REGIONAL MODELLING SYSTEM

RM Spec4 Active Modes Model Specification 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 Introduction

1.1 Regional Modelling System

The NTA has developed a Regional Modelling System for the Republic of Ireland to assist in the appraisal of a wide range of potential future transport and land use options. The regional models are focused on the travel-to-work areas of the major population centres of Dublin, Cork, Galway, Limerick, and Waterford. The models were developed as part of the Modelling Services Framework by the NTA, SYSTRA and Jacobs Engineering Ireland.

An overview of the 5 regional models is presented below in both Table 1.1 and Figure 1.1

Table 1.1 Regional Models and their Population Centres

Model Name	Code	Counties and population centres
West Regional Model	WRM	Galway, Mayo, Roscommon, Sligo, Leitrim, Donegal
Eastern Regional Model	ERM	Dublin, Wicklow, Kildare, Meath, Louth, Wexford, Carlow, Laois, Offaly, Westmeath, Longford, Cavan, Monaghan
Mid-West Regional Model	MWRM	Limerick, Clare, Tipperary North
South East Regional Model	SERM	Waterford, Wexford, Carlow, Tipperary South
South West Regional Model	SWRM	Cork and Kerry

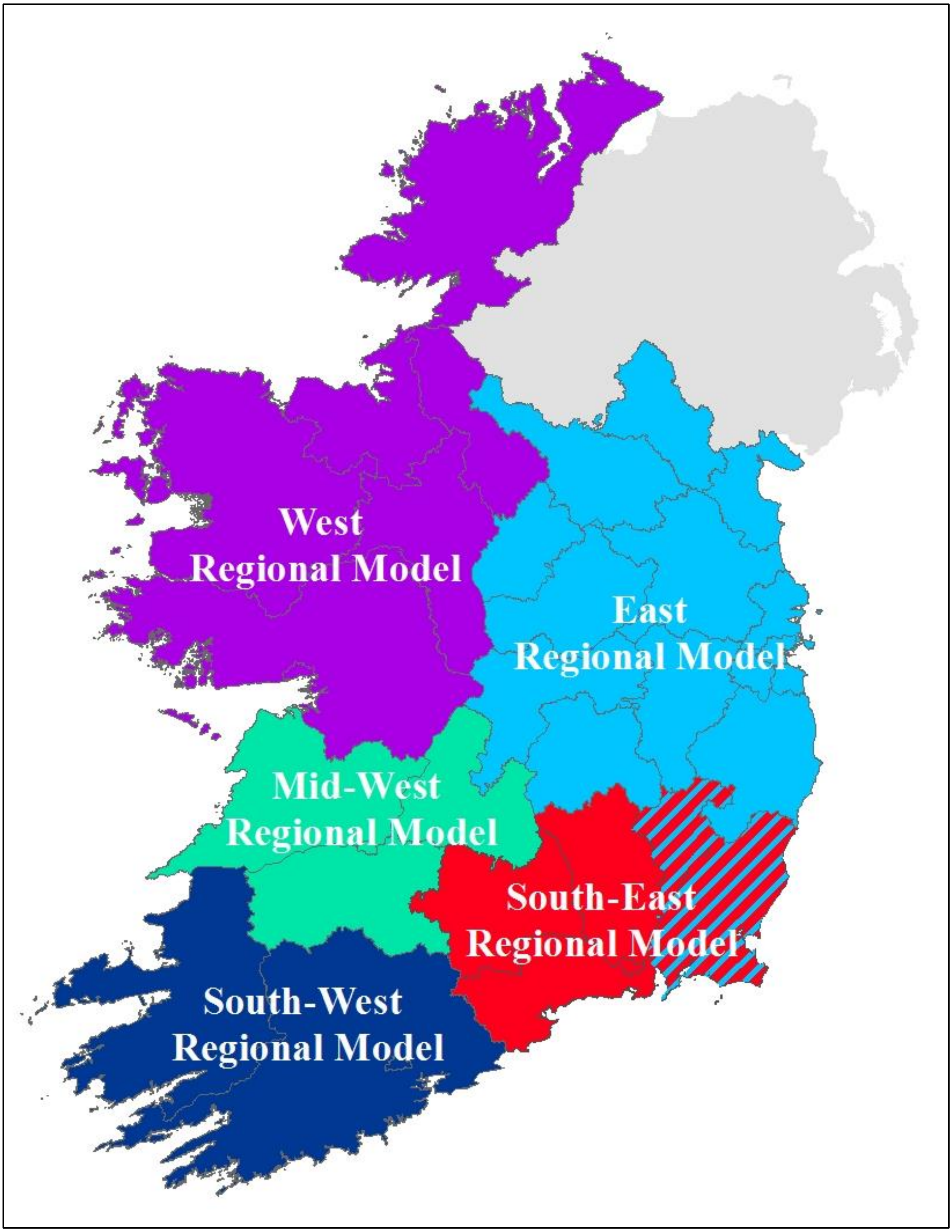

Figure 1.1 Regional Model Areas

1.2 Development of the Active Modes Model Specification

This report presents the specification for the Active Modes Model components of the NTA regional models. This specification has been principally prepared to enable the development of the Eastern Regional Model, however it is expected that the other regional models will follow the same specification.

Four technical notes have been prepared that provide the basis for the specification of the update of the Greater Dublin Area (GDA) Model, which are as follows:

- RMS Scope 1 NTA Modelling Needs Review;
- RMS Scope 2 Greater Dublin Area Model Review;
- RMS Scope 3 Transport Modelling Best Practice Review; and
- RMS Scope 4 Modelling Data Review

In addition to the above documents an initial scoping task for the Active Modes Model was undertaken as part of Task Order 8.1: Demand Modelling Scoping, Sub-Task 6: Active Modes [FDM Scope6 Active Modes]. These documents, alongside the Regional City Model Scoping Report have formed the foundations for the specification of the AMM and its development, which is described in this report.

TAG unit A5-1 provides guidance on active mode appraisal including demand forecasting, which can be found via the following web link. With no specific Irish equivalent, this document will be used as the primary point of guidance for the AMM specification and development in conjunction with the expertise and experience of NTA staff and the Consultants.

https://www.gov.uk/government/publications/webtag-tag-unit-a5-1-active-mode-appraisal

TAG unit M1, Principles of Modelling and Forecasting, also provides a useful context for the specification of the active modes model and procedures:

