REGIONAL MODELLING SYSTEM

Modelling Services Framework

East Regional Model

Full Demand Model Calibration Report

Údarás Náisiúnta Iompair
National Transport Authority

CONTENTS

Tables

Figures

Foreword

The National Transport Authority (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 NTA, SYSTRA and Jacobs Engineering Ireland.

The Regional Modelling System comprises the National Demand Forecasting Model (NDFM), 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 the 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 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 area of coverage

Model Name	Code	Counties and population centres
West Regional Model	WRM	Galway, Mayo, Roscommon, Sligo, Leitrim, Donegal
East 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

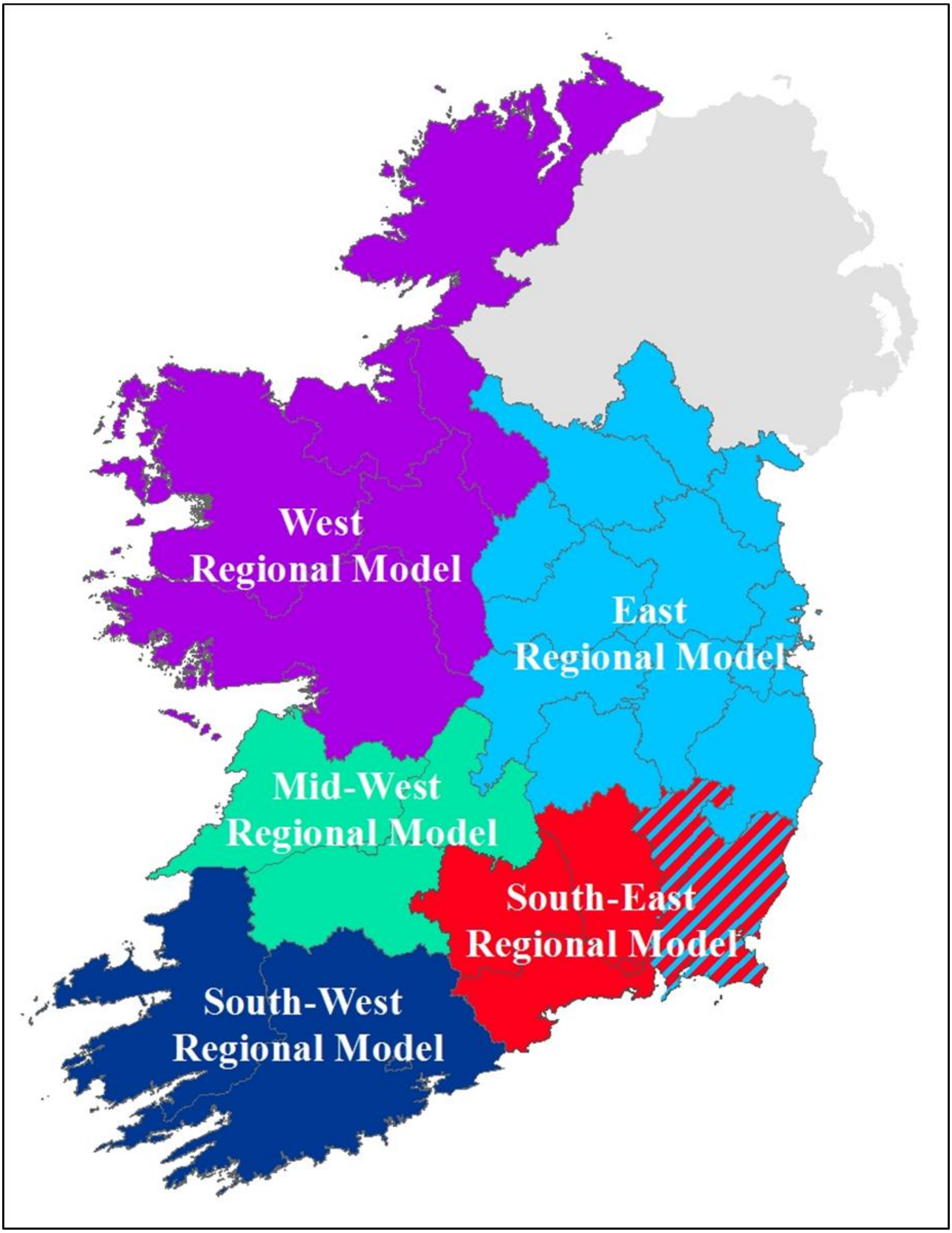

Figure 1.1: Regional Model Areas (the ERM and SERM overlap in the hashed area)

1.2 Regional Modelling System 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 ERM (and the other regional models) is shown below in Figure 1.2. The main stages of the regional modelling system are described below.

1.2.1 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.

1.2.2 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 Spec2 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 Spec3 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.

1.2.3 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.

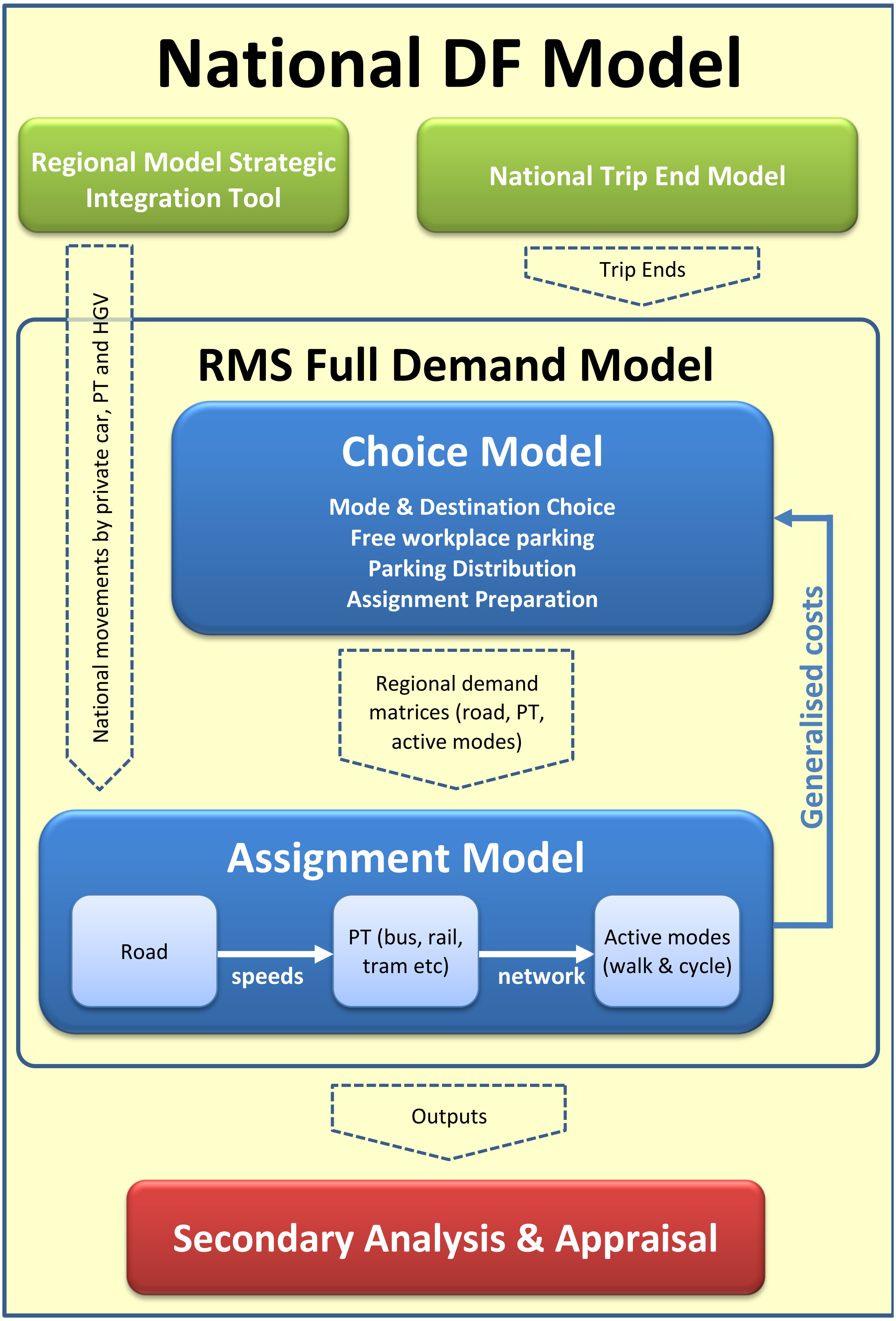

Figure 1.2: National and Regional Model Structure

1.3 Full Demand Model (FDM)

The full demand model is common across all five regions of the RMS. Its form is of the 'absolute' type, so trip matrices for each forecast year are calculated directly from input trip ends and costs. Figure 1.3 on Page 9 shows an overview of the different modules of the FDM, including those which have yet to be fully implemented (in green). The purpose of the FDM is to take input trip ends (at the 24-hour level) and costs (from the road, PT and active modes assignment models) and then to allocate trips to different time periods, modes and destinations for input to the peak-hour road, PT and active modes assignment models.

The FDM consists of the following modules:

- **Trip End Integration:** Converts the 24 hour trip ends output by the National Trip End Model (NTEM) into the appropriate zone system and time period disaggregation for the RMS;
- **Add-in Preparation:** Takes the output of the Regional Model Strategic Integration Tool (RMSIT), factors it if necessary, and converts it into the zone system and time period disaggregation required by the RMS. In addition, it also reads in internal goods movements, and can apply a growth factor to them, and subtracts the long distance movements from the trip ends passed on to the later stages of the model;
- **Initialisation:** Converts the trip ends into tours and the costs into the required formats;
- **Tour Mode & Destination Choice:** Calculates where each production trip end will match with an attraction trip end, and by what mode the trip will be made, given the time when the trip will take place;
- **Free Workplace Parking:** For the journey purposes which have free workplace parking the initial mode & destination choice does not include parking charges. This module takes the initial car demand and decides whether it can be accommodated in the available free workplace parking spaces. For the proportion of the car matrix which cannot be accommodated, and for the corresponding proportions of the other mode matrices, it undertakes a secondary mode split including parking charges;
- **One Way Mode & Destination Choice:** Similar to the main mode & destination choice stages except that it works on the one way trip inputs;
- **Special Zone Mode Choice:** Models mode choice for zones such as ports and airports which are forecast differently than the regular population. Demand must be input for the peak hour in each time period;
- **User Class Aggregation:** Aggregates the initial 33 trip purposes into five user classes for further processing;
- **Park & Ride:** This module takes the trips assigned to Park & Ride by the mode & destination choice stage, works out which Park & Ride site each will use, and outputs the car and PT legs of each trip as well as information to be used in the calculation of the generalised costs;

- **Parking Distribution:** This allows car trips to park remotely from their destination, which is critical where parking capacity is limited or cheaper parking is available nearby. It only applies to certain areas in each of the regional models. The module gives car trips the choice to park in a number of alternative zones, based on the total trip cost and adds a penalty to over-capacity zones. It outputs the car and walk legs of each trip, as well as information to be used in the calculation of the generalised costs;
- **Parking Constraint:** For models where the details of parking distribution are not of interest this module can be used to apply a basic limit on car demand.
- **Tour to Trip Conversion:** Takes the tour based information, including that using free workplace parking, and converts it into the outbound and return legs needed by the assignment;
- **Assignment Preparation:** Combines the tour based and one way trips, special zone movements and Add-ins and applies vehicle occupancy and period to peak hour factors as appropriate. It also applies incremental adjustments, calculates taxi matrices and allows for greenfield development input;
- **Road Assignment Model:** Uses SATURN to assign traffic to the road network and generate costs;
- **PT Assignment Model:** Assigns public transport demand and generates costs;
- **Active Modes Assignment Model:** Assigns walk and cycle demand and generates costs;
- **Generalised cost calculations:** Takes the road, PT and active modes costs and processes them to generalised costs. It also calculates costs and cost adjustments for Park & Ride and Parking Distribution affected trips;
- **Convergence Check:** Undertakes a comparison of costs and demand from each successive loop to identify if the model has converged within acceptable criteria.

The following module is not yet fully implemented or tested:

- **Macro Time of Day Choice:** This module has not yet been implemented due to a lack of data on time choice behaviour. If implemented, it will allow trips to shift between macro time periods (e.g. from 7-10am to 10am-1pm).

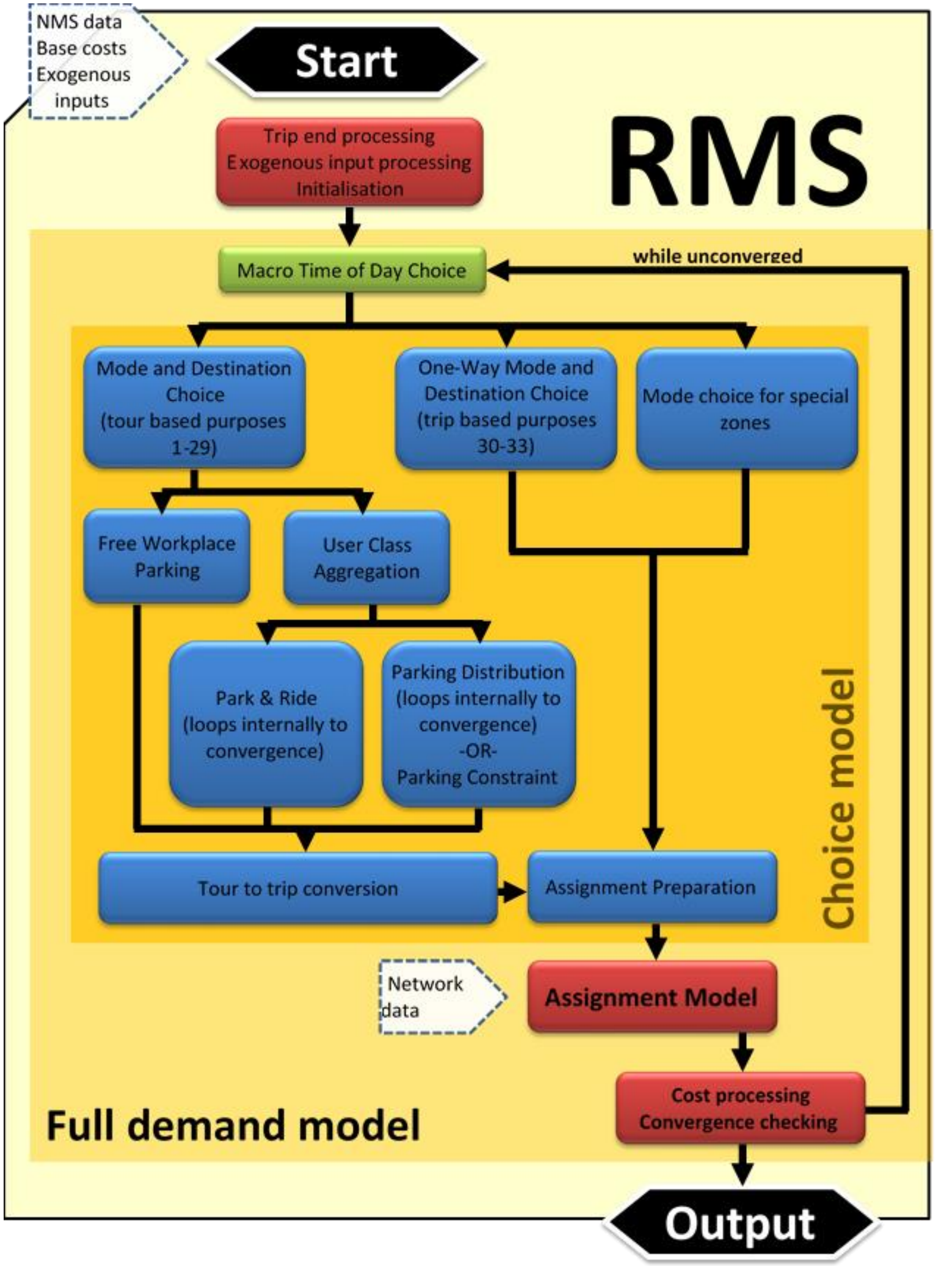

Figure 1.3: RMS Model Structure Overview

1.4 Report Library

This report is one document in a library of reports which describe various aspects of the scoping, building, development, calibration and validation of the NDFM and the five regional models.

