume and location of trips redistributing, changing mode, changing time of departure)

Category	Simple Models	Microsimulation Models	Assignment Models	Variable Demand Models
	• Ratio of flow to capacity (RFC) and Degree of Saturation (DoS)	• Vehicular throughput by link and junction • Average speed	• Travel time by link • Level of crowding by public transport service/link • Average speed by link • Time skims (e.g. average trip time between origin zones and destination zones for each user class) • Distance skims (e.g. average trip distance between origin zones and destination zones for each user class) • Network wide performance indicators such as total vehicle kilometres, total network travel time (in the case of public transport modelling split by walk, wait, in-vehicle and crowding penalty), total network delay and total network average speed.	• Demand and actual link flows by mode and user class per peak hour modelled • AADT flows and annualised public transport flows • Travel time by link • Level of crowding by public transport service/link • Average speed by link • Time skims (e.g. average trip time between origin zones and destination zones for each user class of private and public transport) • Distance skims (e.g. average trip distance between origin zones and destination zones for each user class of private and public transport) • Toll skims (e.g. tolls as a result of traversed tolled links between origin zones and destination zones for each user class) • Estimates of fare revenues • Network wide performance indicators such as total vehicle kilometres, total network travel time (in the case of public transport modelling split by walk, wait, in-vehicle and crowding penalty), total network delay and total network average speed

Category	Simple Models	Microsimulation Models	Assignment Models	Variable Demand Models
Scoping Issues	• What is the model trying to assess? • Definition of time periods • Choice of Model years	• What is the model trying to assess? • Extents of transport network • The number of vehicle type / user class matrices required • Definition of time periods • Choice of model years	• What is the model trying to assess? • The extent of the transport network to be modelled • The level of detail of transport network required • The definition of an appropriate zoning system • The number of vehicle type / user class matrices required • The definition of suitable time periods • The number of model years to be assessed	• What is the model trying to assess? • Will scheme alternatives / government policies result in modal shift • The extent of the transport network to be modelled • The level of detail of transport network required • The definition of an appropriate zoning system, if necessary • The number of vehicle type / user class matrices required • The definition of suitable time periods • The number of model years to be assessed
Benefits	• Efficient and cost-effective approach – large, complex models not warranted where a simple model can provide adequate representation of travel behaviour • Transparent – simple models allow for straightforward explanation of travel behaviour and the assumptions underpinning it	• Takes into consideration more complex effects on travel behaviour therefore should be more robust than a simple model	• More efficient than variable demand modelling as fixed matrix with and without scheme – better for option sifting • Fixed matrix approach also allows comparison of schemes on an equal footing (e.g. impact on network journey time and costs) • More stability than variable demand modelling as fewer variables and inputs	• More comprehensive scheme assessment taking account of full set of transport scheme impacts – better for detailed option testing • More sophisticated scheme assessment enabling impacts of schemes on long-term home/work locations to be taken into consideration rather than focus on time savings • More robust assessment than assignment modelling means more suited to support scheme funding applications

Category	Simple Models	Microsimulation Models	Assignment Models	Variable Demand Models
Costs/Risks	• Approach may be over-simplistic and not account for certain effects on travel behaviour e.g. manual assignment approach will not account for effects of congestion	• May provide excessive complexity where this is not warranted • Due to greater complexity, more difficult to explain travel behaviour than simple models	• Narrow assessment based solely on travel time savings • Less suited to detailed scheme funding applications • Not all impacts of transport schemes accounted for therefore less robust than variable demand modelling on that basis	• More comprehensive approach means more inputs and therefore more potential for model noise, instability and spurious effects • More cumbersome approach means longer model run times, more input preparation/output extraction and analysis and higher potential for error • Demand effects of transport generally harder to validate and therefore to justify than assignment effects

Table 5.0.3 Criteria for Scoping of Variable Demand Modelling

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
Description	• Mathematical calculation used to estimate change in transport demand based on % change in a cost variable (e.g. fuel cost, PT service headway) either directly or indirectly related to the mode concerned using research-based elasticity values	• Calculation within transport model to adjust demand at O-D matrix cell level in response to a change in transport cost using elasticity and/or other method	• National/Regional models which can be used to assess the effects of changes in transport costs on transport demand (Trip Generation, Trip Distribution, Mode Share, Time of Travel) at a strategic level; • The TII NTpM assesses impacts of transport schemes/policies on the National Road Network. The NTA RMS assesses impacts of transport schemes/policies on the road and public transport networks at a regional level. • Transport schemes/policies within the main urban centres (i.e. Dublin, Cork, Waterford, Limerick and Galway) should adopt this approach rather than develop a New Local VDM as these areas have a detailed representation within the NTA RMS.	• Model which assesses the effects of changes in transport costs on transport demand (Trip Generation, Trip Distribution, Mode Share, Time of Travel) at a local level, outside the main urban centres (i.e. Dublin, Cork, Waterford, Limerick and Galway)
Example Modelling Packages	• Typically standalone calculation undertaken outside modelling package	Use of existing transport models such as: • TII NTpM – National or cordoned version (VISUM)	• TII NTpM – VISUM • NTA RMS – CUBE/SATURN	• VISUM • CUBE • SATURN • EMME