https://www.gov.uk/government/publications/webtag-tag-unit-m1-1-principles-of-modelling-and-forecasting

1.3 RMS Model Structure

The Regional Modelling System is comprised of three main components, namely:

- The National Demand Forecasting Model (NDFM);
- 5 Regional Models; and
- A suite of Appraisal Modules.

The modelling approach is consistent across each of the regional models. The general structure of the regional models is shown below in Figure 1.2. The main stages of the regional modelling system are described below.

1.3.1 National Demand Forecasting Model (NDFM)

The NDFM is a single, national system that provides estimates of the total quantity of daily travel demand produced by and attracted to each of the 18,488 Census Small Areas. Trip generations and attractions are related to zonal attributes such as population, number of employees and other land-use data. See the NDFM Development Report for further information.

1.3.2 Regional Models

A regional model is comprised of the following key elements:

Trip End Integration

The Trip End Integration module converts the 24-hour trip ends output by the NDFM into the appropriate zone system and time period disaggregation for use in the Full Demand Model (FDM).

The Full Demand Model (FDM)

The FDM processes travel demand and outputs origin-destination travel matrices by mode and time period to the assignment models. The FDM and assignment models run iteratively until an equilibrium between travel demand and the cost of travel is achieved.

Assignment Models

The Road, Public Transport, and Active Modes assignment models receive the trip matrices produced by the FDM and assign them in their respective transport networks to determine route choice and the generalised cost for origin and destination pair.

The Road Model assigns FDM outputs (passenger cars) to the road network and includes capacity constraint, traffic signal delay and the impact of congestion. See the RM Spec 2 Road Model Specification Report for further information.

The Public Transport Model assigns FDM outputs (person trips) to the PT network and includes the impact of capacity restraint, such as crowding on PT vehicles, on people's perceived cost of travel. The model includes public transport networks and services for all PT sub-modes that operate within the modelled area. See the RM Spec 3 Public Transport Model Specification Report for further information.

Secondary Analysis

The secondary analysis application can be used to extract and summarise model results from each of the regional models.

1.3.3 Appraisal Modules

The Appraisal Modules can be used on any of the regional models to assess the impacts of transport plans and schemes. The following impacts can be informed by model outputs (travel costs, demands and flows):

- Economy;

- Safety;
- Environmental;
- Health; and
- Accessibility and Social Inclusion.