The NDFM is covered in detail in the report:

- NDFM Development Report

The scoping of the RMS FDM is covered in a number of reports:

- FDM Scope1 Demand Modelling Workshop Recommendations
- FDM Scope2 Demand Segmentation
- FDM Scope3 Modelling Time of Travel
- FDM Scope4 Trips, Tours and Triangles
- FDM Scope5 Car Ownership Scoping Report
- FDM Scope6 Active Modes
- FDM Scope7 Parking Model Specification
- FDM Scope8 Goods Vehicle Model Specification
- FDM Scope9 Taxi Model Specification
- FDM Scope10 Airport and Other Special Zones
- FDM Scope11 External Zones
- FDM Scope12 Base Year Matrix Building
- FDM Scope13 Incorporation of Road Assignment
- FDM Scope14 Public Transport Assignment
- FDM Scope15 Choice Model Specification
- FDM Scope16 Trip End Integration
- FDM Scope17 Modelling of Greenfield Developments
- FDM Scope18 Regional Transport Model Exogenous Variables

The full, and finalised FDM specification is reported in:

- RM Spec1 Full Demand Model Specification Report

The detailed development and testing of the FDM is covered in:

- RM Full Demand Model Development Report

This report deals with the calibration and validation of one of the five RMS models, the East Regional Model.

The following reports deal with FDM calibration and validation for the other RMS regions.

- WRM Full Demand Model Calibration Report
- SWRM Full Demand Model Calibration Report
- MWRM Full Demand Model Calibration Report
- SERM Full Demand Model Calibration Report

Three additional reports give detailed information on the development, calibration and validation of the ERM assignment models:

- ERM Road Model Development Report
- ERM Public Transport Model Development Report
- ERM Active Modes Model Development Report

1.5 This report: Calibration and Validation of the RMS for the Eastern Region (ERM)

This report focuses on the calibration and validation of the RMS in the Eastern Region, otherwise known as the East Regional Model or ERM, including a description of the underlying theoretical process and the individual test runs conducted in the process of refining the model output. The report chapters include:

- **Chapter 2: RMS Full Model Calibration Methodology:** gives an overview of the theoretical process of calibrating and validating the FDM in general terms.
- **Chapter 3: Full Demand Model calibration test history:** in this chapter there is a detailed history of the various test runs undertaken in the process of calibrating the FDM.
- **Chapter 4: Final calibration / validation results:** presents the detailed calibration and validation results.
- **Chapter 5: Realism Testing:** the model's response to sensitivity or realism tests is outlined.
- **Chapter 6: Conclusion:** provides a summary of the process of model calibration and validation and makes recommendations for further work.

1.6 A note on terminology

There are five time periods in the model, one for the off-peak (OP), one for each of the morning and evening peaks (AM and PM) and two for the interpeak. The interpeak time periods were initially labelled 'lunchtime' referring to the period between 10:00 and 13:00 (LT) and 'school run' referring to the period between 13:00 and 16:00 (SR). These were later re-labelled as IP1 and IP2. However, as IP1 and IP2 are three letter codes whereas all of the original codes were two letter codes there were technical reasons why it was easier to retain the LT and SR labels in a number of places. The terms LT and IP1 are therefore used interchangeably, as are SR and IP2.

2 RMS Full Model Calibration Methodology

2.1 Introduction

Calibration involves the adjustment of the parameters which control the road, public transport and demand models, so that model predictions of flow and demand are as close to the observations as possible. Each NTA regional model is calibrated using the same process, which can be divided into distinct stages as shown below in Figure 2.1.

The calibration of the overall model requires the improvement of road and PT network assignment models so as to improve the costs being input to the FDM. It also requires calibration of the FDM so that the output assignment matrices match observed data (trip distributions and mode shares). As both requirements depend on each other, the calibration process is iterative. When the assignment models are calibrated to counts and journey times, and the demand model is responding appropriately to the input costs by outputting matrices that replicate observed data, the overall model is considered to be calibrated.

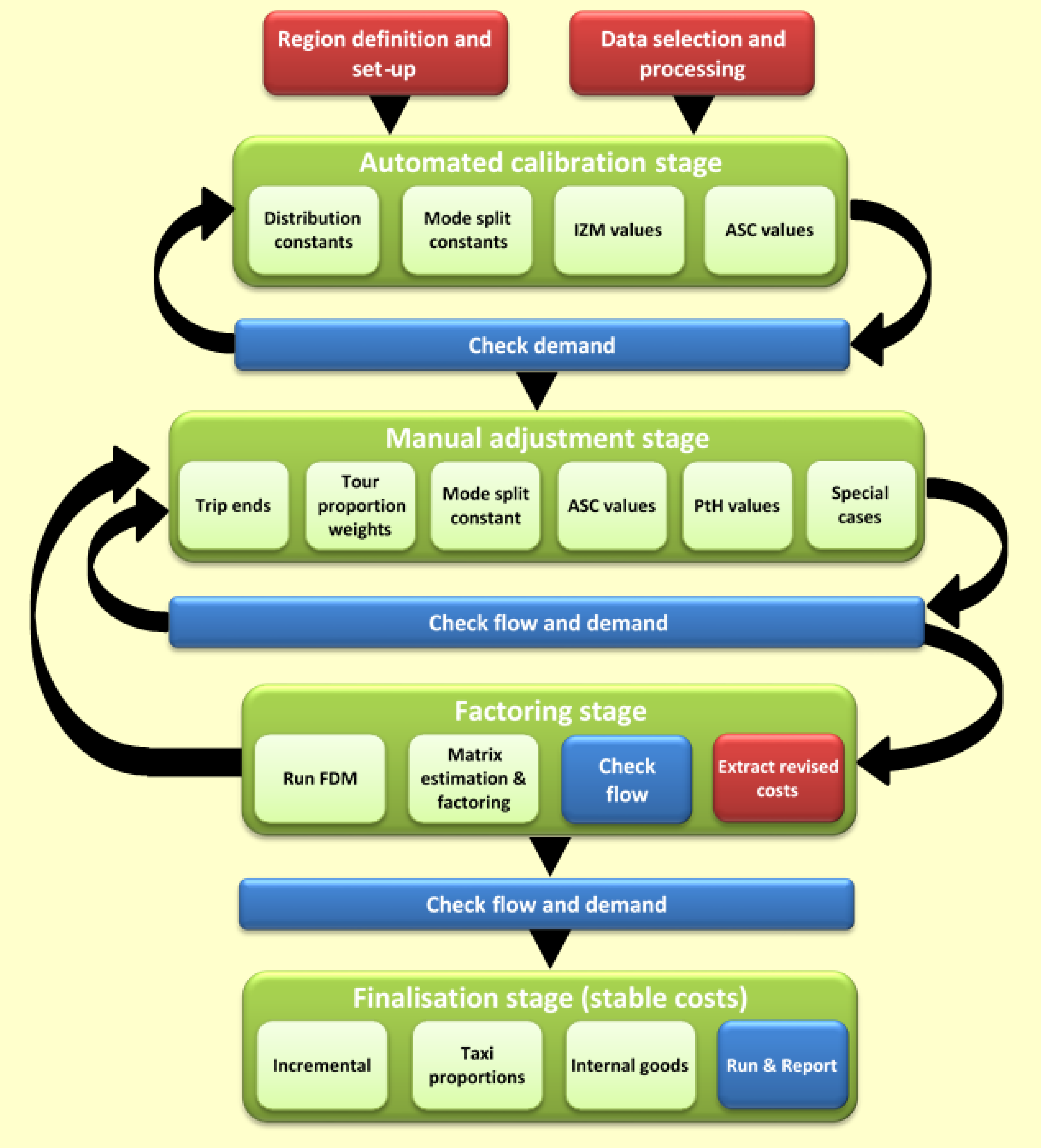

Figure 2.1: FDM calibration process

2.2 Region definition and set-up

The FDM implementation is identical across the regional models. A regional model is composed of the FDM plus the specific inputs required by that region, for example, input matrices expressed in the region's zoning system, or the region's particular road network. There are around 250 input files per regional model. These are listed in full in Annex 1 and they fall broadly into the following categories:

Table 2.1: Model inputs

Type of Input	Notes / Description
NDFM outputs	RMSIT matrices and NTEM trip ends.
Base cost matrices	From the best current estimation of the behaviour of the base network.
Preliminary test files	Dummy matrices and files for the assignment test stage.
Zone information files	Sequential to hierarchical numbering conversions, area, zone to small area correspondences and similar.
Mode and destination choice parameter matrices	Alpha, beta, lambda, ASC and IZM.
Parking information	Capacities, charges and parking parameters.
Greenfield inputs	Any input information for greenfield sites.
Road networks	All road network information files for all five modelled time periods.
PT network files	All PT information including networks, services, fares, values of time, annualisation factors and factor files for the four assigned time periods.
Active modes network files	Additional links and speed information.
Finalisation files	Incrementals, taxi proportions, car user to car driver factors and period to hour factors.

These files are found in the following locations within each model directory:

- {CATALOG_DIR}\Params (for those which are region specific but not run specific)
- {CATALOG_DIR}\Runs\{Year}\Demand (for those which are region and year specific)
- {CATALOG_DIR}\Runs\{Year}\{Growth}\Input (for those which are region, year and scenario specific)

As part of a model's calibration, all input files should be checked to ensure the region, year and scenario are correct. A smoother calibration can be expected if this checking process is carried out in full.

2.3 Data selection and processing

Each RMS is calibrated and validated to the available data collected in each region.

For demand modelling purposes and the automated calibration stage there are two major sources; the 2012 National Household Travel Survey, and the 2011 census output

"Census 2011 Place of Work, School or College - Census of Anonymised Records (POWSCAR)".

For road calibration and validation, the primary data sources are traffic counts and travel time surveys.

Public transport data availability is not as extensive but can consist of passenger counts, boarding and alighting data or journey time data.

Active mode information is limited to a small number of counts in some city centres: much of the calibration / validation of these modes depends on getting matches to the known mode shares in the demand data and in achieving plausible output flows and trip lengths.

All of the available data requires processing into the correct formats to be readily compared with the model outputs. Data processing is a major undertaking and more details can be found in the ERM Road, PT and Active Modes Model Development Reports.

2.4 Automated calibration stage

2.4.1 Automated calibration

The automated calibration stage is used to provide an initial, approximate calibration of the demand model. The mode and destination choice loop is iterated while automatically varying selected calibration parameters to try and match key observations, such as the average journey lengths and mode shares.

Mathematically the probability of making a choice is:

$$P_n = \frac{e^{\lambda U_n}}{\sum_{n \in N} e^{\lambda U_n}}$$

Where: λ <0 is the relevant spread parameter;
U_n is the utility (or composite utility) of choice n; and
N is the subset of choices considered.

The utility value, which is required by both the mode and destination choice models, is calculated using the following formula:

$$U_{ij}^{mode} = \alpha^{mode} \times GC_{ij}^{mode} + \beta^{mode} \times \ln\left(GC_{ij}^{mode}\right) + ASC^{mode} + IZM^{mode}$$

The objective of the automated calibration stage is to adjust the lambda values and the utility by mode to match the observed cost distribution, mode share, and level of intrazonals (by mode), for each of the 33 journey purposes.

In the current version of the model the parameters which can be varied by the automated process are:

- Alpha (α): which controls the calculation of trip utilities at the distribution and mode split stages.
- Mode split lambda (λ): which controls the mode split.

- Intrazonal cost adjustments (IZM): which adjust the overall trip length by controlling the level of intrazonal demand.
- Alternative Specific Constants (ASC): which cover the unquantifiable costs perceived by travellers and not otherwise calculated.

Values of the parameters are initially set to 'neutral' values (IZM = 0, ASC = 0, $\alpha = 1$, $\beta = 0$. The main purpose of the lambda is to control sensitivity to costs in the calculation of choice probabilities based on the above utility; the higher it is, the higher the chances of a change in mode or destination when costs change. For mode choice there are separate main mode and active mode lambda values and these values are used in both the mode split and composite cost calculations. The lambda value used in the distribution is set according to WebTag guidance and further adjustments to the distribution calibration result from changes to the other parameters.

Beta values are not used in the current version of the model, and so they are set to zero everywhere. If included, the Beta values could be used to adjust the calculation of trip utilities at the distribution and mode split stages. Similarly, the distribution lambda could also be varied during calibration, instead of remaining fixed, but that is not allowed for in the approach adopted for this version of the model.

The calibrated base assignment models provide the generalised cost inputs to the automated calibration process. This is a fixed input. Alternatively, if a less approximate calibration was required, the generalised costs output from the most recent FDM run could be used as the input.

2.4.2 Check demand calibration

After running the automated calibration stage, the next step is comparing the outputs with the cost, trip length and mode split information in the data. There is a suite of spreadsheets able to do this efficiently and the outputs allow a decision to be made as to whether to proceed to the manual adjustment stage or to refine and repeat the automatic adjustment stage.

2.5 Manual adjustment stage

2.5.1 Manual calibration

Once a reasonable result was achieved using the automated process, manual adjustment could begin.

In some early iterations of the model this stage involved adjustments to trip ends and tour proportion weightings. In some cases, these improved the overall operation of the NDFM and these modifications were retained. In other cases, they tended to complicate a process of output factoring which could be better achieved by other means. For this reason, later iterations of the process did not include adjusted trip ends (with the exception of those which are now incorporated into the NDFM) or, for the most part, tour proportion weightings. Most adjustments in later versions of this stage are to ASC values and Period to Hour factors.

This stage may also include:

- The calibration of the mode split for the demand in some special zones, such as airports.
- The calibration of the Park & Ride module.

2.5.2 Check flow and demand calibration

Once suitable adjustments were made, and the FDM was run through, the standard output dashboards could be used to examine the levels of calibration in the demand, road, PT and active modes models and to decide if further adjustments were required. If further adjustments were required then they could be made, otherwise the process could proceed to the assignment adjustment stage, as described below.

It is important to note that the process is fluid and will switch from FDM calibration to assignment adjustment or vice versa, depending on the course of action suggested by the available results at the time.

2.6 Assignment Adjustment Stage

2.6.1 Matrix estimation, PT factoring and active modes adjustments

At this stage the matrices produced by the demand model may be adjusted to improve the fit of observed to modelled flow in the assignment models, using either matrix estimation (for road), PT factoring (for PT) or simple factoring (for active modes).

