REGIONAL MODELLING SYSTEM

Non-Technical Scoping Report

Údarás Náisiúnta Iompair
National Transport Authority

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Foreword

The NTA has developed a Regional Modelling System (RMS) for Ireland that allows for the appraisal of a wide range of potential future transport and land use alternatives. The RMS was developed as part of the Modelling Services Framework (MSF) by the National Transport Authority (NTA), SYSTRA and Jacobs Engineering Ireland.

The National Transport Authority's (NTA) Regional Modelling System comprises the National Demand Forecasting Model, five large-scale, technically complex, detailed and multi-modal regional transport models and a suite of Appraisal Modules covering the entire national transport network of Ireland. The five regional models are focussed on the travel-to-work areas of the major population centres in Ireland, i.e. Dublin, Cork, Galway, Limerick, and Waterford.

The development of the RMS followed a detailed scoping phase informed by NTA and wider stakeholder requirements. The rigorous consultation phase ensured a comprehensive understanding of available data sources and international best practice in regional transport model development.

The five discrete models within the RMS have been developed using a common framework, tied together with the National Demand Forecasting Model. This approach used repeatable methods; ensuring substantial efficiency gains; and, for the first time, delivering consistent model outputs across the five regions.

The RMS captures all day travel demand, thus enabling more accurate modelling of mode choice behaviour and increasingly complex travel patterns, especially in urban areas where traditional nine-to-five working is decreasing. Best practice, innovative approaches were applied to the RMS demand modelling modules including car ownership; parking constraint; demand pricing; and mode and destination choice. The RMS is therefore significantly more responsive to future changes in demographics, economic activity and planning interventions than traditional models.

The models are designed to be used in the assessment of transport policies and schemes that have a local, regional and national impact and they facilitate the assessment of proposed transport schemes at both macro and micro level and are a pre-requisite to creating effective transport strategies

1 Background

The National Transport Authority (NTA) uses transport modelling to help develop strategies and assess schemes that are undertaken as part of its national remit–which includes:

- preparation and regular review of a transportation strategy in the Greater Dublin Area (GDA);
- adoption of an integrated implementation plan and a strategic traffic management plan;
- financing the construction of public transport infrastructure;
- promoting an integrated public transport network;
- implementing integrated ticketing, fares and information schemes;
- regulating fares and encouraging increased public transport use;
- implementing demand management measures (excluding road pricing);
- ensuring integration of land use and transport planning in Development Plans, Local Area Plans and Strategic Development Zones;
- Developing traffic management plans in each of the following regions:
    - Cork City and Region;
    - Galway City and Region;
    - Limerick City and Region;
    - Waterford City and Region.

In order to develop the regional transport modelling system needed to support the NTA's national and regional remits, the Authority commissioned a Modelling Services Framework (MSF) in 2012. Under the MSF, SYSTRA and Jacobs Engineering Ireland along with sub consultants Minnerva Transport Planning began the task of developing the regional transport modelling system in early 2013.

2 The NTA's Need for a Regional Modelling System

The NTA's remit requires it to develop traffic management strategies in each of the aforementioned city-regions. To develop a traffic management strategy it is necessary to have an appropriate transport modelling system, i.e., a strategic transport model covering each city region. When developing similar strategies with common goals in a number of regions, it is important to be able to appraise schemes consistently. Hence, strategic models with similar features and functionality are required in all of the regions.

There are currently four models[1] which correspond to the city-regions available to the NTA and relevant local authorities, as follows:

- The Greater Dublin Area (GDA) Model;
- The Cork Area Strategic Planning (CASP) Model;
- The Mid-West Area Strategic Planning (MWASP) Model (Limerick City); and
- The Galway Transport Model (GTM).

While these models all share the features expected of a strategic city-regional model, they are built at varying levels of detail, represent each transport mode differently (and to varying degrees of sophistication) and use different software platforms. Furthermore, these current models do not provide the NTA with the required level of appraisal consistency which is important for prioritising investment and funding. There is, therefore, a strong need for the NTA to replace these existing regional models with a standardised transport modelling system across all the regions.