Further information on each of the Appraisal Modules can be found in the following reports:

- Economic Module Development Report;
- Safety Module Development Report;
- Environmental Module Development Report;
- Health Module Development Report; and
- Accessibility and Social Inclusion Module Development Report

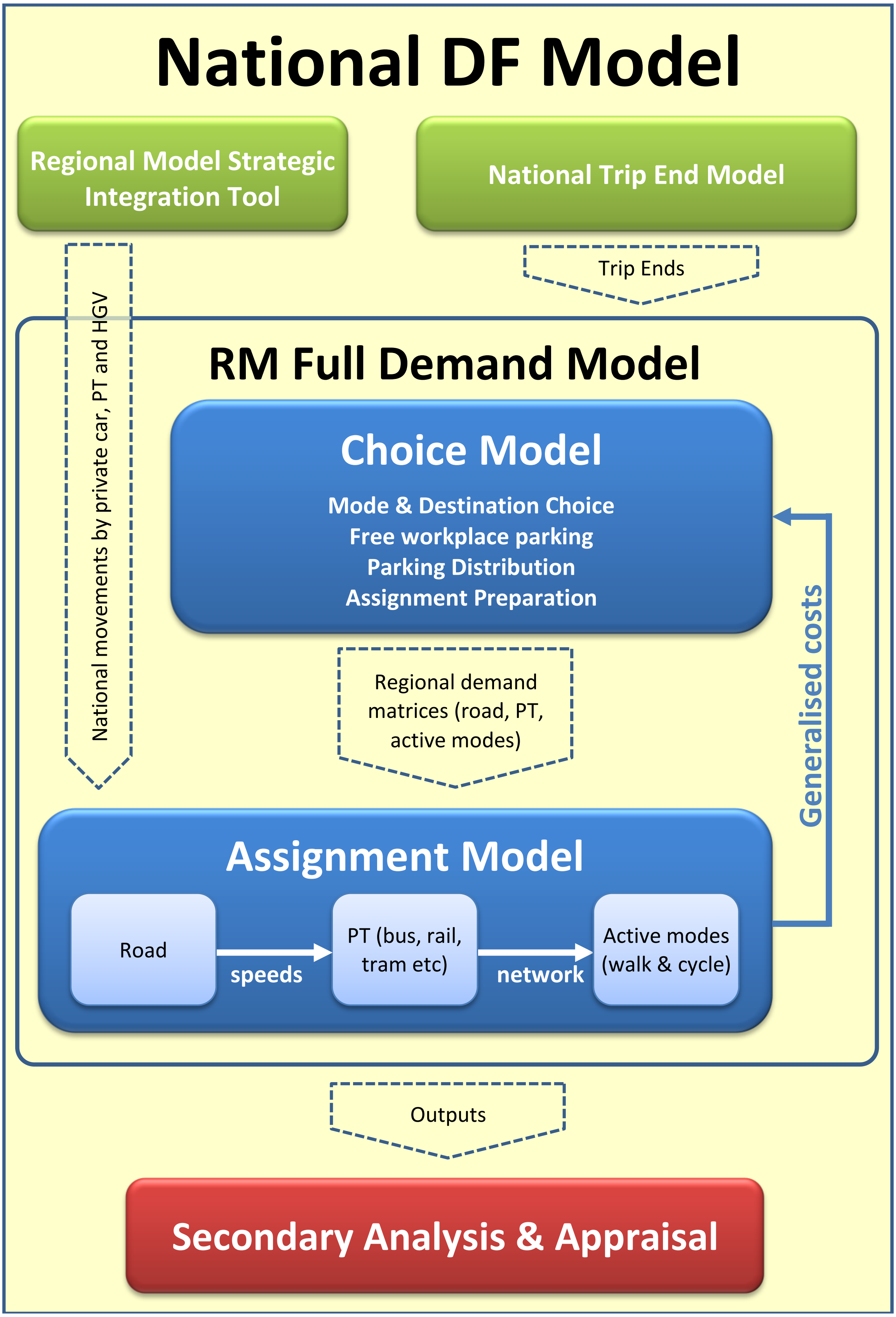

Figure 1.2 Model Structure

1.4 Structure of this Report

This report contains two chapters as follows:

- Chapter 2 RMS Active Modes Model Overview: provides an overview of the RMS Active Modes Model (AMM); and
- Chapter 3 RMS Active Modes Model Specification: describes the specification of the RMS AMM.

2 RMS Active Modes Model Overview

2.1 Introduction

Figure 2.1 provides an overview of the AMM structure. The AMM includes representation of network supply, travel demand, and assignment procedures to calculate routes and travel costs. The figure also shows the relationship with other model components.