2.6.2 Check flows

The results of the adjustments with respect to assignment calibration are then checked to decide if further estimation / factoring is required, or if the pre-estimation matrices could be improved by further FDM calibration.

2.6.3 Cost extraction

The FDM may be improved further at this stage (in terms of distribution and mode split across the region) if the costs used are obtained from the latest assignments.

In later iterations, it may also help to update the (non FDM) processes that create internal goods matrices and taxi proportions with the latest assignment results. This is discussed in more detail below.

2.7 Finalisation

2.7.1 Exit criterion

The above process is repeated until it is observed that new demand model outputs do not produce noticeably different assignments as the previous loop of the process before estimation.

2.7.2 Finalisation

Once a stable solution is achieved the model can be finalised. At this stage three processes are required:

1) Internal goods matrices must be taken from the matrix estimated networks and provided as an input to the FDM.
2) The proportion of OTH[1] trips in each sector which are made by taxi must be extracted from the estimated road networks and provided as an input to the FDM.
3) The difference between the matrices output by the demand model and the matrices output by the estimation / factoring processes must be calculated. These are the incremental matrices and must be provided as in input to the FDM.

2.7.3 Reporting

With these three updated sets of inputs and a stable set of cost matrices. the final output from the FDM should match the final estimated / factored output and final demand, and flow dashboards can be populated.

[1] OTH refers to the ‘other’ user class. The remaining user classes are employer’s business (EMP), commuting (COM), education (EDU) and retired (RET)

3 Full Demand Model Calibration Test History

3.1 Region definition and set-up

The process of calibrating the ERM began in January 2016 in version '2.0.0: Save 10' of the RMS FDM. The input files were fully checked to ensure that they matched the latest input formats, were for the correct region and had been upgraded to be the best match to the actual networks on the ground, based upon the lessons learned from Model Version 1.

Initially the inputs were, in summary, as follows:

- NDFM outputs: RMSIT matrices, from January 2016 and NTEM trip ends, version A6.
- Base cost matrices: from Version 1.
- Preliminary test files: created especially for the new version.
- Zone information files: checked and revised for version 4.2 of the zone system.
- Mode and destination choice parameter matrices: from Version 1.
- Parking information: checked for the new version.
- Greenfield inputs: zeroed out.
- Road networks: created especially for the new version, based on the lessons learned from Version 1.
- PT network files: created especially for the new version, based on the lessons learned from Version 1.
- Active modes network files: created especially for the new version, based on the lessons learned from Version 1.
- Finalisation files: taxi proportions taken from Version 1, car user to car driver factors from data, period to hour factors from count and incremental data, set to leave the matrices unchanged.

3.2 Data selection and processing

The ERM demand calibration data came from the "Census 2011 Place of Work, School or College - Census of Anonymised Records (POWSCAR)" which was processed and used to calibrate the mode splits and trip length distributions for the COM and EDU user classes and from the 2012 National Household Travel Survey which was processed and used to calibrate the mode splits and trip length distributions for the EMP, OTH and RET.

Due to the much larger available dataset, the ERM also used POWSCAR data for the COM and EDU user classes at the automated calibration stage. This gave the automated calibration a more robust target to aim at, particularly for the smaller journey purpose groupings, but the lack of car availability information in the dataset did mean that some manual adjustments were needed later to give the correct overall modal split.

In order to convert the data into the correct format for automated calibration, the key step was to convert the origins and destinations recorded by the survey, into the origin and destination zones required by the model. Once the data was re-coded into a zone to zone format, the generalised cost, time, and distance skim matrices could be used to get the average trip costs and lengths used in the process, and to check the outputs, in each of the 33 journey purpose groupings.

Conversion into zone to zone format is also the key step in processing the trip survey data for the demand dashboard, but in this case more detailed information is output, such as detailed mode shares, sector to sector information and generalised cost, trip distance, and journey time distributions (rather than averages).

There was a large volume of data available for road calibration in the ERM. Over 100 individual (uni-directional) link counts were grouped into six cordons (see Figure 3.1):

- Central – running along the River Liffey and cutting the various crossing points;
- Canals: north and south – running along the two canal across the various crossing points; and,
- M50: north, west and south – running just inside the M50 / its continuations and cutting the roads joining it.

An additional 400 counts were included as individual calibration counts while more than 1,000 more were included as validation counts. Each count was processed to give the flows in cars (including taxis), LGVs and HGVs in the four daytime modelled time periods. There was insufficient data available in the off-peak period to carry out a comparable process.

Figure 3.1: Calibration screenlines[2]

In addition, there was also validation data for 21 (two-way) journey time routes taken from a combination of moving car observations, collected annually by the NTA, and TomTom data. The extent of the network covered by these is shown in Figure 3.2 and Figure 3.3.

The moving car observation data was obtained for 2012 and cleaned to remove any unusually quick or unusually slow observations. Data was available from point to point along 16 pre-defined arterial and 5 orbital routes. The point-to-point observed travel times were attributed to a link or number of links in the road network, allowing detailed route

[2] OpenStreetMap data is available under the Open Database Licence www.openstreetmap.org/copyright or www.opendatacommons.org/licenses/odbl

profiles of the observed travel times to be built up for comparison with the modelled travel times.

The TomTom data was obtained through the use of their Custom Area Analysis product. This product provides average travel times over user-defined time periods across every road within the specified custom area. Using ArcGIS, the TomTom travel time network was spatially joined to the modelled road network, again, allowing the extraction of detailed observed travel times.

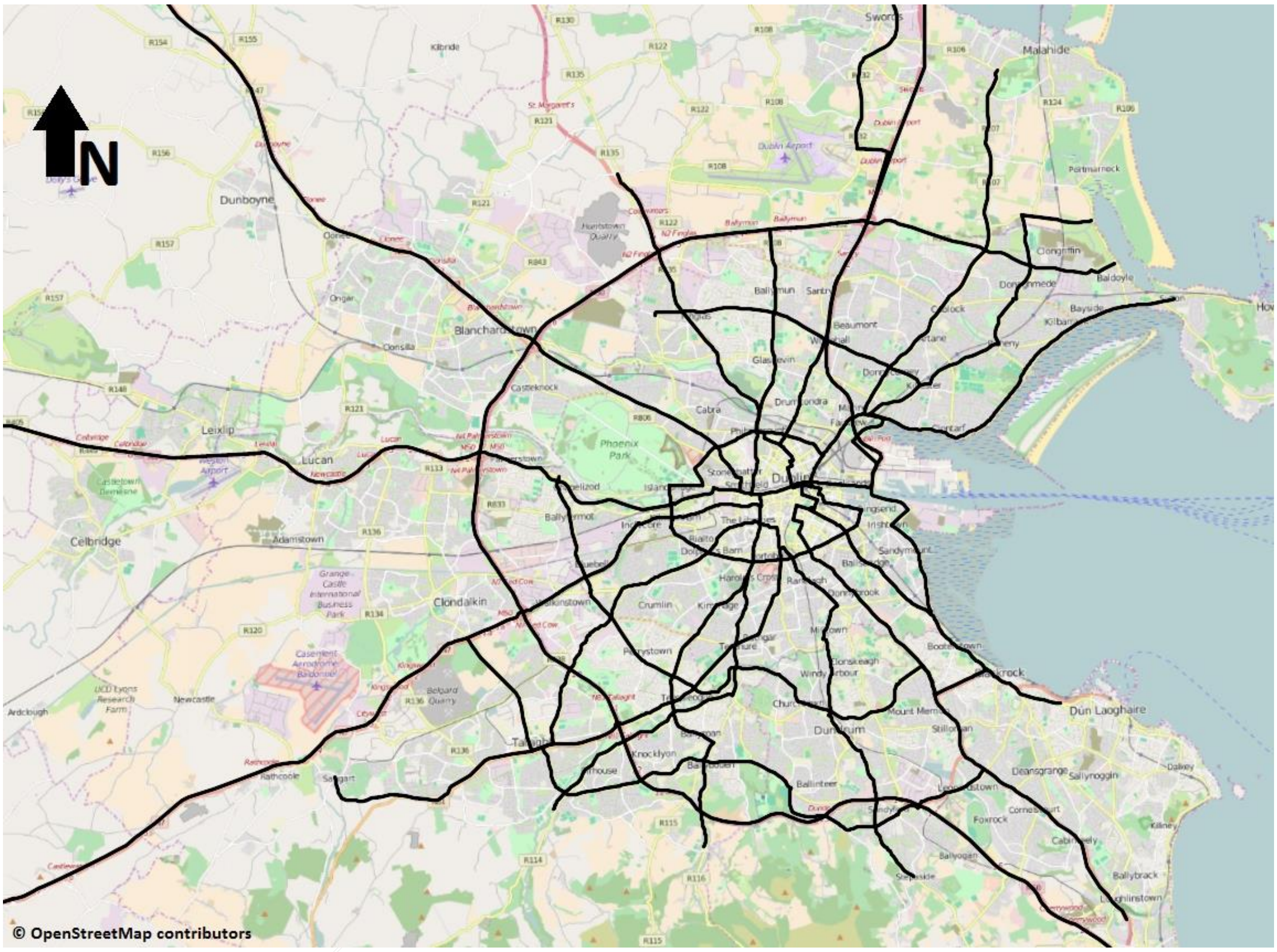

Figure 3.2: Journey time routes, Dublin detail[3]

[3] OpenStreetMap data is available under the Open Database Licence www.openstreetmap.org/copyright or www.opendatacommons.org/licenses/odbl

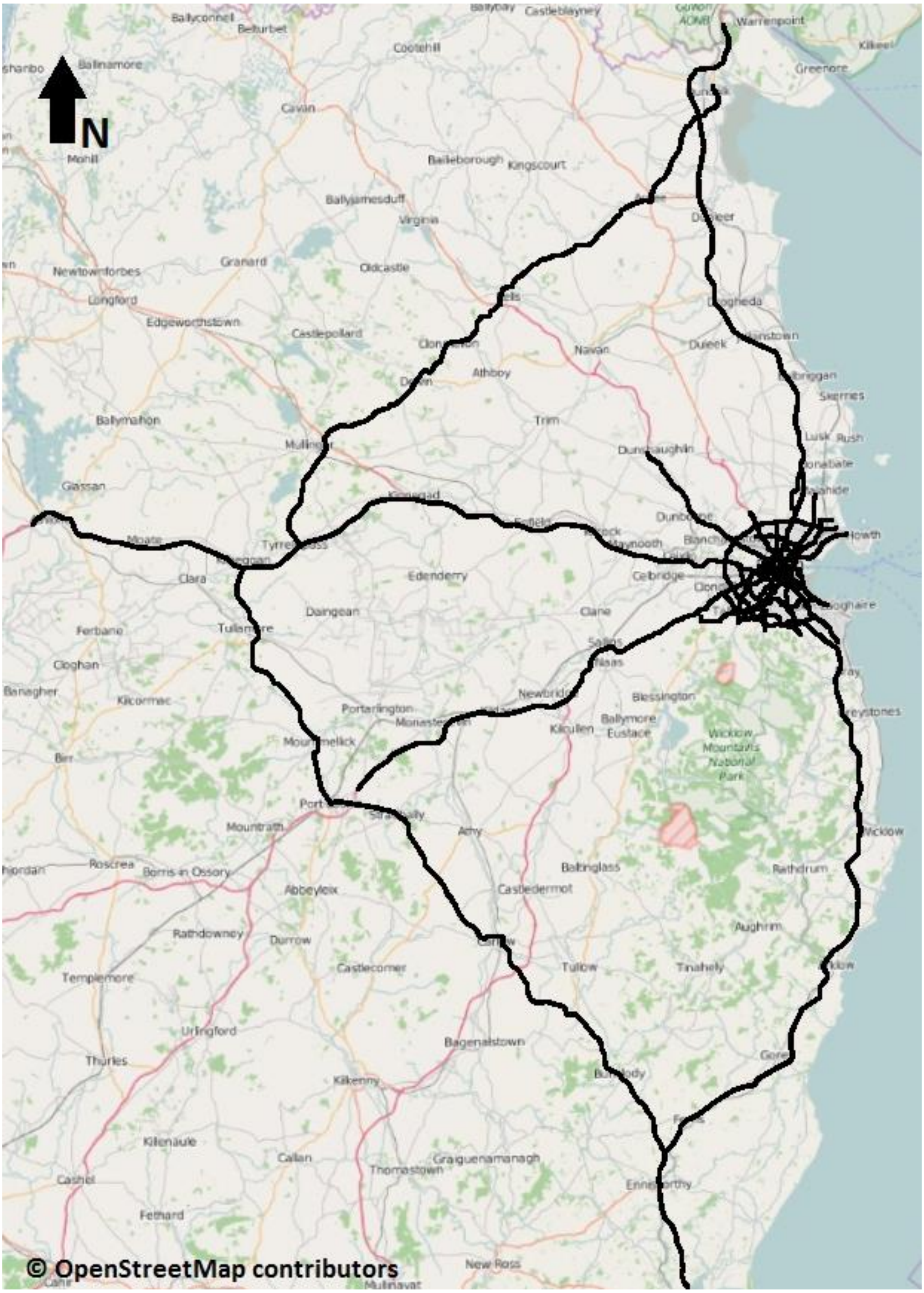

Figure 3.3: Journey time routes, full extent[4]

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4 OpenStreetMap data is available under the Open Database Licence

Of the five regional models, the ERM is the best supplied with public transport data, with flow information for the same cordons as in the road model, boarding and alighting information for bus, rail and Luas passengers, bus journey time information and line flow information for the Luas and DART lines.

Passenger flows came from the 2011 Dublin Bus survey and NDC surveys from 2014 and 2015, as well as from the 2013 Irish Rail Census and the 2012 Luas Census. These were processed in Excel to calculate peak hour flows (by direction and time period) and matched to PT model network links.

Boarding and alighting information came from the 2013 Irish Rail Census, the 2012 Luas Census and the 2014 Dublin Bus boarding survey. For the rail and Luas information times, boarding numbers and alighting numbers were recorded directly and so boarding / alighting counts for each station were easy to derive and assign to sectors. In the bus case, the data includes boardings by stop, service, hour, direction, and ticket type. Boardings, therefore, are easy to derive, but the processing of the data to provide alightings was more complex and dependent on assumptions linking alighting stop to ticket type (ticket types depend on the number of stops travelled) and this data was not of sufficiently good quality for use in the calibration process.

Bus journey time information came from two different data sources, Automatic Vehicle Location (AVL) and GTFS timetables. AVL data was processed in MS Excel and GTFS in MS Access to give average overall runtimes in each time period.

Line flow information for the Luas and DART lines came from the 2013 Irish Rail Census and the 2012 Luas Census and was processed in MS Access.

The availability of active modes data was sparse across all of the RMS regions, but the ERM had the best data availability with inbound counts and outbound counts across the canal cordon from 07:00 to 19:00. It was felt that the most useful validation data, with the lowest level of noise introduced by tourist and other potentially indirect or circular movements, was given by the inbound movement in the morning time period and the outbound movement in the evening time period and so the data for these movements was extracted from the counts and used to build dashboards containing walk and cycle flows.

3.3 Calibration / Validation Phases

The calibration and validation process can broadly be split into three phases. Phase 1 involved adjustments to trip ends, tour proportions, mode split lambda values and ASC values. Phase 2 largely removed the trip end and tour proportion adjustments and Phase 3 incorporated an upgraded model structure able to feed costs from the parking distribution module around the outer FDM model loop.