[1] Currently there is no regional city model covering the South East (Waterford / Wexford) area.

3 Overview of the Regional Modelling System Scoping Process

Prior to embarking on the task of developing the new regional modelling system for the NTA, a detailed scoping process was undertaken. This process examined the NTA's needs (based on its remit), reviewed the current GDA Model against these needs, reviewed best practice approaches to regional model development, and examined the availability of data to support the development of the regional modelling system.

Figure 3.1 illustrates the regional modelling scoping process which involved seven steps as follows:

- Step 1: Workshops held between the consultants and the NTA to agree the terms of reference for the scoping process;
- Step 2: A review of comparable models from elsewhere;
- Step 3: A review of the NTA's transport modelling needs based on its remit (which culminated in the development of RMS Scope 1 Greater Dublin Area Model Review);
- Step 4: A review of the current Greater Dublin Area Model functionality to determine if it supports the NTAs remit in the GDA (which culminated in the development of RMS Scope 2 Greater Dublin Area Model Review);
- Step 5: A review of best practice development and application of regional transport models and functionality required by the NTA (which culminated in the development of RMS Scope 3 Best Practice Approaches);
- Step 6: A review of data and its availability and the transport modelling options supported by the data (which culminated in the development of RMS Scope 4 Modelling Data Review); and
- Step 7: Production of the Regional Modelling System Scoping Report, which details the recommended type of regional model the NTA should develop to support its remit in the GDA and in the other regions.

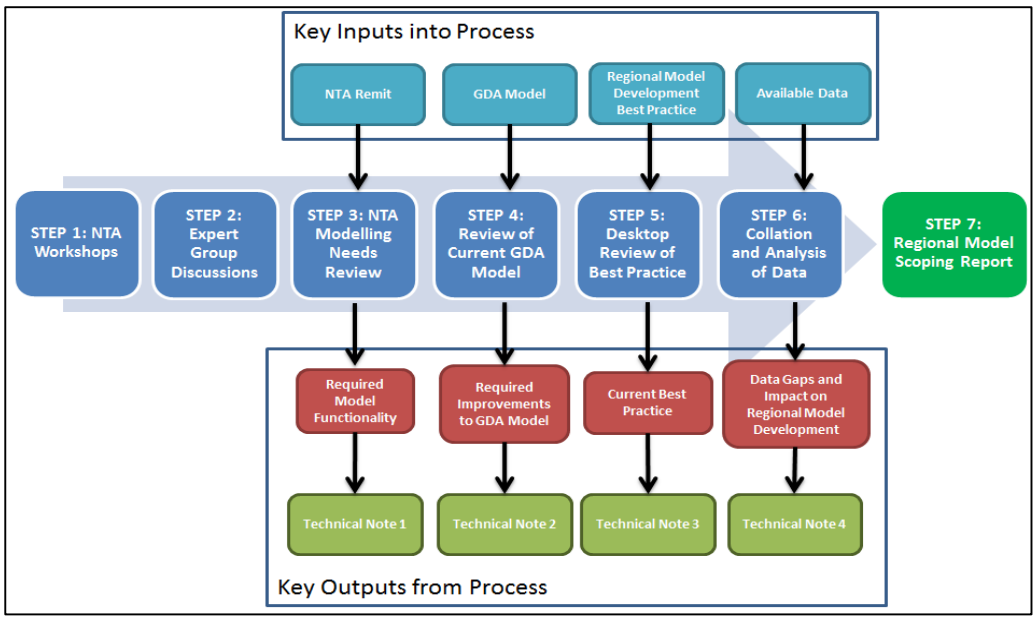
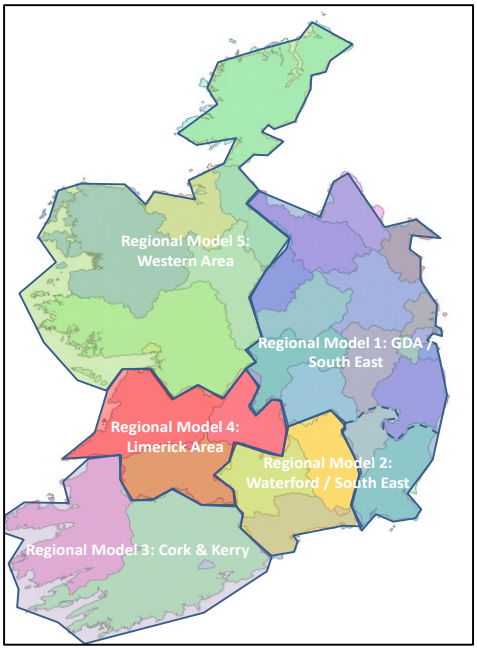