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
	• Assignment model could be used to derive change in transport demand from 'own' mode (e.g. shift in demand from one rail service to another as a result of rail frequency improvement; in this case elasticity calculation needs to account for shift in demand from highway and newly generated trips)	• NTA RMS – relevant regional model version (CUBE/SATURN) • Other (VISUM/CUBE/SATURN/EMME)		
Nature of Scheme	• Minor schemes (e.g. junction improvement, new rail station, new Park and Ride facility) • Localised improvement	• Minor schemes (e.g. junction improvement, new rail station, new Park and Ride facility) • Localised improvement • Basic schemes (e.g. changes in service frequency for which a response in demand in terms of quantum and spatial distribution may be reasonably inferred using elasticity/other method) • Major schemes/changes in pricing/changes in policy for which it is reasonably intuitive which areas will be affected by change in travel demand (note however that these would typically require a full VDM exercise – a simple approach may suffice to provide initial indications of likely demand impacts or to sift between options)	• Strategic studies • Major schemes • New roads • Significant upgrades to existing roads • Interventions / traffic management in major urban areas • Public transport schemes including new lines/routes, enhancements of existing lines / routes (e.g. frequency/capacity enhancements) • Public transport fare changes • Intermodal impacts • Land use planning tests • Road pricing tests • Tests concerning demand management (e.g. tolling and multi point tolling)	• Major local schemes outside main centres (i.e. Dublin, Cork, Waterford, Limerick and Galway) including; • Town bypass • Other new roads • Road upgrades • Enhanced bus services (coverage, frequency, capacity); • Rail service enhancements/extensions; • Public transport fare changes; • Traffic management/town centre improvements; • Land use plans and developments

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
			• Tests concerning government transport policy (e.g. fuel price changes)	
Likely Impacts of Scheme	• Some effect on demand but not a transformative effect (i.e. not significantly changing demand across a wide area) • Demand attracted within a limited area (e.g. in the vicinity of a junction improvement or new rail station) • Attracts new trips or demand from other modes within the locality • Does not have a major impact on origin and destination trip choice (i.e. impacts along mainline or in the vicinity of scheme)	• Minor/local schemes impact at a local level (as per elasticity approach – see opposite) • Basic schemes impact at a local or strategic level • Major schemes/changes in pricing/changes in policy impact at a strategic level • Generates new trips (can be estimated using elasticity method) • Trips transfer from other modes (can be estimated using elasticity method) • Change in origin/destination trip choice (can be estimated using other method)	• Transformative effect on transport demand resulting from large changes in transport costs (e.g. significant impact on congestion/ crowding and/or journey time/cost across a wide area) • Significant impact on generation of new trips • Significant impact on generation of new trips which were previously suppressed due to size of transport costs without scheme • Increased competition with other modes • Mode choice is likely to be a significant issue • Significant impact on trip origin and/or destination • Impact on time of travel	• Transformative effect on transport demand in study area resulting from large relative changes in transport costs (e.g. significant relative impact on congestion / crowding and or journey time / cost) • Significant relative impact on generation of new trips • Significant relative impact on generation of new trips which were previously suppressed due to size of transport costs without scheme • Increased competition with other modes • Mode choice is likely to be a significant issue • Significant relative impact on trip origin and/or destination • Impact on time of travel
Demand Inputs	• As contained in transport model – adjustment is made to existing/future demand	• As contained in transport model • If demand is segmented, can apply/adjust calculation selectively to certain groups (e.g. apply separate calculations for peak rail commuters and off-peak highway leisure trips)	• Segmented by a variety of journey purposes and modes based on: demographic & economic models, car ownership models, trip attraction generation models, and trip distribution models	• As model developed from scratch, following modules would need to be developed in order to generate demand inputs • Demographic & economic models • Car ownership models