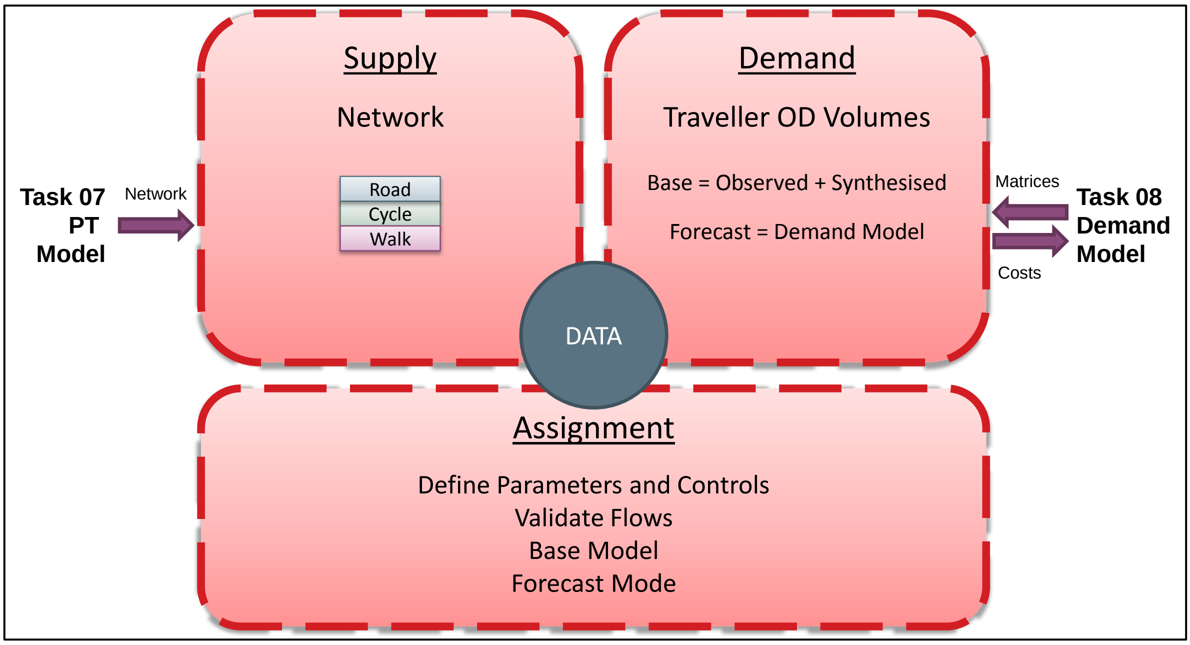

Figure 2.1 AMM Structure Overview

2.2 Linkages with Regional Modelling System

The development of the AMM is inter-dependent with the development of other parts of the overall model. These linkages are highlighted in later sections where relevant and can be summarised as follows.

- Definition of Zone System
  - definition of zonal boundaries for the AMM.
- System Architecture
  - coordination of the overall modelling;
  - standardisation of models (e.g. scripts, procedures, units).
- Road Model and Public Transport Model
  - interchange of network details.
- Demand Model
  - the provision of assignment matrices;
  - the provision of generalised costs from the AMM to the overall demand model application.

3 RMS Active Modes Model Specification

3.1 Overview

The purpose of the Active Modes Model (AMM) is to allocate pedestrians and cyclists to routes between their origin and destination zones. The model will be representative of the walk and cycle network throughout the relevant modelled area, with particular focus on the representation within urban areas where walk and cycle trips are most prevalent. Costs of travel are calculated within the AMM for input to the demand model.

The aspects of the AMM which are specified in this note include:

- the **time periods** to represent;
- **the segmentation of travel demand** (e.g. by journey purpose);
- **network preparation**;
- **the assignment routines** used to allocate travellers to the network;
- **the parameters** used within the assignment; and
- **suitable validation** of the model.

This chapter describes the specification of the AMM.

3.2 Data Sources

Appropriate data is an essential input for the development of the AMM, particularly to build the AMM network, to prepare demand matrices, derive parameter values and provide observed validation data. The various data sources include:

- **NTA Journey Planner –** this includes a range of network data on walk and cycle network characteristics; of particular interest was the “Introute” data, which is based on NavTEQ data, but with additions and modifications to line work and attributes. The additional information includes:
    - Footpath matrix;
    - Cycle Lanes;
    - Bus Lanes; and
    - Pedestrian Crossings

Note that the coverage and detail of Journey Planner / Introute data sources may vary by region.

- Census POWSCAR data;
- National Household Travel Survey Diary (NHTS); and
- Walk and Cycle Cordon Counts.