Figure 3.1 Overview of the Regional Modelling System Scoping Process

4 Regional Modelling System Recommendations

The regional modelling system scoping process recommended that:



- The national remit of the NTA requires a system of regional models to help it deliver on its planning and appraisal needs. This regional modelling system should include regional models for the:
  - Greater Dublin Area (Regional Model 1);
  - Waterford / South East Area (Regional Model 2).
  - Cork & Kerry Area (Regional Model 3);
  - Limerick Area (Regional Model 4);
  - Western Area (Regional Model 5).
- All regional models for each area should have the following key attributes:
  - **Full geographic coverage** of the relevant region;
  - Contain a detailed **representation of the road network**, particularly the impact of congestion on on-street public transport services and include modelling of residents' car trips by time period from Origin to Destination;
  - Contain a detailed **representation of the public transport network & services**, and be able to predict demand on the different public transport services within the regions;
  - Represent **all major transport modes** including active modes (walking and cycling) and including accurate **mode-choice modelling** of residents;
  - Ensure a detailed **representation of travel demand** e.g., by journey purpose, car ownership/availability, mode of travel, person types, user classes & socio-economic classes, and representation of a minimum of four time periods (AM, Inter-Peak, PM and Off-Peak); and
  - Be able to **predict changes** in **trip destination & time-of-day choice** in response to changing traffic conditions, transport provision and/or policy.
- The current GDA model did not provide a suitable basis for the development of the type of regional model required in each region or to enable the consistency required across the regional models. A new regional modelling

system should be developed and tested for the GDA Area and then replicated across the other regions.

- There is sufficient data available to develop the regional modelling system that meets almost all the NTA requirements.

A best practice review of approaches to regional model development specified the functionality and features that should be incorporated into the regional modelling system to meet the NTA's assessment needs.

Overall, the regional modelling system will be very beneficial for the NTA because it will:

- Provide a suite of city models with similar features and functionality;
- Significantly reduce the cost of model development;
- Provide consistency in policy and scheme appraisal nationally; and
- Reduce the cost of future regional model updates.

5 Regional Modelling System Dimensions

Following the regional modelling scoping process and its recommendations, the regional modelling system is should be developed with the following dimensions:

5.1 Modelled years represented:

- Base year for the regional modelling system will be 2012 (to coincide with Census/POWSCAR and National Household data sets);
- For forecasting, the regional modelling system will represent any year for which land use and infrastructure provision assumptions can be provided. These will be prepared for 5-year increments from the base year model (e.g., 2017, 2022, 2027 and so on) to support short, medium and long term horizon planning and appraisal; and
- In addition, long-range (20 – 30 year) forecasts will be prepared to support Strategy development.

5.2 Modes of Travel modelled will include:

- Private vehicles – cars (distinguishing between car driver and car passenger) within the demand model;
- Public transport sub modes (bus, rail, Luas);
- Park and Ride (including Park and Walk) to/from designated locations;
- Active modes (Walking and cycling); and
- Light goods vehicles and other goods vehicles in the highway assignment model.

5.3 Time Periods to be represented:

- AM Peak period covering the period between 07:00-10:00;
- Morning Inter-Peak covering the period between10:00-13:00;
- Afternoon Inter-Peak covering the period between13:00-16:00;
- PM Peak period covering the period between 16:00-19:00; and
- Off-Peak covering the period between19.00-07.00.