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
			• Incorporates projections for horizon years	• Trip attraction/generation models • Trip distribution models • Demand inputs segmented by a variety of journey purposes and modes • Projections for horizon years
Prior Requirements	• Initial transport demand (from survey data/forecast/transport model) • % change in cost variable • Elasticity value (from research) (e.g. elasticity of car trips with respect to car journey time of –0.2, UK TAG)	• Initial transport demand (as contained in transport model) • % change in cost variable (could be informed by knowledge of transport scheme improvement or by changes in cost between Do-Minimum and Do-Something model runs) • Elasticity values (from research) • Other research/studies to inform adjustment for trip origin/destination changes • Understanding of which areas will reasonably be impacted by scheme.	• Agreement with relevant authority concerning model access and usage • Agreed modelling plan with relevant authority • Major scheme investment alternatives • Land use proposals/ scenarios to be tested	• Agreement with relevant authority concerning model ownership arrangements and usage • Agreed modelling plan with relevant authority including both model development and application considerations • Scheme investment alternatives • Land use proposals/ scenarios to be tested
Main Indicators / Outputs	• Change in/new transport demand	• Change in/new transport demand (if applicable split by demand segment) at O-D matrix cell level within transport model • The new demand can then be run in assignment model to derive network effects (e.g. demand, journey time by link)	• Demand responses (volume and location of new trips, trips redistributing, changing mode, changing time of departure) • Demand and actual link flows by mode and user class per peak hour modelled • AADT flows and annualised public transport flows • Travel time by link	• Demand responses (volume and location of new trips, trips redistributing, changing mode, changing time of departure) • Demand and actual link flows by mode and user class per peak hour modelled • AADT flows and annualised public transport flows • Travel time by link

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
			• Level of crowding by public transport service/link • Average speed by link • Time skims (e.g. average trip time between origin zones and destination zones for each user class of private and public transport) • Distance skims (e.g. average trip distance between origin zones and destination zones for each user class of private and public transport) • Toll skims (e.g. tolls as a result of traversed tolled links between origin zones and destination zones for each user class) • Estimates of fare revenues • Network wide performance indicators such as total vehicle kilometres, total network travel time (in the case of public transport modelling split by walk, wait, in-vehicle and crowding penalty), total network delay and total network average speed	• Level of crowding by public transport service/link • Average speed by link • Time skims (e.g. average trip time between origin zones and destination zones for each user class of private and public transport) • Distance skims (e.g. average trip distance between origin zones and destination zones for each user class of private and public transport) • Toll skims (e.g. tolls as a result of traversed tolled links between origin zones and destination zones for each user class) • Estimates of fare revenues • Network wide performance indicators such as total vehicle kilometres, total network travel time (in the case of public transport modelling split by walk, wait, in-vehicle and crowding penalty), total network delay and total network average speed
Scoping Issues	• Geographical extent of transport network affected • Physical infrastructure affected (Highway user classes/PT services)	• Geographical extent of area affected by change in transport demand	• What is the model trying to assess? • What affects will scheme alternatives / government policies have on demand?	• What is the model trying to assess? • What affects will scheme alternatives have on demand?

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
	• Time periods affected • Assessment Years	• Demand segments affected (time period/mode/user class/car ownership etc.) • Assessment Years	• The extent of the transport network to be assessed • Taking the above considerations into account an alternative approach is to apply a simpler version of model in which zones are aggregated except within the study area • Time periods affected • Assessment Years	• The spatial extent of the transport model • The detail of the transport model (transport network/zoning) • Segmentation of demand • Time periods • Assessment Years
Benefits	• Low-cost, simple and transparent approach • Quick turnaround	• Low-cost, simple and transparent approach • Quick turnaround • Cost and demand represented spatially	• More comprehensive scheme assessment better suited for detailed option testing • More sophisticated scheme assessment better suited for impacts of schemes on long-term home/work locations • More robust assessment means more suited to support scheme funding applications	• More comprehensive scheme assessment better suited for detailed option testing • More sophisticated scheme assessment better suited for impacts of schemes on long-term home/work locations • More robust assessment means more suited to support scheme funding applications
Costs/Risks	• High-level assessment, lack of granularity • Can significantly overestimate the effect of variable demand responses on scheme benefits	• High-level assessment (transport model used to derive spatial definition of cost and demand otherwise redundant) • Unlikely to be suitable for major scheme funding applications	• More comprehensive approach means more inputs and therefore more potential for model noise, instability and spurious effects • More cumbersome approach means longer model run times, more input preparation/ output extraction and analysis and higher potential for error	• More comprehensive approach means more inputs and therefore more potential for model noise, instability and spurious effects • More cumbersome approach means longer model run times, more input preparation/ output extraction and analysis and higher potential for error

Category	Elasticity Approach	Simple VDM	Existing National VDM (TII NTpM / NTA RMS)	New Local VDM
				• Compared to using existing National VDM significant additional resource required to construct model.

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Ionad Ghnó Gheata na Páirce,
Stráid Gheata na Páirce,
Baile Átha Cliath 8, D08 DK10, Éire

www.tii.ie

+353 (01) 646 3600

Parkgate Business Centre,
Parkgate Street,
Dublin 8, D08 DK10, Ireland

info@tii.ie

+353 (01) 646 3601