3.3 AMM Zone System

The AMM will use the same zone system as the overall relevant regional model. The version of the zone system to be used for initial AMM development in the ERM (v1) is as described in the ERM Zone System Development Report and shown in Figure 3.1 below.

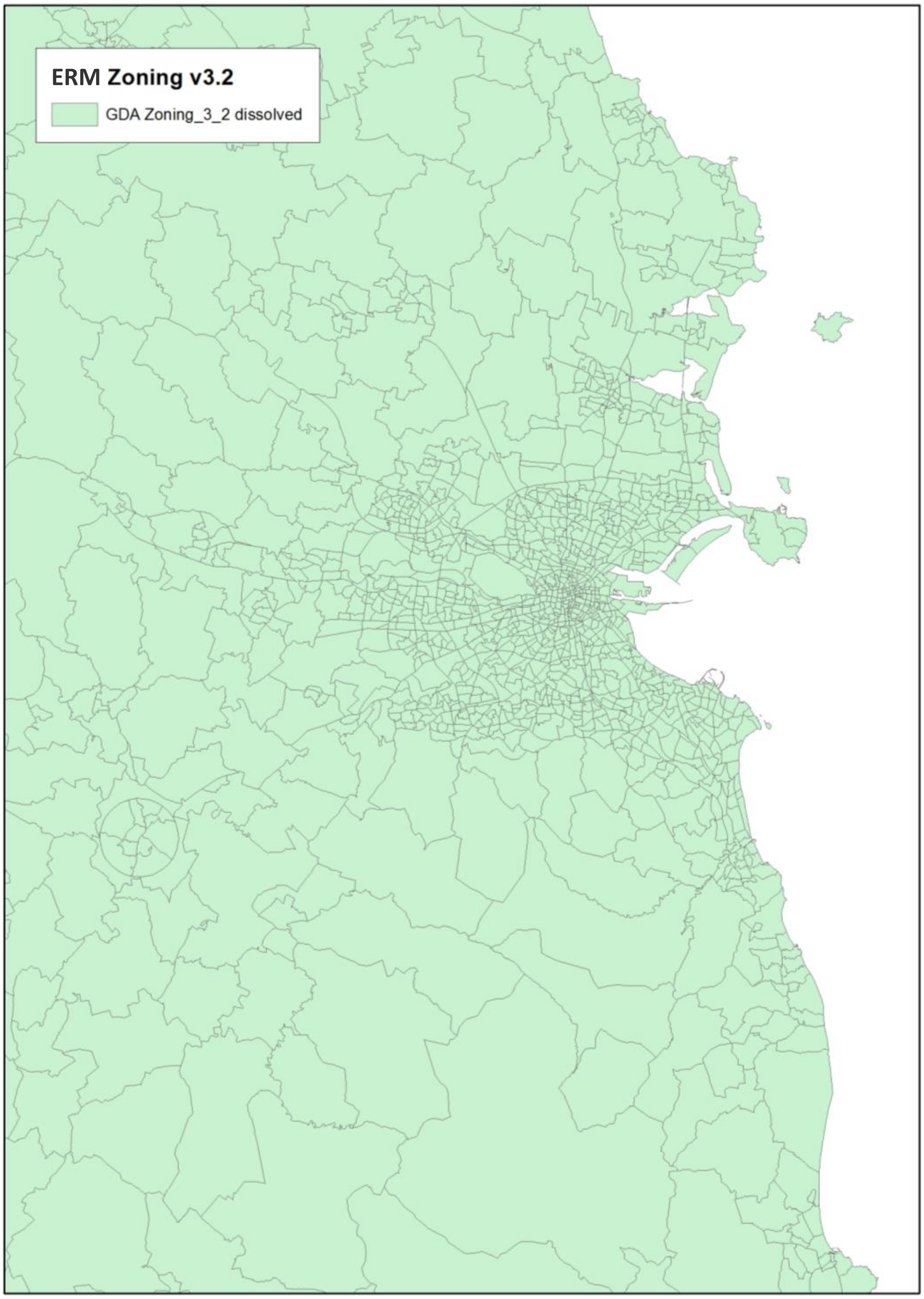

Figure 3.1 ERM model Zone System v3.2

3.4 AMM Base Year

The base year of the model will be 2012 with a nominal month of April. This is largely driven by the time of POWSCAR and NHTS surveys. It should be noted that the POWSCAR dates to 2011 but the travel patterns are assumed to be broadly the same in 2012.