Overall, Phase 1 was undertaken from mid-January to late February, 2016; Phase 2 from mid-March to late June, 2016, and Phase 3 from mid-July to late August, 2016.

3.4 Phase 1 Test 1

3.4.1 Run details

Model Version: *Model version 2.0.0: Save 9*

Date: *19/01/16*

This was an initial run intended only to confirm that the model ran through and there were no missing inputs or other issues. It used updated input files but Version 1 parameters.

3.4.2 Results / outputs

This run was carried out to clarify the process of using the model and outputting results. However, it only used Version 1 costs and updated costs were required before useful conclusions could be drawn. No detailed outputs were extracted.

3.5 Phase 1 Test 2

3.5.1 Run details

Model Version: *Model version 2.0.0: Save 11*[5]

Date: *28/01/16*

Test 2 included updated costs from the most recently calibrated base networks and a single pass of automated calibration.

3.5.2 Results / outputs

Though this test was really only intended as a proof of principle, the revised alpha, beta, ASC, IZM and lambda values were supplied to Test 3. No detailed outputs were extracted.

3.6 Phase 1 Test 3

3.6.1 Run details

Model Version: *Model version 2.0.0: Save 12*

Date: *05/02/16*

Test 3 ran the model with the newly updated parameters from Test 2. As there had been only a single pass of automatic calibration these were still essentially uncalibrated test parameters.

[5] Save 10 fell between these two tests

3.6.2 Results / outputs

As there was only a single automatic calibration pass in Test 2 and neither set of parameters was close to being correct, full results were not extracted from Test 3.

3.7 Phase 1 Test 4

3.7.1 Run details

Model Version: *Model version 2.0.0: Save 12 revised*[6]

Date: *10/02/16*

This run included 30 passes of automatic calibration.

3.7.2 Results / outputs

Improved calibrations were achieved within the limits of the data examination possible in the automatic calibration stage. A demand dashboard was produced at this stage, which indicated that the mode split required further work as car and walk were too low while PT was far too high (see Figure 3.4). However, detailed automatic calibration outputs were not extracted as it emerged that incorrect calibration costs had been input. The full demand dashboard has been supplied in electronic format along with this document (see the Test 4\2 Demand folder).

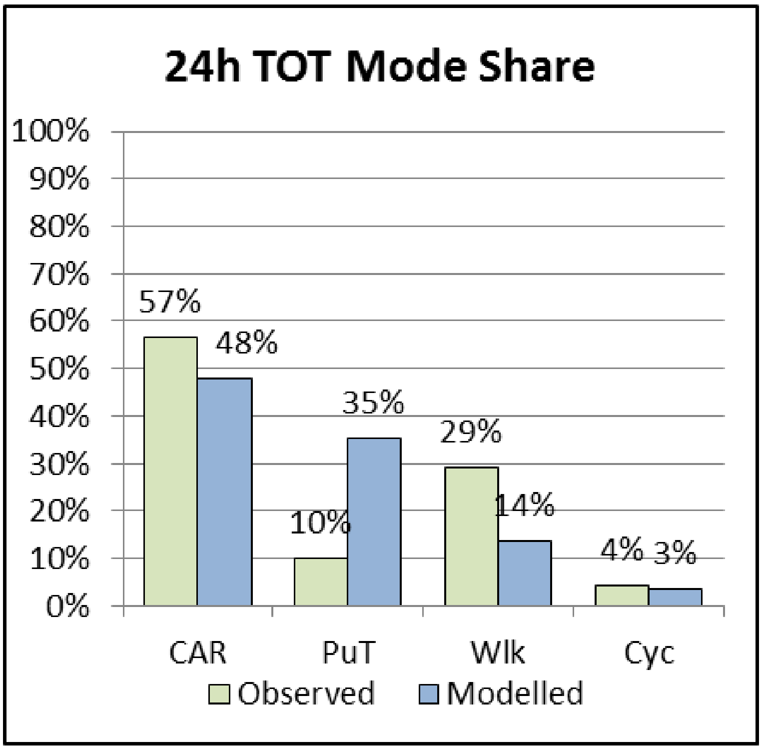


Figure 3.4: Test 4 mode split

[6] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

3.8 Phase 1 Test 5

3.8.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[7]

Date: *15/02/16*

In Test 5, the corrected costs were input and there were numerous passes of automatic calibration. The model itself was then run through.

3.8.2 Results / outputs

Automatic calibration continued until there was a good match for all 33 purposes within the limits of the data examination possible at the automatic calibration stage. Figure 3.5 to Figure 3.8 (beginning on Page 28) give an example of the output from the automated calibration, and the results for all of the trip purposes are supplied in electronic format along with this document (see the Test 5\1 Automatic calibration folder), which also serves to highlight the issues imposed by poor data availability, especially for the longer trips. Park & Ride was not an option allowed by the automated process in this case, but the data is available and was incorporated in later calibration processes.

The outputs of this run can be summarised as follows:

- Car demand was too high while demand for the other modes was too low (see Figure 3.9 or the Test 5\2 Demand folder for more details).
- Road calibration / validation (on percentage difference) was at:
  - AM 41% / 38%
  - IP1 33% / 41%
  - IP2 34% / 39%
  - PM 29% / 33% (see the Test 5\3 Road folder for more details)
- Public transport calibration showed nearly universally low modelled flows on screenlines and an excess of bus and rail boardings at the expense of Luas boardings. Figure 3.10 gives an example of the screenline match and Figure 3.11 shows the boardings and alightings (for more information see the Test 5\4 PT folder).
- Active modes validation was reasonable, but a little high at 114 – 150% (for more information see the Test 5\5 Active modes folder).

The level of network calibration output from this test was not good enough for matrix estimation or PT factoring to be carried out so as to provide updated costs.

[7] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

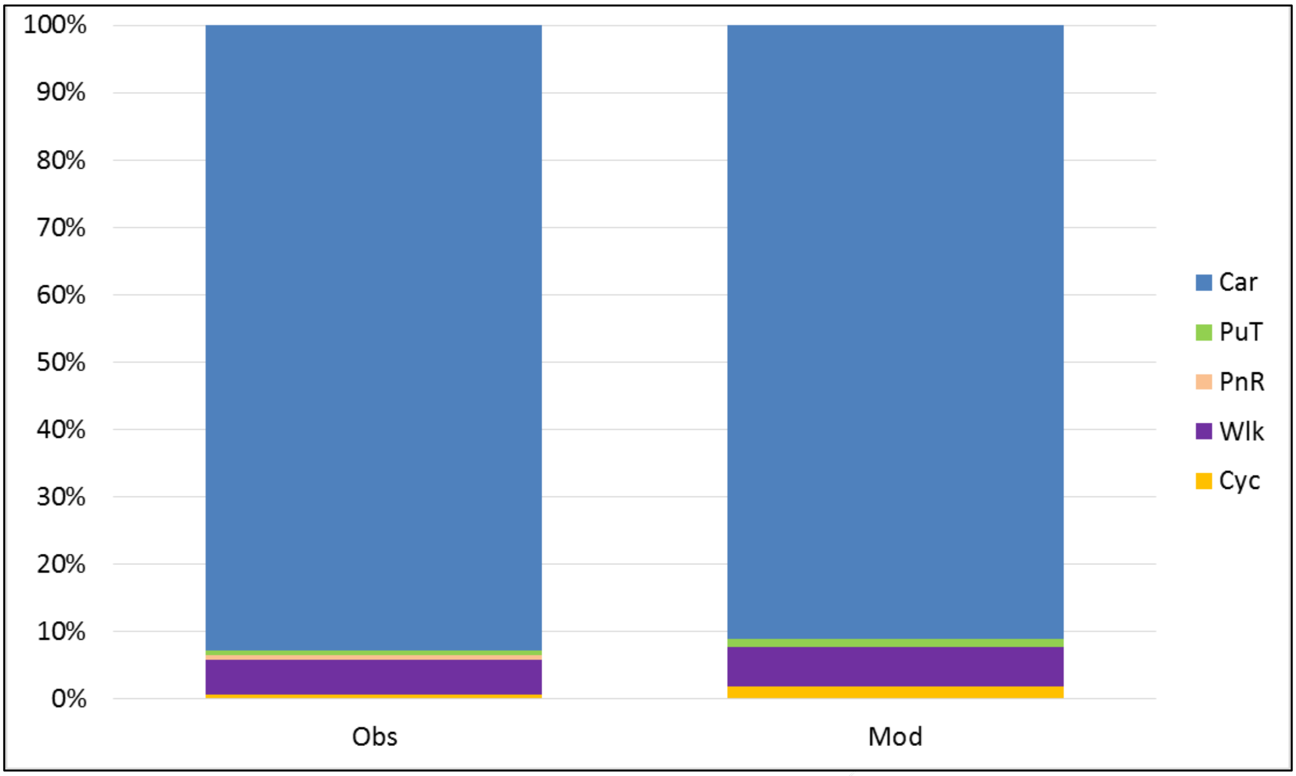
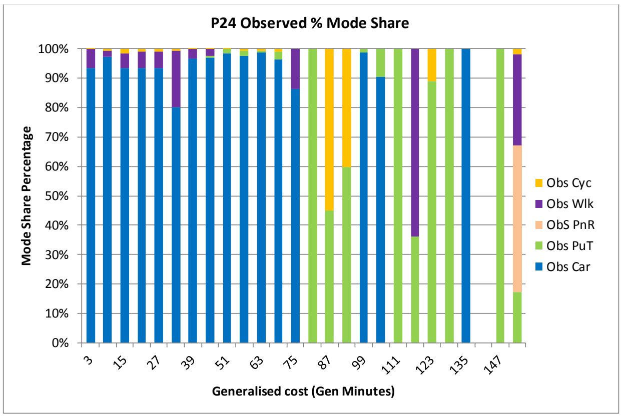


Figure 3.5: Example automatic calibration outputs for P24: Overall mode split



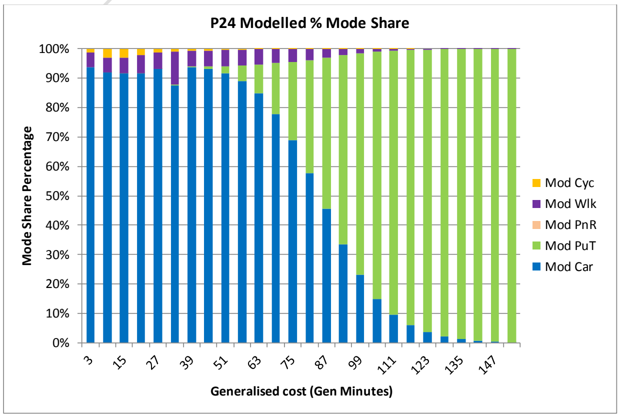
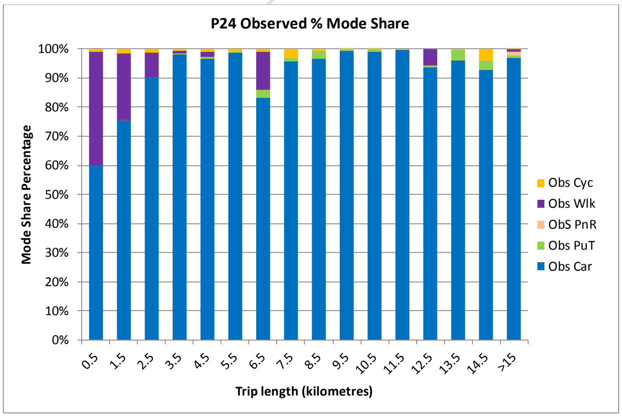


Figure 3.6: Example automatic calibration outputs for P24: Cost distribution



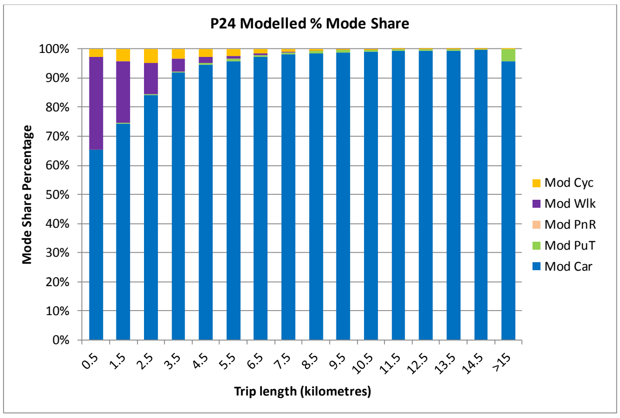
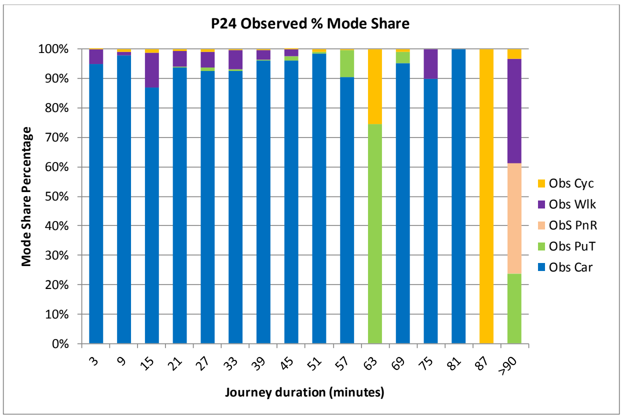


Figure 3.7: Example automatic calibration outputs for P24: Trip length distribution



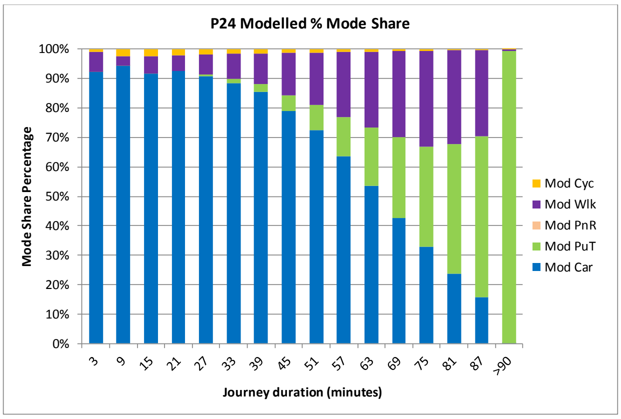


Figure 3.8: Example automatic calibration outputs for P24: Journey time distribution