In the assignment of trips to the transport networks, a representative single hour will be extracted to represent each time period.

5.4 Level of Demand Segmentation:

Groups of people with similar travel behaviours (for example, commuters who own a car) will be represented by distinct demand segments in the regional modelling system. This will allow those groups to be treated differently in the model according to their behaviour, for example, people travelling to do shopping may have a choice of retail locations, whereas those travelling to work have less flexibility. Demand for travel can be adjusted

more accurately to change in populations, jobs, etc. when it is segmented. Demand will be segmented by the following attributes, based on an analysis of the National Household Travel Survey:

- Journey purpose, e.g. Commute, education, shopping and other purposes will each be modelled separately within the main demand model;
- Home based / non home based;
- Access to free car parking / no access to free parking;
- Car availability;
- Income or a proxy; and
- Concessionary fare eligibility or age.

Segments with very small proportions will be combined. It will also be necessary to combine segments with correlated features (e.g. are no car owning households almost always from lower income groups), so that the final segments represent differing travel behaviours.

The level of demand segmentation proposed within each of the regional models is based on analysis the National Household Travel Survey, in which all respondents note the purpose for making a trip.

5.5 Zoning System:

The zone system disaggregation will be Census SAPS zones and boundaries defined by Census Electoral Districts (EDs). Model zones can be smaller or larger than either of these units where required. The criteria to be used for developing zone boundaries in the regional modelling system include:

- Population, Employment and Education – maximum values will be specified for zone population, number of jobs and persons in education;
- Activity Levels – limits will be applied to zone activity levels ensuring that zones are not created which have very low, or very high, levels of trips;
- Intra-zonal Trips – threshold values will be applied to the proportion of intra-zonal trips, within each zone, to avoid an underestimation of flow, congestion and delay on the network;
- Land Use – zones will be created with homogeneous land use and socio-economic characteristics where possible;
- Zone Size/Shape – thresholds will be applied to zone size, and irregularity of shape, to avoid issues with inaccurate representation of route choice;
- Political Geography – it will be possible to aggregate all zones to ED level i.e. zone boundaries do not intersect ED boundaries;
- Special Generators/Attractors – large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. will be allocated to separate zones.

6 Key Regional Modelling System Components

The regional modelling system will comprise the following key modules:

6.1 Trip End Model

The National Trip End Model (NTEM) will provide estimates of current and future total average week-day travel by all residents of the Republic of Ireland (and to Northern Ireland residents and overseas visitors), taking account of, *inter alia,* input changes in future demographics, employment and household car ownership. These forecasts will be disaggregated by journey purpose, on a production-attraction basis and will be distinguished between from-home, to-home and non-home-based trips. The NTEM will be based on the latest available information from data sources such as the 2011 Census, POWSCAR, and the 2012 National Household Travel Survey (NHTS) for Ireland. The NTEM will endeavour to reflect any significant new trends and influences in trip-making that are apparent from this latest data.

6.2 Demand Model

The demand model component of the regional modelling system will model trip making behaviours such as when travel happens, where it happens and by what mode it happens. The outputs of the demand model will be a series of travel (or trip) matrices representing travel demand. The demand model will include components that model the most significant and well observed travel choices. Common demand model components include destination choice (to model the long term impact of changes in the transport network on choice of destination – particularly for shopping, leisure and other discretionary trips), mode choice and departure time choice (when to make the trip) .

Trip matrices (e.g. for private car) of travel demand in the base year will be developed from data sources such as census travel to work and education information, or using synthetic approaches where the demand between zones is a function of the cost of travel between zones and of trip ends (taken from the NTEM). These trip matrices are then adjusted to represent forecast (i.e. future year) scenarios.

6.3 Road Network Model

The road network model component of the regional modelling system will allocate persons using car and heavy goods vehicles to routes (i.e. roads) between their place of origin and place of destination (i.e. between model zones). It will calculate the time and distance between zones and output the costs of travel for use in the demand model and in economic appraisal.