3.5 Optional Time Period and User Class Reduction

The AMM will have consistent time period specification as the PT model component of the relevant regional model. Generally the required number of time periods will be 4, as set out in the section below. If runtime improvements are necessary (which may be particularly relevant to the ERM – the largest of the models), an option to reduce the number of modelled time period to 3 has been made available.

3.6 AMM Time Periods

Table 3.1 details the standard 4 weekday periods that will be modelled in the AMM in each of the regional models. Peak hour factors, to be applied to AM or PM full period demand, are determined from analysis of count data in each regional model area. For the non-peak periods, the assignment matrices are created by averaging the full period demand to a single average hour.

Table 3.1 AMM Time Periods

PERIOD	FULL PERIOD FOR DEMAND MODEL	ASSIGNMENT PERIOD
AM Peak	07:00-10:00	Peak Hour (appropriate factor must be calculated)
Lunchtime (IP1)	10:00-13:00	Average of Period
School Run (IP2)	13:00-16:00	Average of Period
PM Peak	16:00-19:00	Peak Hour (appropriate factor must be calculated)
Off Peak	19:00-07:00	Not Assigned

3.7 AMM Modes

Travel movements split by walk and cycle sub-modes will be produced by the demand model. These will be assigned separately reflecting the difference in walk and cycle routing and speed. Walk trips will be assigned to the shortest distance route, assuming a constant speed, and cycle trips will be assigned based on the quickest journey time influenced by available infrastructure, e.g. off-road cycle ways.

3.7.1 Representation of the Impact on Other Modes

The impact of pedestrian activity (use of pedestrian crossings, jay-walking etc.) on other modes will not be modelled in the regional models. Similarly for cycling, there will be no representation of the impact of changes in levels of cycling activity on other modes, including the impact of cyclists on road or junction capacity or traffic speeds etc.

3.8 Journey Purposes

The AMM journey purposes are the exact same as the demand model and are as follows:

- ***employers-business*** (EMP), trips on employers business;
- ***commute*** (COM), commuting trips between home and work;
- **education** (EDU), primary, secondary and tertiary student trips between home and place of education;
- ***other*** (OTH), other journey purposes;

Walk and cycle demand matrices will be output by the Demand Model for each segment.

3.9 Model Network

The AMM will be developed in CUBE Voyager using the latest release versions of the software (CUBE 6.1.0 is used for ERM v1). The model will also be designed for use within a Windows 7 operating system.

A single network will be used as the input to the AMM based on the combination of the components detailed in the section below.

3.9.1 Active Modes Network Components

The AMM network is a combination of the following components:

- **road network** from the relevant regional road model;
- **walk network** additional to the road network (e.g. short cuts, routes through parks, footbridges);
- **cycle network**, including additional off-street cycle paths, and information on quality derived from the NTA Journey Planner (see 3.9.2 below).

NTA journey planner data (e.g. 'Introute'/NavTeq, see Section 3.2 above) forms the basis for much of the additional walk and cycle network.

The PT Model includes most of the necessary additional walk network. In order to retain the connectivity provided by walk links in the PT model, the road network in the AMM will be based on the full PT network except Rail and Luas links (Link_type 27). This will be automatically copied by the modelling procedures, and all 1-way links inherited from the PT model network will be reversed by the process, to allow walking in both directions. Zone connectors used in the active modes network are the same as in the PT network. Motorway links will be inaccessible to walk and cycle modes.

3.9.2 Walk Network Speed Calculation

Average walk and cycle speeds differ by age. To take this into account in the Active Modes Model, three age categories have been defined and average walk and cycle speeds calculated based on National Household Transport Survey 2012 data. Age categories considered and average walk speeds calculated are:

- 0 to 20 years: 4.9km/h;
- 20 to 60 years: 5.1km/h; and
- Over 60 years: 4.4km/h.

3.9.3 Cycle Network Speed Calculation

To assign cycling speeds to network links it was necessary to estimate a relationship between the quality of cycle path (based on available information) and cycling speed.