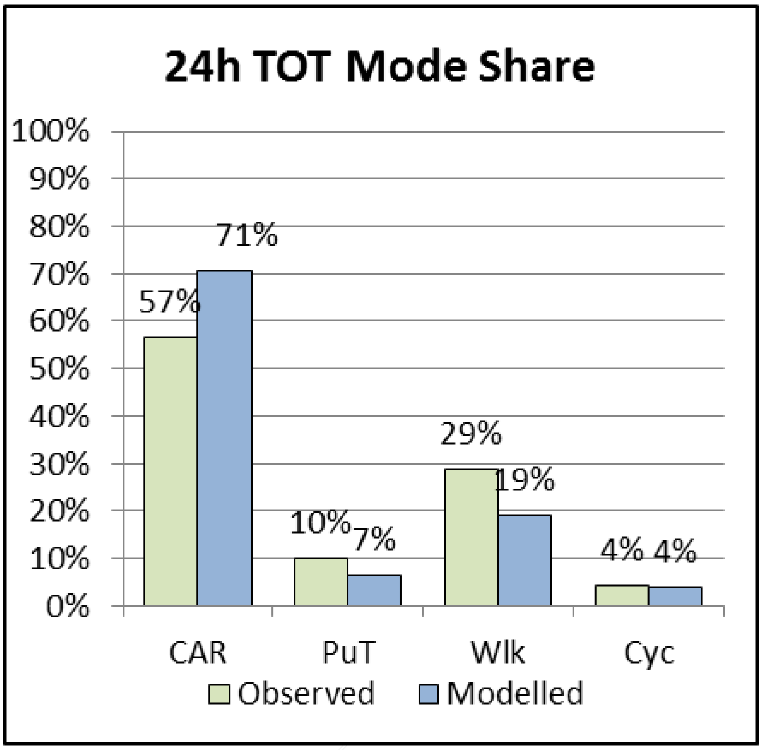


Figure 3.9: Test 5 mode split

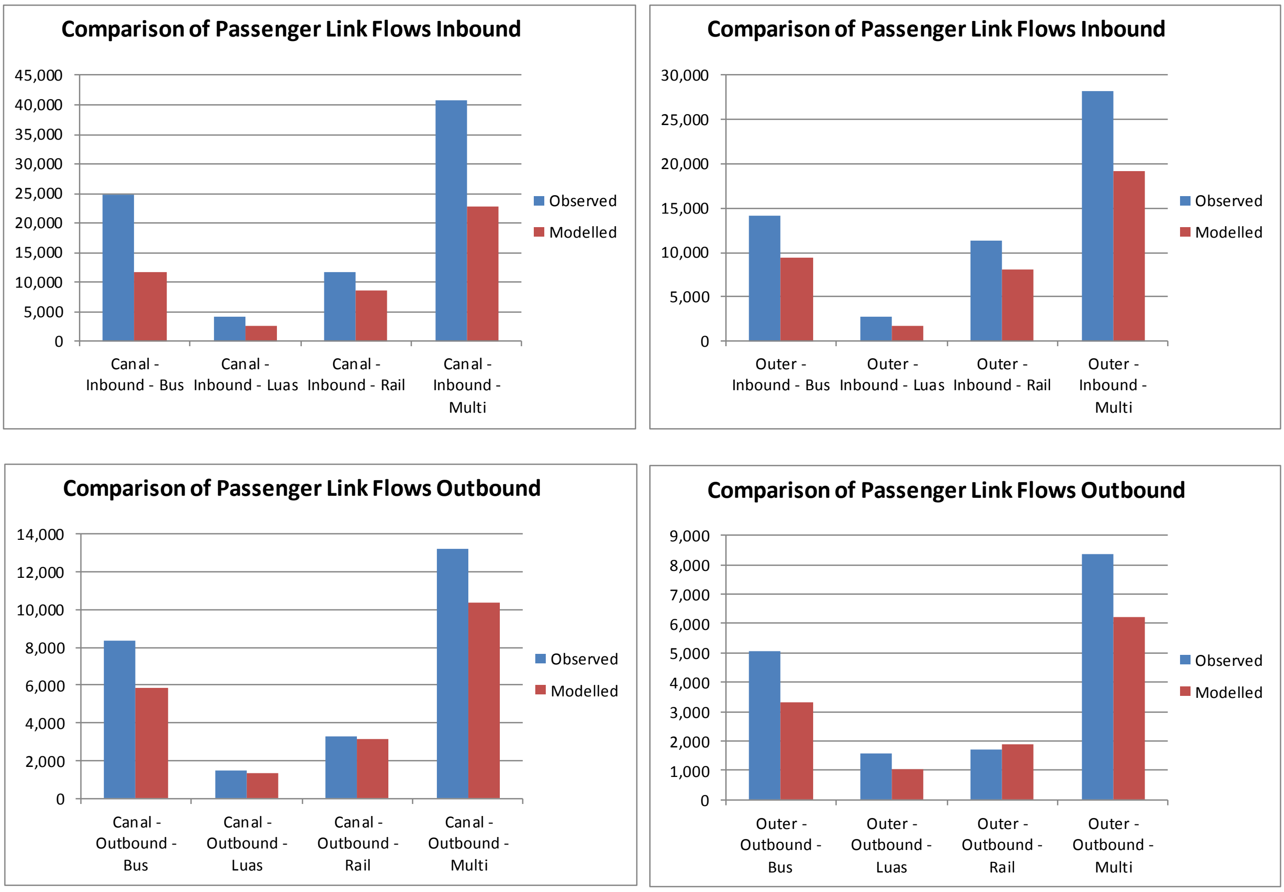


Figure 3.10: Test 5 morning peak flows on screenlines

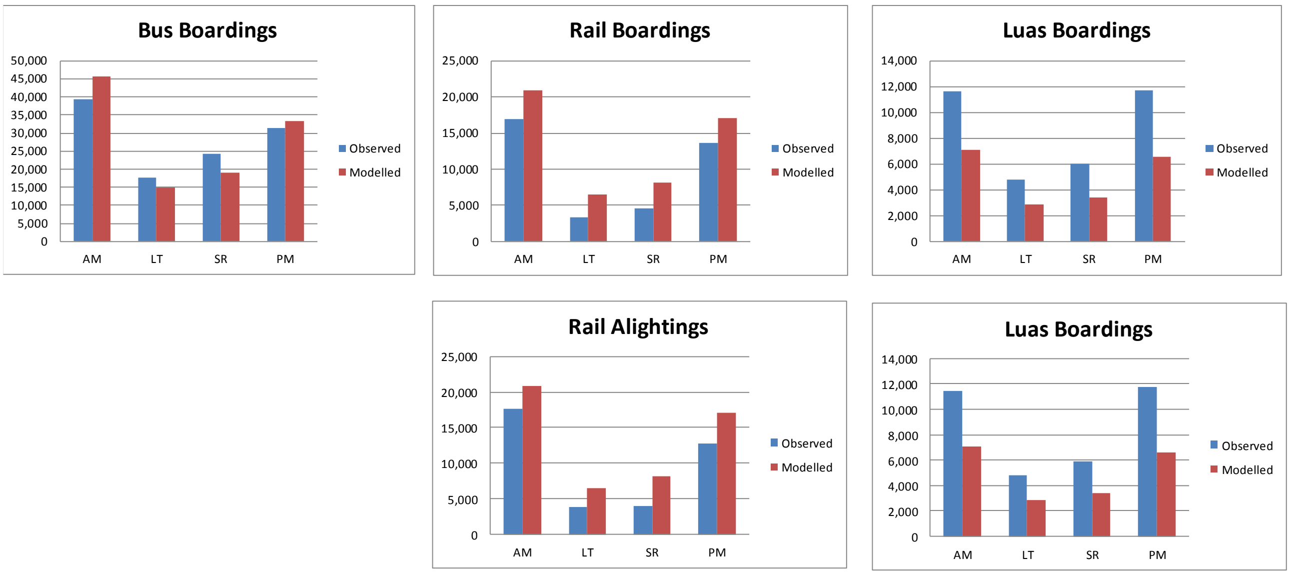


Figure 3.11: Test 5 PT boardings / alightings

3.9 Phase 1 Test 6

3.9.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[8]

Date: *18/02/16*

For Test 6 the model was run through using the parameters from Test 5 with the addition of a manual adjustment to the trip ends to factor them all up by 4%. This factor was based on the total observed and modelled flows in the model across both the car and PT demand and was intended to correct an overall shortfall in trips and improve flow calibration.

3.9.2 Results / outputs

This run gave a better match to the overall number of trips but otherwise the outputs were not much improved and can be summarised as follows:

- Car demand was essentially unchanged and remained too high while demand for the other modes was too low (see Figure 3.12 and the Test 6\2 Demand folder for more details).
- Road calibration / validation (on percentage difference) was similar at:
  - AM 40% / 37%
  - IP1 35% / 41%
  - IP2 35% / 40%
  - PM 30% / 33% (see the Test 6\3 Road folder for more details)
- Public transport calibration still showed nearly universally low modelled flows on screenlines and an excess of bus and rail boardings at the expense of Luas boardings. Figure 3.13 gives an example of the screenline match and Figure 3.14 gives an example of the match for the boardings and alightings (for more information see the Test 6\4 PT folder).
- Active modes validation remained reasonable, but worsened slightly to 119 – 156% (for more information see the Test 6\5 Active modes folder).

[8] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

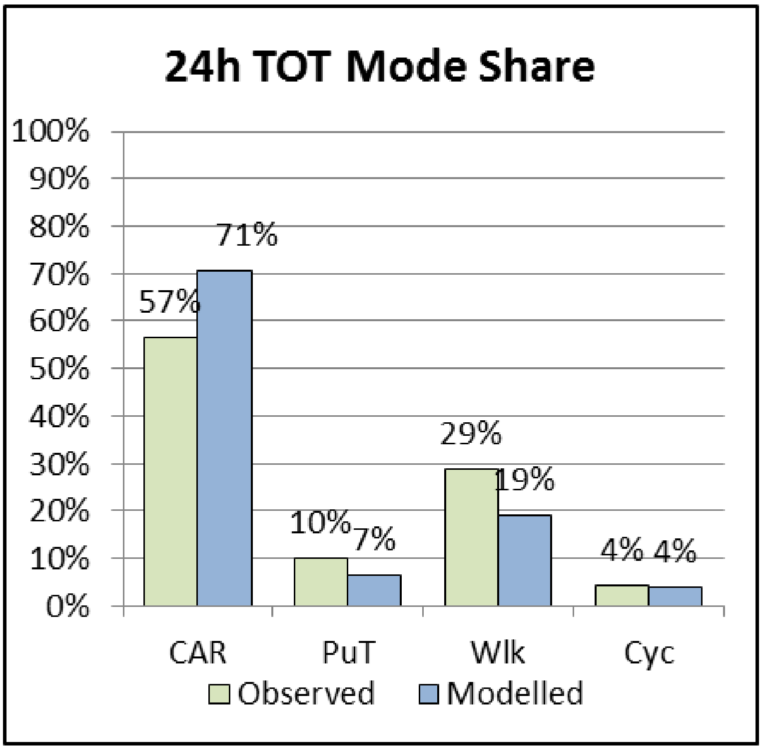
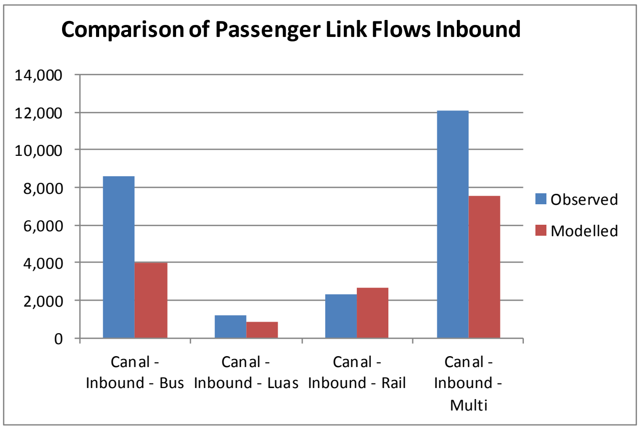
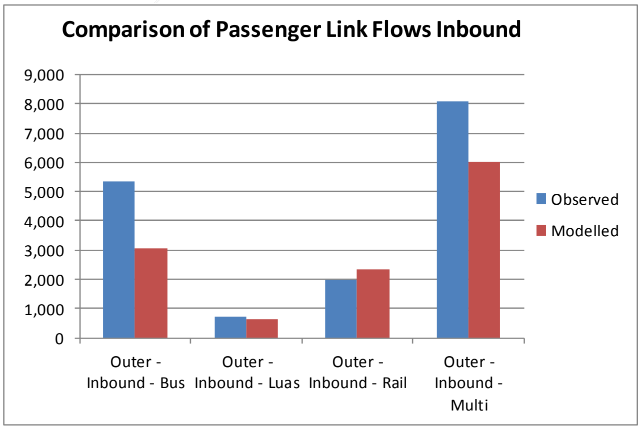
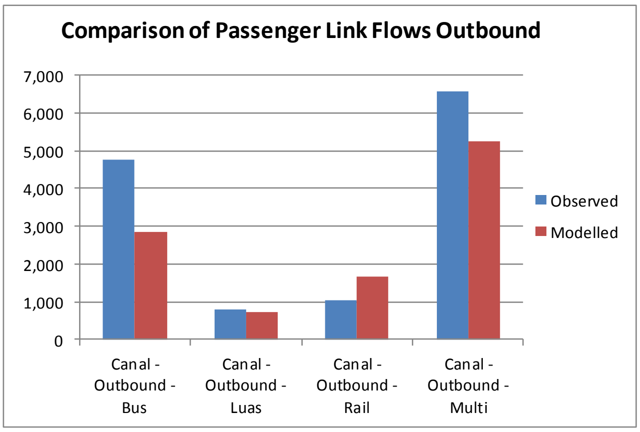


Figure 3.12: Test 6 mode split







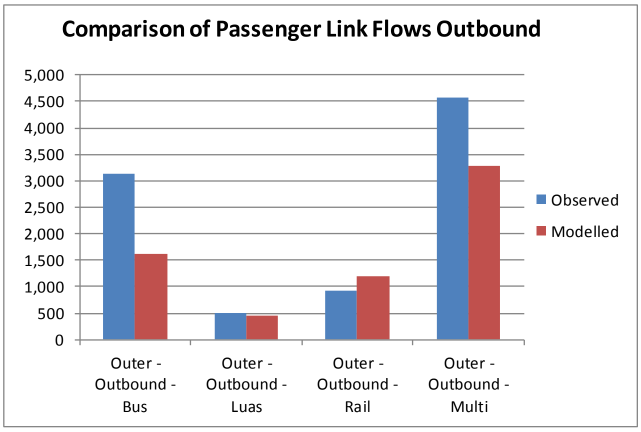


Figure 3.13: Test 6 interpeak 1 peak flows on screenlines

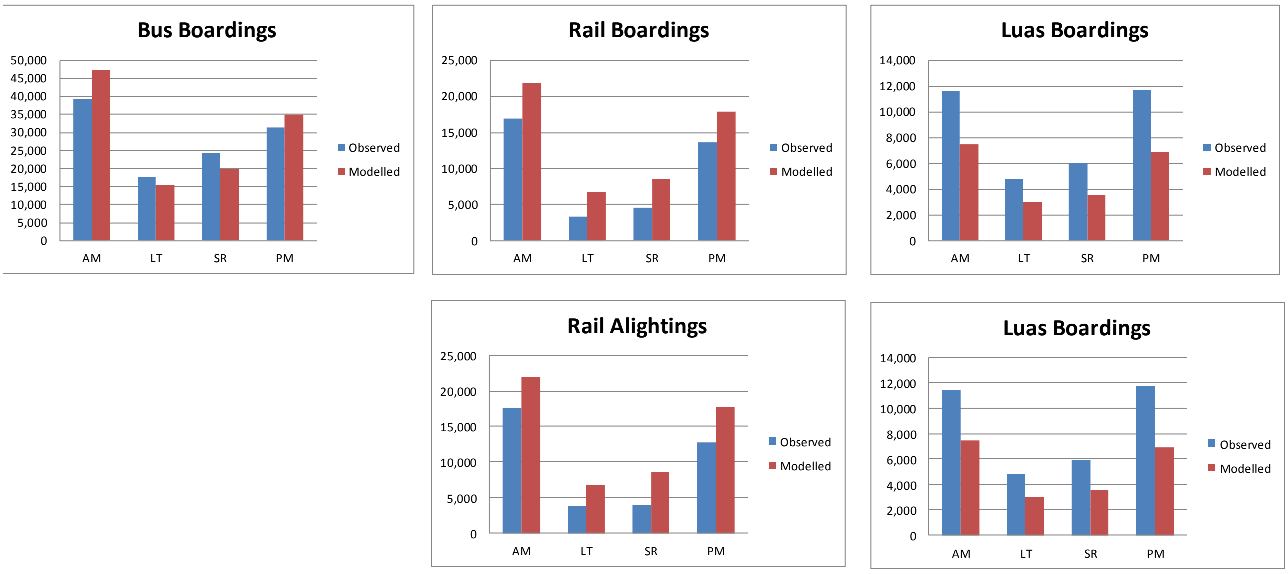


Figure 3.14: Test 6 PT boardings / alightings

3.10 Phase 1 Test 7

3.10.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[9]

Date: *20/02/16*

Test 7 took the parameters from Test 5 and the trip ends from Test 6 and applied a manual adjustment to the tour proportions. These adjustments were based on a comparison between observed and modelled flows inbound and outbound at the two circumferential cordons (around the canals and around the M50) and attempted to give a better match against observed directionality and pattern of flows across time periods so as to improve flow calibration. These adjustments were generally quite small (see Table 3.1).