6.4 Public Transport Network Model

The public transport (PT) network model component of the regional modelling system will allocate PT users to services between their place of origin and their place of destination (i.e. between zones). Costs of travel including walk, wait and in vehicle time, and fares, will be calculated by the PT network model for input to the demand model and economic appraisal. The PT Network Model will include bus, rail and Luas modes.

6.5 Modelling Active Modes

The Regional Modelling System will also represent active modes (i.e. walking and cycling) within the demand model to improve the realism of travel choices.

6.6 Other Modes – Taxis & Goods Vehicles

Taxis and goods vehicles will also be represented within the Regional Modelling System. The mechanism for predicting growth in goods vehicles will be linked to economic forecasts, with specific consideration of key freight generators/attractors (e.g. ports and major freight distribution centres.

7 Overview of Regional Modelling System Structure

The regional modelling system components (described above) will be combined into the high level structure shown in Figure 7.1 which shows five key modelling stages. The ***Trip Generation*** stage (i.e. the Trip End Model) is used to estimate the total quantity of travel demand generated by, and attracted to, each model zone (known as trips ends). The level of demand from, and to, each zone is related to attributes such as population, number of employees and retail floor space.

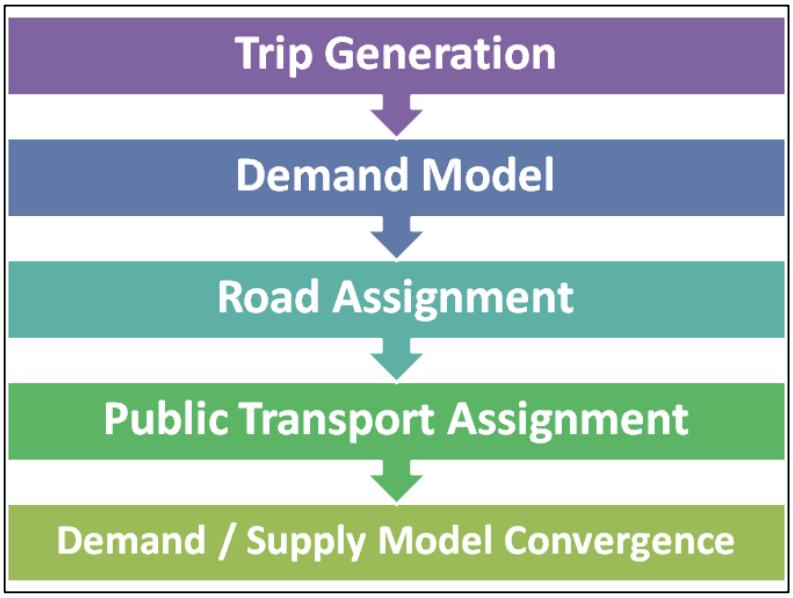


Figure 7.1 Key Modelling Stages

From this information, trip rates are generated which are used to estimate the number of productions and attractions when forecasting to a future year. Trip end totals feed into the demand model.

The ***demand model*** is used to represent travel behaviour and choices such as when, where, and how to travel. It represents all day travel demand, including linked from home / to home trip pairs, which enables more accurate modelling of mode choice behaviour. The demand model processes total all-day travel demand through several choice models to represent combined mode, time of day, destination and parking decision making. It outputs origin-destination travel matrices by mode and time period. These matrices represent total travel in a period of time for all pairs of zones in the modelled area.

These matrices are then used by **Road or Public Transport modelling** processes to find the routes chosen when travelling between zones and hence traffic conditions on the road network and passenger volumes.