The first step was using available evidence to estimate an appropriate range of cycling speeds. The NHTS 2012 suggests that average cycling speed is 11.7 km/h. A frequency distribution of cycle speeds recorded in the NHTS is presented in Figure 3.2 below:

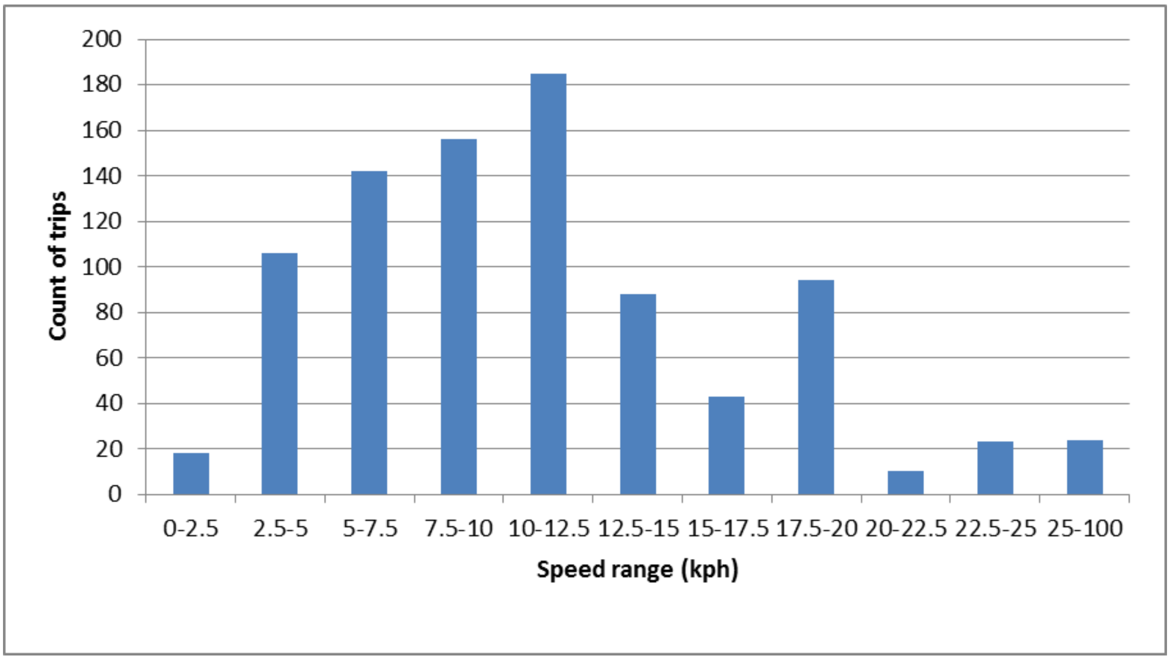

Figure 3.2 NHTS Cycle Speed Distribution

The NHTS average speed of 11.7 km/h was assumed to be representative of cycling speeds without any special facilities that could be assumed to increase the expected speeds, e.g. dedicated cycle ways.

The WebTAG data book was then used to estimate factors of the minimum speed (11.7 km/h) according to the type of facilities present. The base speed was rounded to 12 km/h for use in the model and in subsequent calculations.

Table 4.1.6 of WebTAG provides journey ambience benefits of cycle facilities (relative to no facilities). These values were used to calculate a speed increase, assuming the perceived relative cost saving could be directly translated to relative times. A value of time of £8.05 was assumed, and a £/€ conversion rate of 1.2, i.e., €9.66 per hour.

Using these assumptions, values were calculated for the speed increase above the average. The full set of perceived benefit weightings and associated speed increase calculations are shown in the table below.

Table 3.2 Cycle Facilities Journey Ambience Benefits

Scheme type	Value p/min or pence(if *)	Source	Speed increase
Off-road segregated cycle track	7.03	Hopkinson & Wardman (1996)	63%
On-road segregated cycle lane	2.99	Hopkinson & Wardman (1996)	27%
On-road non-segregated cycle lane	2.97	Wardman et al. (1997)	27%
Wider lane	1.81	Hopkinson & Wardman (1996)	16%
Shared bus lane	0.77	Hopkinson & Wardman (1996)	7%
Secure cycle parking facilities	98.14*	Wardman et al. (2007)	
Changing and shower facilities	20.82*	Wardman et al. (2007)	

Using the above information, gives a potential maximum average speed across all cyclists of 1.63*12, which when rounded to the nearest integer, is 20 km/h.

The minimum and maximum speeds (for average use of particular facilities) are hence set as follows in the table below.

Table 3.3 Minimum and Maximum Cycle Speeds

	Min (no cycle facility)	Max (on best cycle facility)
Base Network speed (km/h):	12	20

The next step was to assign speeds within the range defined above to various link types, depending on the level of information available on the quality of the road space for cyclists.

The primary source of information is the Quality of Service attribute, which is defined by the NTA National Cycle Manual, and assigned to links in the NTA Journey Planner road/cycle network. There is a direct relationship provided between the QoS and the typical level of journey time delay for each of 5 categories. The values are shown in Table 5 below, along with the value chosen for the estimation of cycle speeds. The modelled value is the % reduction applied to the speed difference between the best facilities for cyclists, and roadway with no provision for cyclists.