Table 3.1: Tour proportion adjustment factors

Time period	Canals inbound	Canals outbound	M50 inbound	M50 outbound
AM	88%	102%	99%	111%
IP1	99%	80%	71%	80%
IP2	108%	90%	97%	97%
PM	114%	78%	121%	93%

These individual directional values were combined and converted to tour proportions. For example, a tour which leaves the area outside the M50 in the morning peak to travel to outer Dublin, remains throughout the day and returns in the evening peak will be factored

[9] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

by the average of the two relevant factors (99% and 93%), giving 96%, and so on. Overall the combined adjustment factors for each tour proportion in each area type (centre, outer Dublin, outside the M50) fell between 75% and 116%.

3.10.2 Results / outputs

This test did result in some improvements to the correspondence between observed and modelled travel directions but overall:

Car demand was essentially unchanged and still too high while demand for the other modes was too low (see Figure 3.15 and the Test 7\2 Demand folder for more details).

- Road calibration / validation (on percentage difference) was slightly improved at:
    - AM 43% / 40%
    - IP1 31% / 39%
    - IP2 33% / 39%
    - PM 30% / 34% (see the Test 7\3 Road folder for more details)
- Public transport calibration was largely unchanged and still showed nearly universally low modelled flows on screenlines and an excess of bus and rail boardings at the expense of Luas boardings. Figure 3.16 gives an example of the screenline match and Figure 3.17 shows the boardings and alightings (for more information see the Test 7\4 PT folder).
- Active modes validation improved to 103 – 133% (for more information see the Test 7\5 Active modes folder).

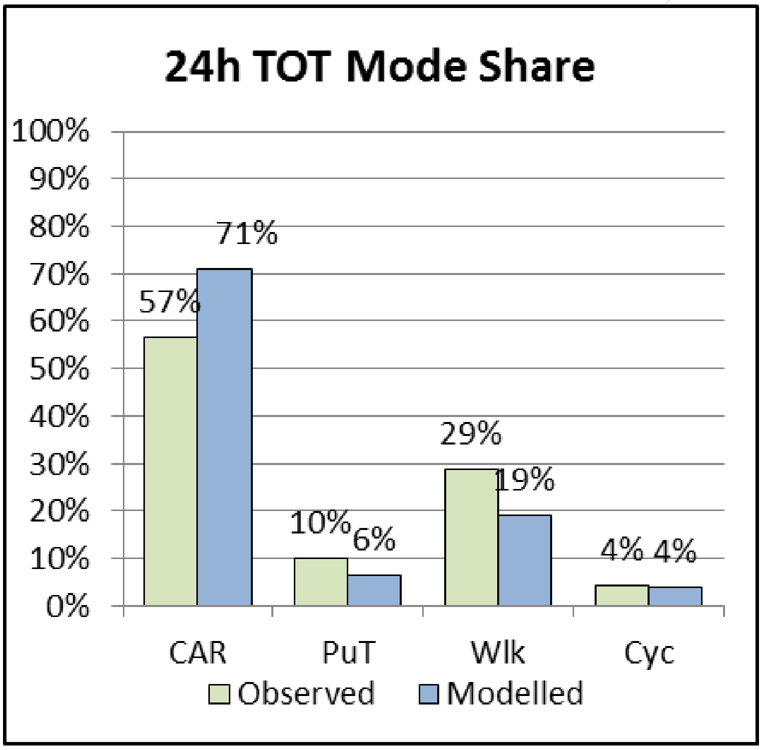


Figure 3.15: Test 7 mode split

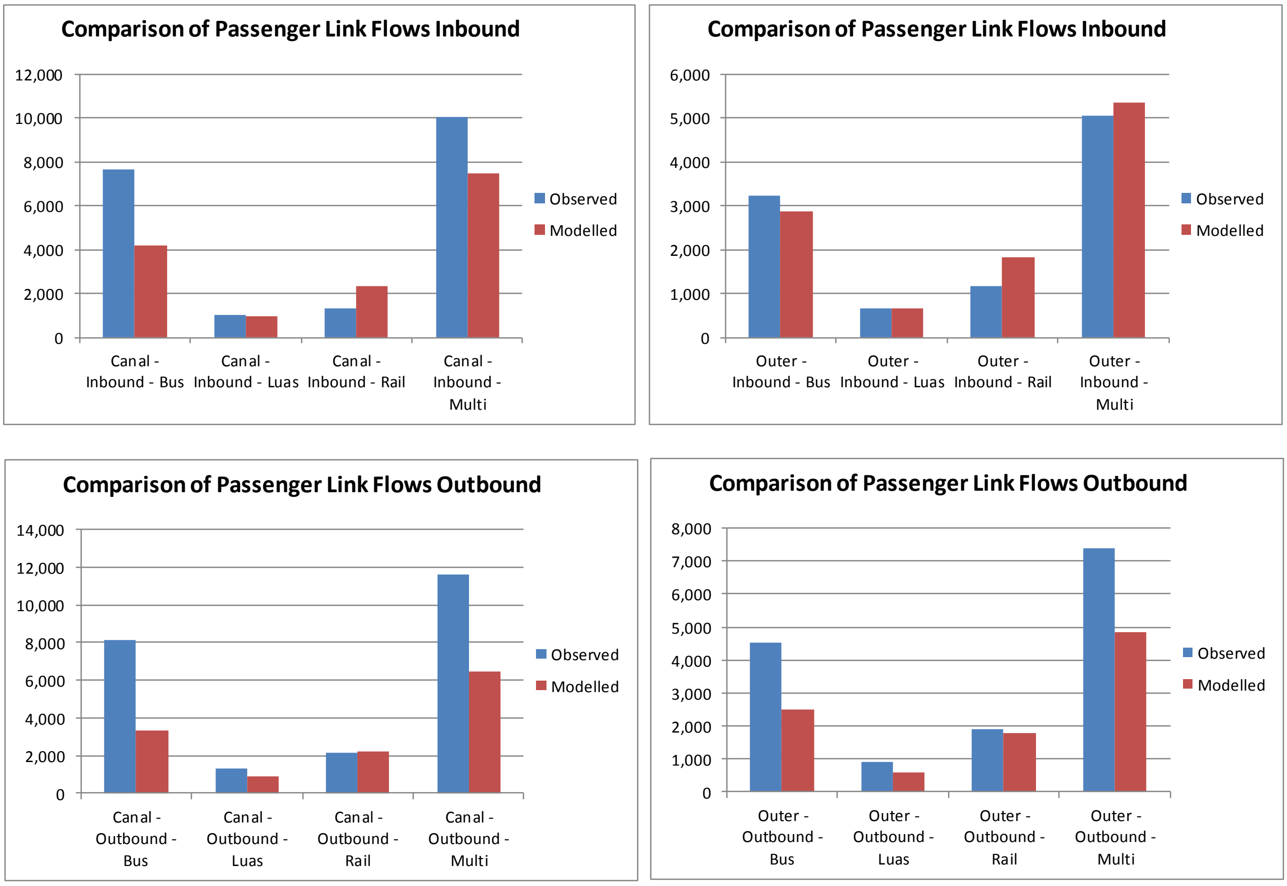


Figure 3.16: Test 7 interpeak 2 peak flows on screenlines

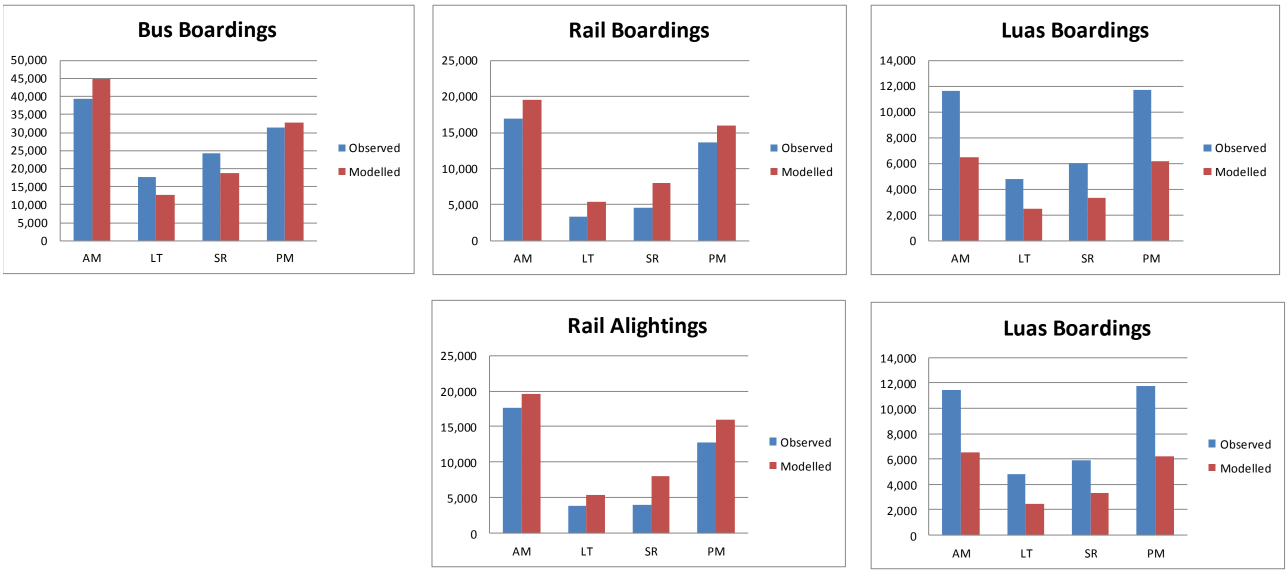


Figure 3.17: Test 7 PT boardings / alightings

3.11 Phase 1 Test 7b

3.11.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[10]

Date: *23/02/16*

Test 7b was identical to Test 7 but with the parking distribution and free workplace parking modules turned on.

3.11.2 Results / outputs

The addition of parking distribution and free workplace parking modules had a noticeable impact locally on city centre flows. Only road calibrations were checked in detail, and, despite the considerable local changes, did not change particularly overall (in percentage difference terms) falling out of the process at:

- AM 41% / 42%
- IP1 31% / 40%
- IP2 33% / 37%
- PM 29% / 33% (see the Test 7b\3 Road folder for more details)

3.12 Phase 1 Test 8

3.12.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[11]

Date: *24/02/16*

Test 8 used the same parameters and inputs as Test 7b but with some adjustments to the mode split lambda and ASC values to improve the calibration of the road and PT flows as the latter were much too low. This was an initial adjustment: mode split lambdas were adjusted to be roughly four times more negative across all trip purposes and active modes lambdas were made approximately 1.1 times more negative. PT ASC values were universally reduced by 10.

3.12.2 Results / outputs

As this was the first stage of mode split adjustment and the changes were only based on flow calibrations, major improvements, particularly to the mode share, were not expected but:

- Car demand got even higher while walk and cycle demands got even lower. PT mode share did improve (see Figure 3.18 and the Test 8\2 Demand folder for more details).

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[10] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

[11] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

- Road calibration / validation (on percentage difference) was slightly improved at:
  - AM 41% / 41%
  - IP1 34% / 41%
  - IP2 35% / 40%
  - PM 32% / 36% (see the Test 8\3 Road folder for more details)
- Public transport calibration was noticeably improved with a mix of high and low matches on screenlines. Bus and rail boardings were still very high, but Luas boardings improved. Figure 3.19 gives an example of the screenline match and Figure 3.20 shows the boardings and alightings (for more information see the Test 8\4 PT folder).
- With the exception of walking in the evening peak, walk and cycle flows were very low in comparison to the observed data (for more information see the Test 8\5 Active modes folder).