8 Regional Modelling System Implementation Process

8.1 Development Strategy

The regional modelling system will be developed to:

- Have a **modularised structure** so that its component procedures and processes are contained within modules. Individual modules can be replaced with a different process or procedure depending on the required uses for the model at a particular time. In addition, where possible[2], modules may also be turned on or off;
- Incorporate an efficient methodology for undertaking transport assessments by providing an analytical toolkit for assessing model outputs. This toolkit will include methods for conveniently extracting the required model data for economic, operational, accident and environmental appraisal and convenient automated methods for comparing the outputs of different modelled scenarios;
- Have a graphical user interface (GUI) to enable a wide user group with varying degrees of technical knowledge of the model system to easily perform single, multiple or partial (e.g. fixed matrix) model runs. The user interface will provide point-and-click functionality for the specification of model assumptions, making the process of running the model easier and faster. Furthermore, this functionality will also provide an audit and reference process to document and control all model runs;
- Be transparent – i.e. the technical detail of the model development and application will be clearly specified to ensure that model outputs are easy to interpret and understand. All key procedures and model components will be supported by extensive technical documentation and the software implementation will be clearly commented and documented;
- Have consistent model software with the full model structure housed within a single model control system (the GUI) to help ensure a seamless flow of model execution and ease of maintenance. This approach will also enable specialised external programmes to be called from the main model as required.

8.2 Hierarchical Regional Modelling System

The regional modelling system will be designed to fit within a hierarchical system. The hierarchical system will include other regional models, each of which will be focussed on

[2] i.e. responses which are based on changes from base-year conditions and which can therefore be turned off without affecting the calibration of the base-year demand model

the travel to work area of major population centres (including: Cork, Dublin Galway, Limerick and Waterford). The hierarchical system will also be structured to be compatible with sub-regional level models that are built specifically to test local schemes and strategies in large towns and settlements. The top-tier will consist of a National Trip End Model (NTEM) that will use land use forecasts based on agreed and consistent national and regional forecasts to derive daily travel demand for the country as a whole.

Each regional model will link directly to the NTEM as the first stage of the model structure to provide the facility to undertake regional testing of land use impacts on the transport network. There will be consistency between the zoning systems of both tiers. The regional modelling system will share common zone boundaries with the NTEM, enabling fluid conversion of data to the appropriate level of detail.

The third tier in the hierarchy will be local transport models that can be developed for specific transport appraisal and assessment purposes. They will typically be more detailed than the regional level to allow assessment of local schemes. They will inherit travel forecasts and other data from the 2nd tier regional models. The regional modelling system will include procedures for using models across all hierarchy tiers. These measures will ensure consistency of application when required.

8.3 Next Steps for Regional Modelling System Development

The NTA will develop the regional model for the Greater Dublin Area (GDA) and use this as the 'template' for the other regional city models. The reasons for focusing work initially on the GDA model include:

- There is a requirement to undertake a review the GDA strategic transport plan in the next 12 months – a new model, founded on recent transport and travel observations and developed using best modelling practice will help underpin this work;
- The GDA is the most-complex of the regions from a transport perspective and is likely to require more modelling functionality than other regions. It is more straightforward to *turn off* model functionality from within an existing model structure than it is to add functionality later. Therefore building in 'all anticipated' model requirements for the GDA area will help ensure all functionality required for every other regional area has been addressed;
- There are on-going applications of the existing GDA model that allow testing and comparison of a new modelling template with an existing model; and
- There is greater transport and travel data availability within the Dublin area to be able to incorporate and confirm 'new' model parameters.

The order of the development of the other regional models will be based on requirement (i.e. as specific applications requiring multi-modal models are identified) or in decreasing order of regional population (i.e. to maximise the coverage of the Irish population with

appropriate regional modelling as quickly as possible), or in some combination of these two approaches.

9 User Engagement

The Regional Modelling System will play a crucial role in policy and scheme assessment for the NTA and for other agencies and development authorities. Processes for Model Control and User Engagement will ensure consistency of assessment, and quality control over how the model is maintained. The following will be the key tests of Model Control and User Engagement:

- Ensuring best practise principles are employed when using the model for transport assessment and appraisal;
- Monitoring and documenting the use of the model;
- Enhancing and strengthening the credibility of model;
- Promoting the model among key stakeholders;
- Engaging with potential end users of the model and understanding their needs and advising them on an appropriate course of action;
- Promoting technical excellence in the performance of transport modelling assessments using the model;
- Evaluating the performance of the model on a regular basis to ensure all key objectives are achieved; and
- Developing a programming of training & user awareness of the model.

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