Table 3.4 Quality of Service Based Cycle Speeds

Quality of Service	Journey time delay (% of total travel time)	Modelled Value	Speed Increase (km/h)	Modelled Speed (km/h)
A+	0 - 5%	0%	8	20
A	6 - 10%	10%	7.2	19.2
B	11 - 25%	20%	6.4	18.4
C	26 - 50%	35%	5.2	17.2
D	>50%	60%	3.2	15.2

Where no QoS information is available, link characteristics and/or type information can be used to calculate a speed. Some links have type only defined. These are as set out in the table below, with assumed speeds for those links relative to the minimum:

Table 3.5 AMM Time Periods

Type speed table	Speed Increase (km/h)
L1 - Mandatory (Solid Line)	6.4
L2 - Advisory (Dashed Line)	3.2

The link type value of L1 has been equated to QoS level B, and L2 to a QoS of D, in order to provide the values in the table above.

Link characteristics, and associated speed assumptions, are as set out in the table below. The table also shows how the speed assumptions are changed depending on whether there is also link type information available. If no link type is available, the standard assumption is as per the L1 column. Hence, the alternative values, as shown in the last column, are only used when there is an L2 link type value on the link. The L2 values are derived from L1 by assuming the associated speed increase is 0.75 that of the L1 values.

Table 3.6 Link Characteristic and Type Based Cycle Speeds

Char & Type speed table	Speed Increase (km/h)	
	L1 - Mandatory (Solid Line) **Standard Assumption**	L2 - Advisory (Dashed Line)
B1 - Bus Lane (no cycle lane)	0.8	0.6
C1 - Cycle Track - separated from road	7.5	5.6
C2 - Cycle Track - immediately adjacent	3.2	2.4
C3 - Cycle Lane (even within Bus Lane)	3.2	2.4
G1 - Cycle Trail or Greenway	7.5	5.6
S1 - Shared with Traffic	0.8	0.6
S2 - Shared Space (Ped's)	0.8	0.6

The variation in the level of 'cycle-friendliness' journey time estimates should be sufficient to capture the benefits of additional cycle lane provision, both in terms of the reduction in perceived journey time for cyclists and the resulting increase in the cycling mode share in the improved corridors.

3.10 Assignment Methodology

The AMM will use the Voyager Highway assignment method. The choice of route will be based solely on the estimated network link times for walk and cycle separately, which are described above. The assignment will be a simple 'All or Nothing' shortest path approach, with no capacity or 'speed-flow' effects – i.e. the speed on the links will not be affected by the number of pedestrians or cyclists using that link. Walking and cycling will be banned on motorways, railways, LUAS links etc.

To provide non-zero costs for intrazonal movement to the demand model, the following assumptions are suggested as starting point for model development:

- Intrazonal walk cost is calculated as 40% of the minimum non-zero walk cost from the zone, capped by the walk cost for 1.5km.
- Intrazonal cycle cost is calculated as 40% of the minimum non-zero cycle cost from the zone, capped by the cycle cost for 2.5km.

It should be noted that cost capping can have a significant influence on costs and hence the responses of the demand model. It is recommended that any caps are rigorously tested during demand model calibration to examine effects on mode share and trip length distributions.

3.11 Calibration/Validation

Calibration/Validation of the AMM will compare the modelled pedestrian and cyclist flows with equivalent observed data across screenlines/cordon where available.

It should be noted that observed counts of pedestrians, particularly in the city centres, will include overseas (and NI) visitors who are not included in the national trip end model or elsewhere in the demand model. The AMM is unlikely include sufficient detail of the features which may affect pedestrian or cyclist route choice and it is therefore unlikely to be able to accurately predict flows on individual links.

If appropriate walk/cycle data are available, the total volume of pedestrians and cyclists crossing at screenlines could be considered in the overall model calibration process, and possibly used to inform adjustments to the mode choice model to match overall levels of observed flow (with due consideration to the above caveat on the relevance of observed pedestrian data to the modelling). The assignment of flows in the AMM will not be calibrated to observed data at the link level.

Walk flows output from the Public Transport model (walk trip between zones and PT stops) should also be considered in the validation process, as such trips are indistinguishable in the data. Both flows (from the AAM and the PT model) should be combined for comparison against counts.

All validation data should be tabulated and provided in full in the relevant AMM Development Report.

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