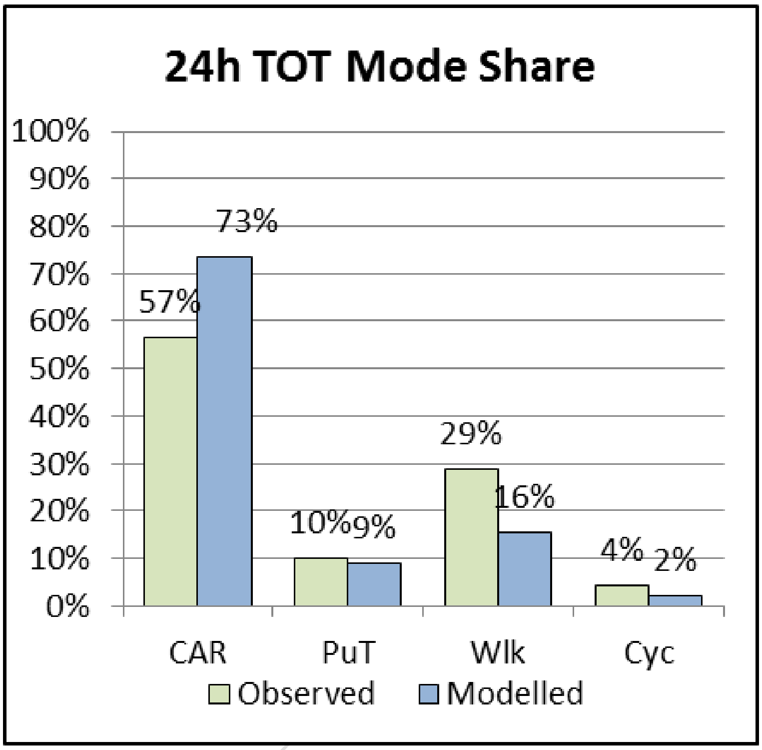


Figure 3.18: Test 8 mode split

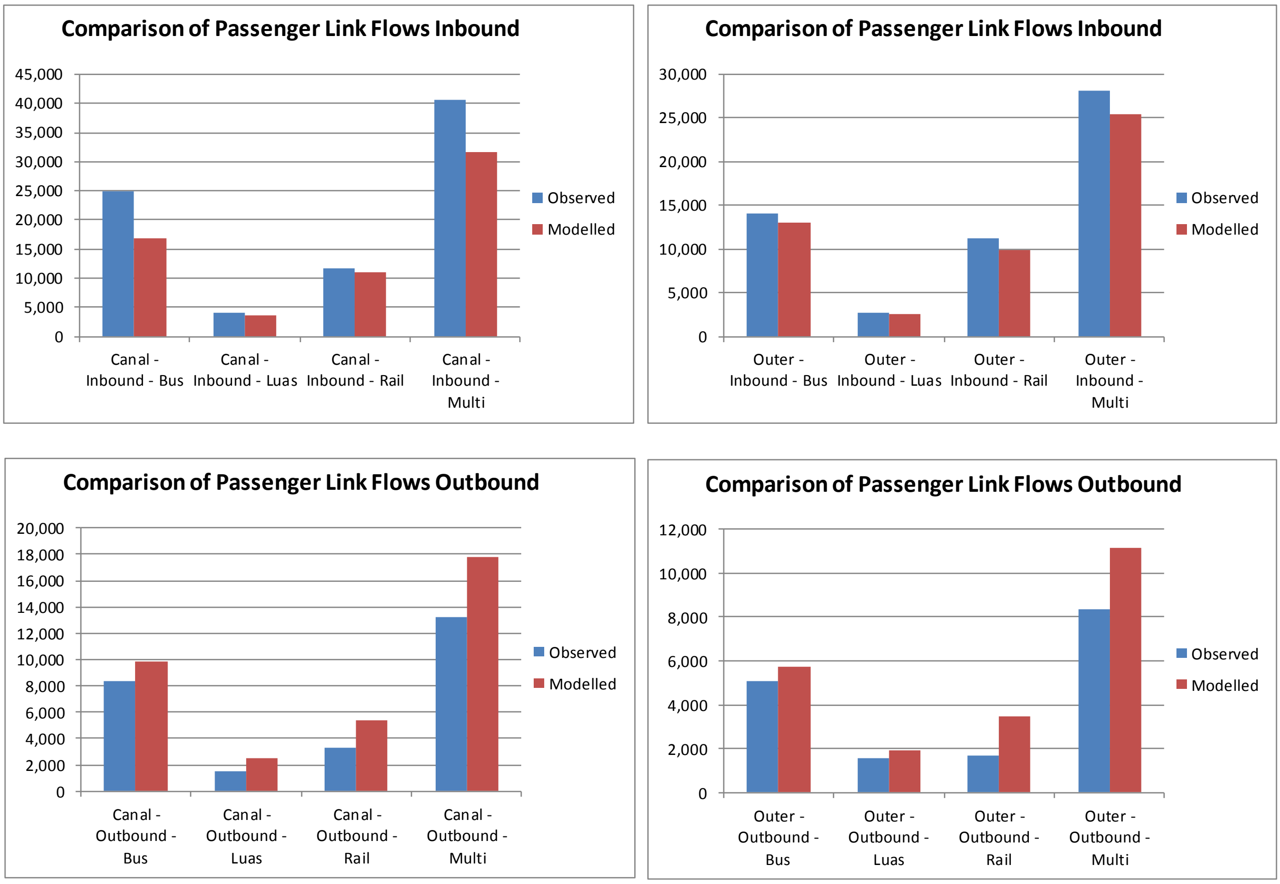


Figure 3.19: Test 8 morning peak flows on screenlines

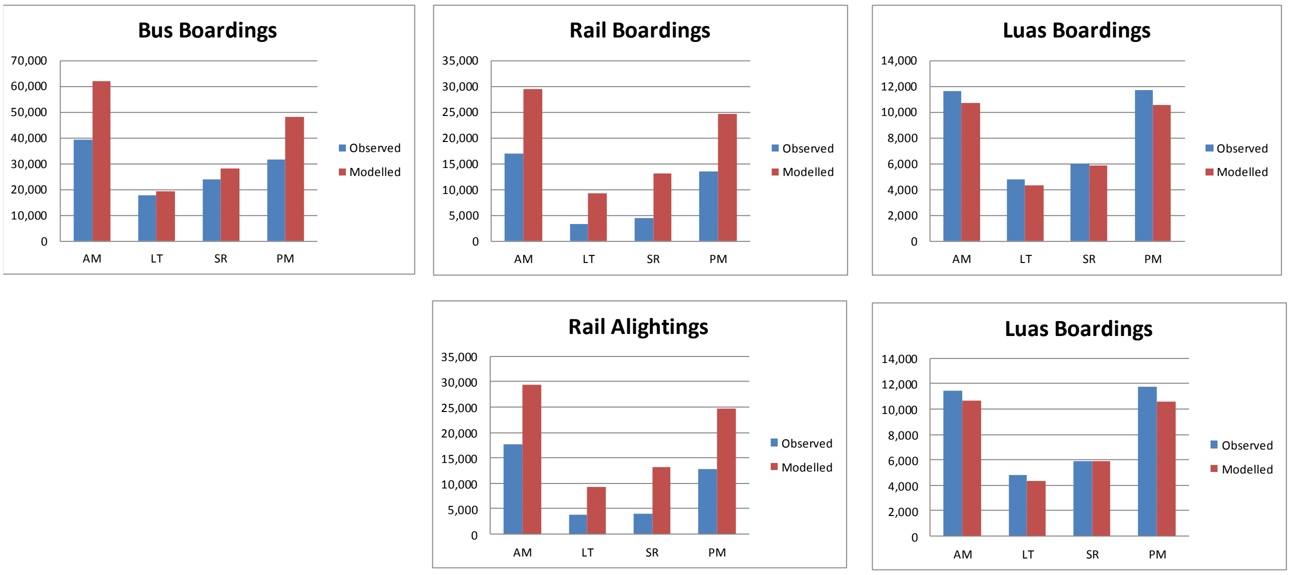


Figure 3.20: Test 8 PT boardings / alightings

3.13 Phase 1 Test 9

3.13.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[12]
Date: *24/02/16*

In Test 9 there were some additional adjustments to the tour proportions based on the outputs of Test 8 that were intended to improve the car and PT flow calibration. They were more weighted towards increases than the adjustments for Test 7, varying between 72% and 132%.

3.13.2 Results / outputs

Again, the improvements resulting from this test were not dramatic but they did show a promising shift in the right direction:

- Mode shares were slightly improved with car share reducing, PT remaining good and walk rising slightly (see Figure 3.21 and the Test 9\2 Demand folder for more details).
- Road calibration / validation (on percentage difference) was similar at:
  - AM 46% / 43%
  - IP1 32% / 40%
  - IP2 36% / 40%
  - PM 30% / 36% (see the Test 9\3 Road folder for more details)
- Public transport calibration continued to show a mix of high and low flows on screenlines and a better match to Luas boardings. Figure 3.22 gives an example of the screenline match and Figure 3.23 shows the boardings and alightings (for more information see the Test 9\4 PT folder).
- Following the increase in the walk mode share, walk flows were high but cycle flows were a reasonable match (for more information see the Test 9\5 Active modes folder).

[12] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

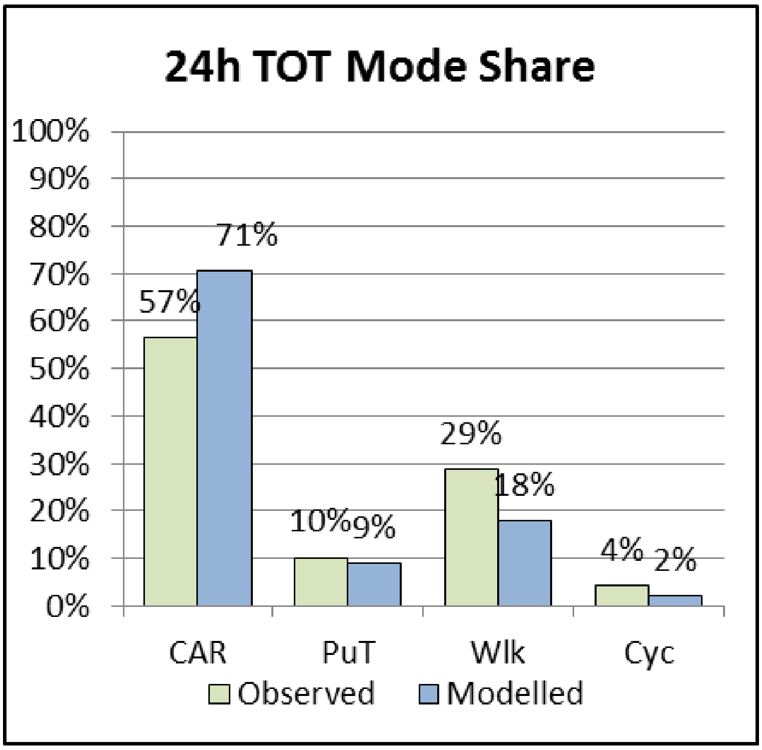


Figure 3.21: Test 9 mode split

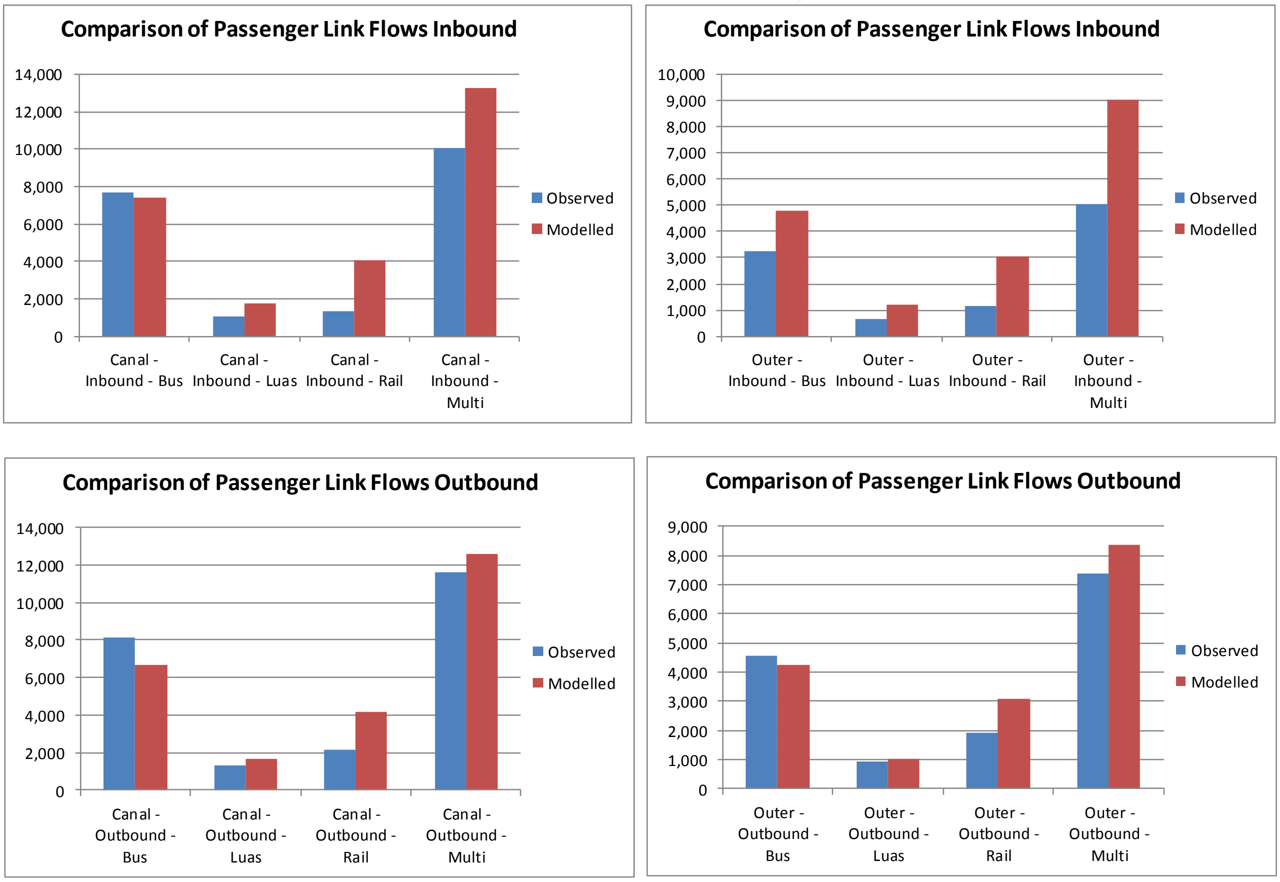


Figure 3.22: Test 9 interpeak 2 peak flows on screenlines

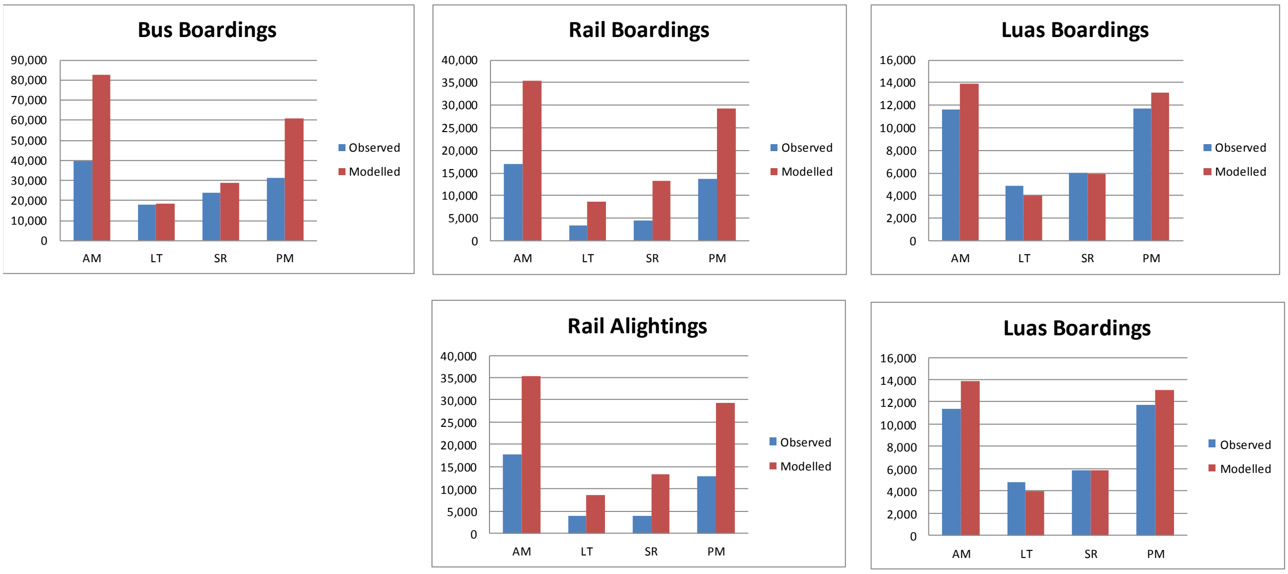


Figure 3.23: Test 9 PT boardings / alightings

3.14 Phase 1 Test 10

3.14.1 Run details

Model Version: *Model version 2.0.2: Save12 revised*[13]
Date: *25/02/16*

Test 10 incorporated a revised highway network along with some additional modifications to the ASC values with PT and walk ASCs increased by a further 2.5 and cycle ASCs by 1.25 in an attempt to further improve flow calibration.

3.14.2 Results / outputs

Similarly to the preceding tests, Test 10 did not result in a significantly improved output overall, but there were improvements to the road calibration, particularly in those time periods which were previously poorly matched.

- Overall mode shares were similar to Test 9 (see Figure 3.24 and the Test 10\2 Demand folder for more details).
- Road calibration / validation (on percentage difference) was improved at:
  - AM 46% / 42%
  - IP1 34% / 41%
  - IP2 38% / 40%
  - PM 33% / 36% (see the Test 10\3 Road folder for more details)
- Public transport calibration was similar to Test 9 with a mix of high and low flows on screenlines and a better match to Luas boardings. Figure 3.25 gives an

[13] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

example of the screenline match and Figure 3.26 shows the boardings and alightings (for more information see the Test 10\4 PT folder).

- Walk flows were still high and cycle flows were still a reasonable match (for more information see the Test 10\5 Active modes folder).

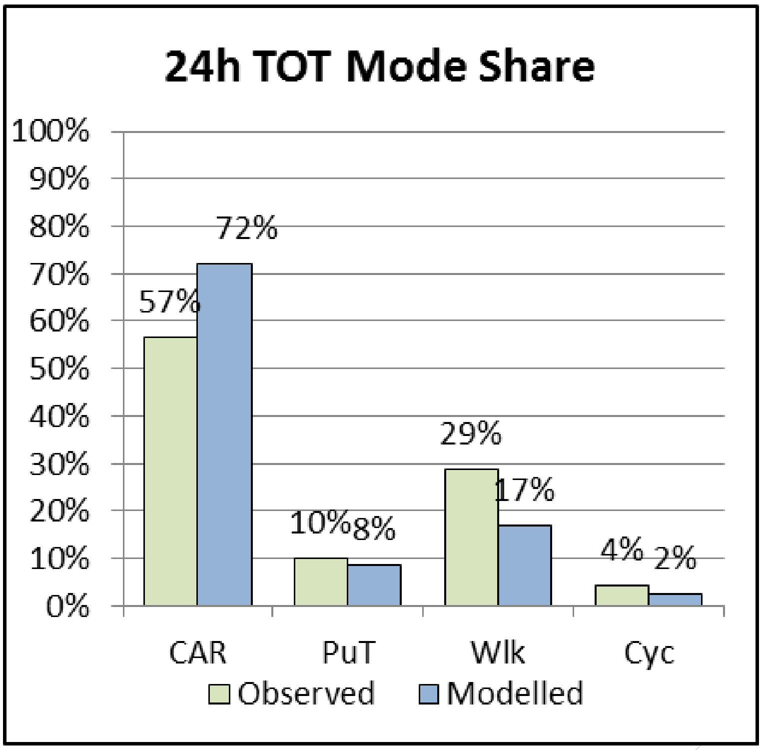


Figure 3.24: Test 10 mode split

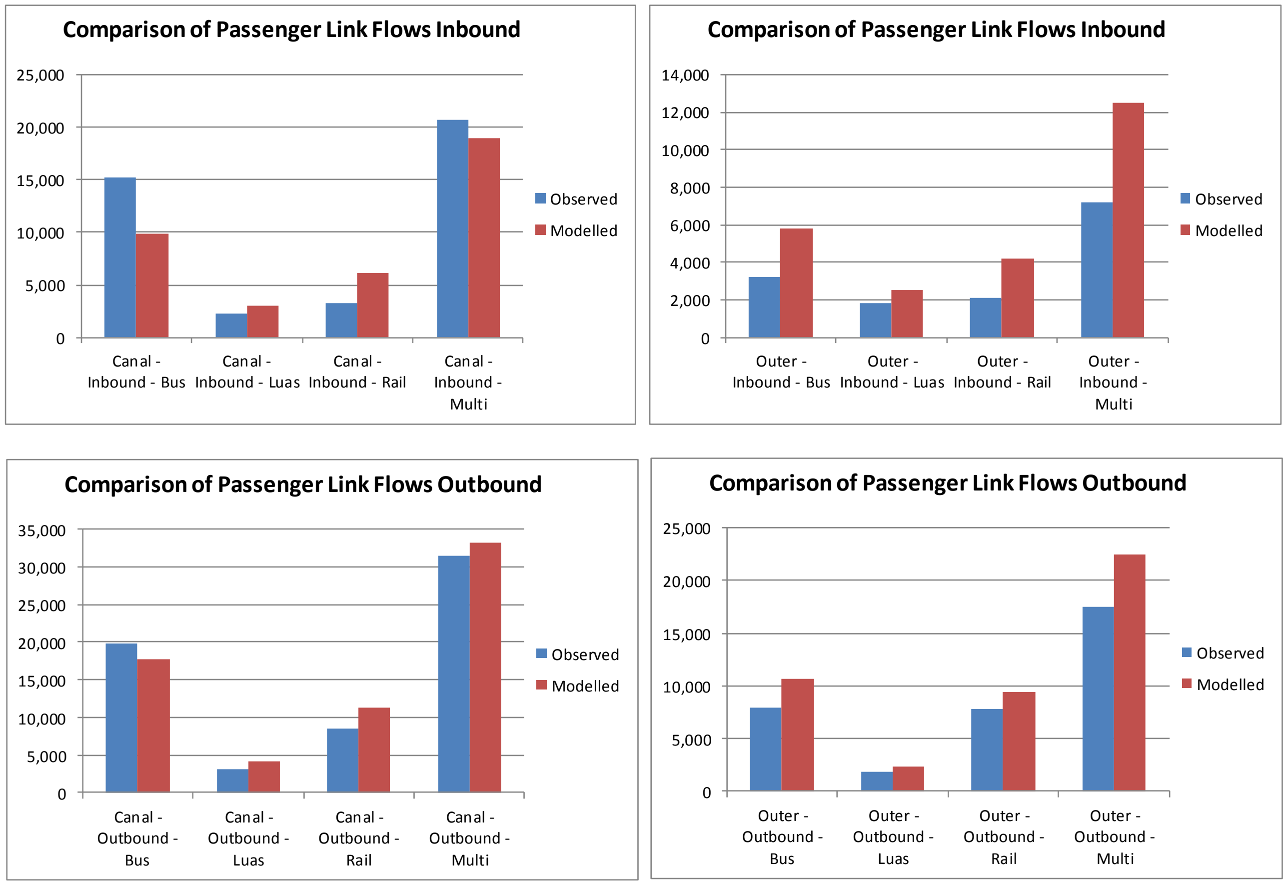


Figure 3.25: Test 10 evening peak flows on screenlines

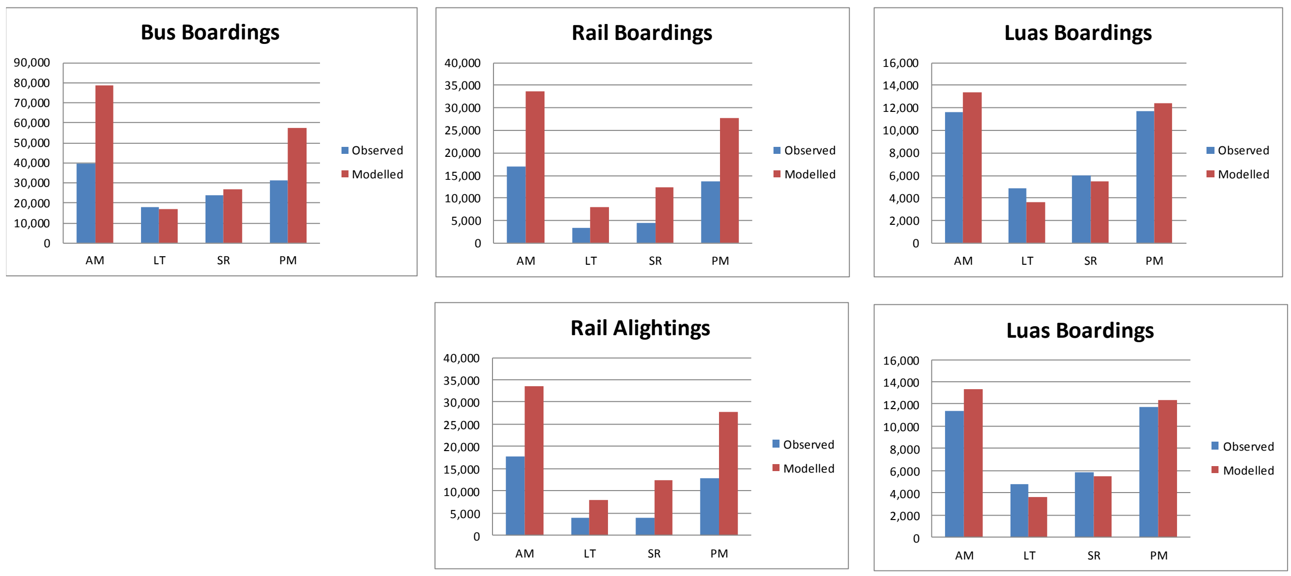


Figure 3.26: Test 10 PT boardings / alightings

3.15 Phase 1 Test 11

3.15.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[14]

Date: *26/02/16*

In Test 11 there were further adjustments to ASC values aimed at improving flow calibration and validation as follows:

- Car -2.5
- PT +10
- Walk +17.5
- Cycle +8.75

3.15.2 Results / outputs

Because the changes were aimed at matching flows rather than mode shares the overall mode share worsened slightly compared to Test 10 (see Figure 3.27 and the Test 11\2 Demand folder for more details).

Road calibration / validation (on percentage difference) improved to:

- AM 47% / 39%
- IP1 43% / 41%
- IP2 43% / 40%
- PM 43% / 35% (see the Test 11\3 Road folder for more details)

Public transport calibration remained reasonable with a mix of high and low values and the largest mismatches got smaller. Figure 3.28 gives an example of the screenline match and Figure 3.29 shows the boardings and alightings (for more information see the Test 11\4 PT folder).

Morning peak walk flows improved and cycle flows were still a reasonable match (for more information see the Test 11\5 Active modes folder).

Matrix estimation and factoring was carried out following this test but the outputs were not considered good enough to provide updated costs.

[14] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

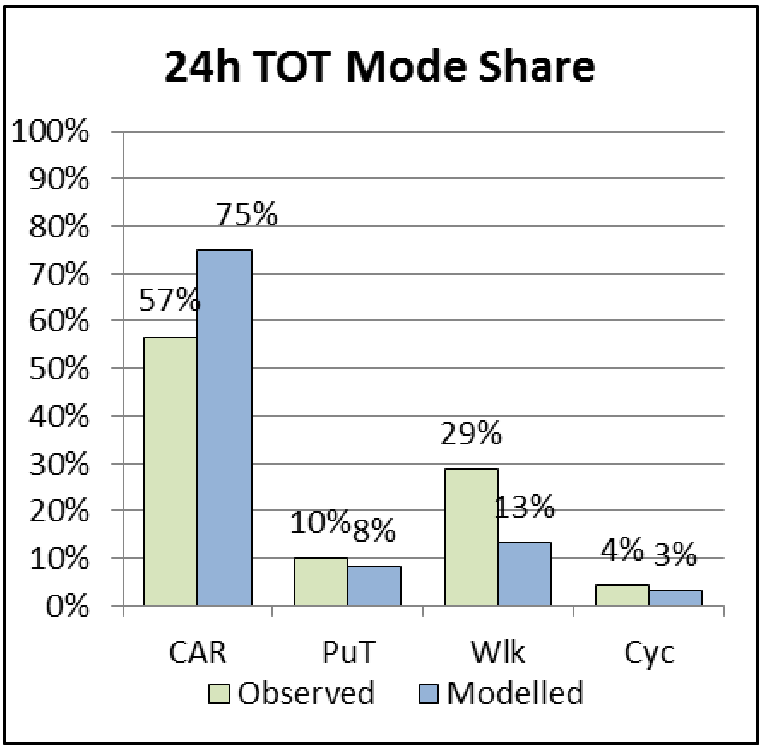


Figure 3.27: Test 11 mode split

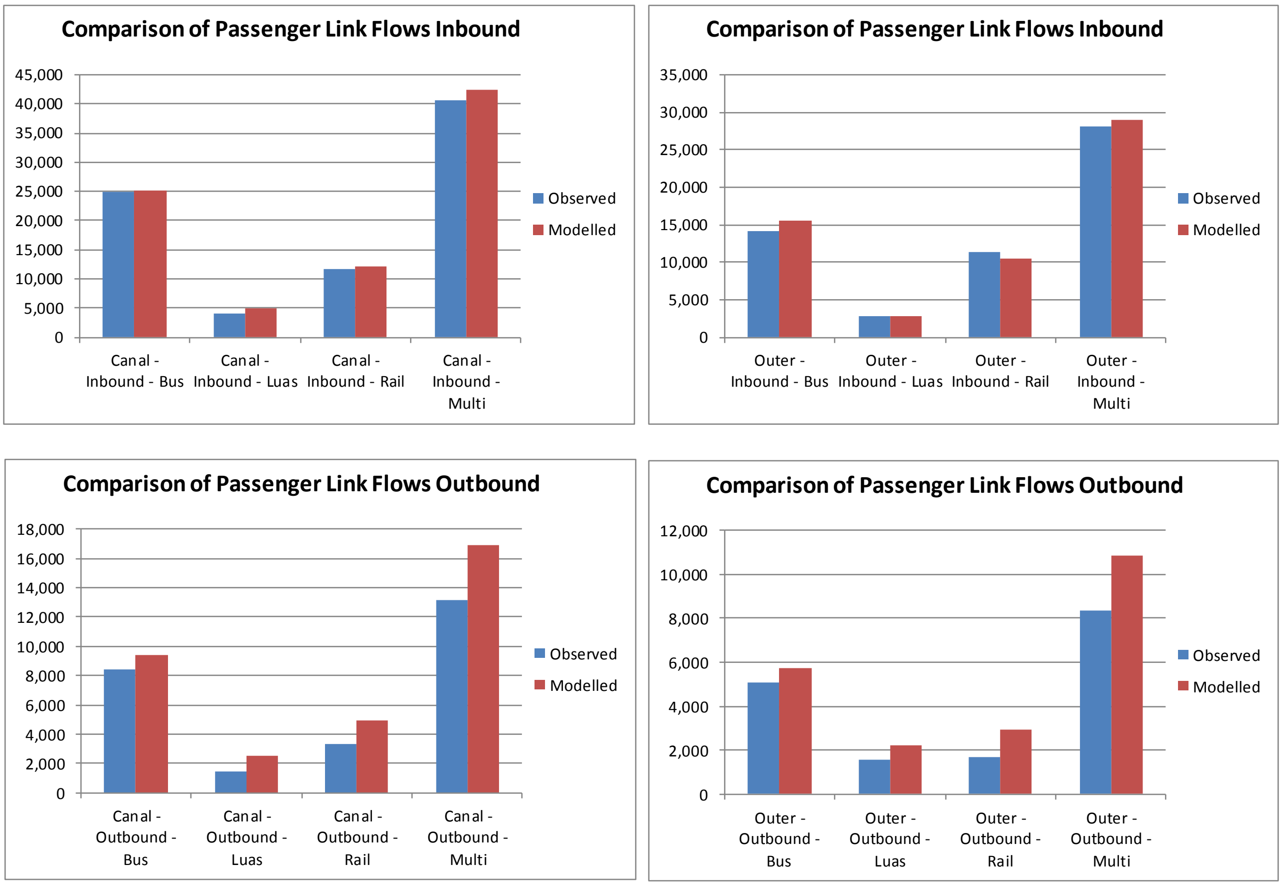


Figure 3.28: Test 11 morning peak flows on screenlines

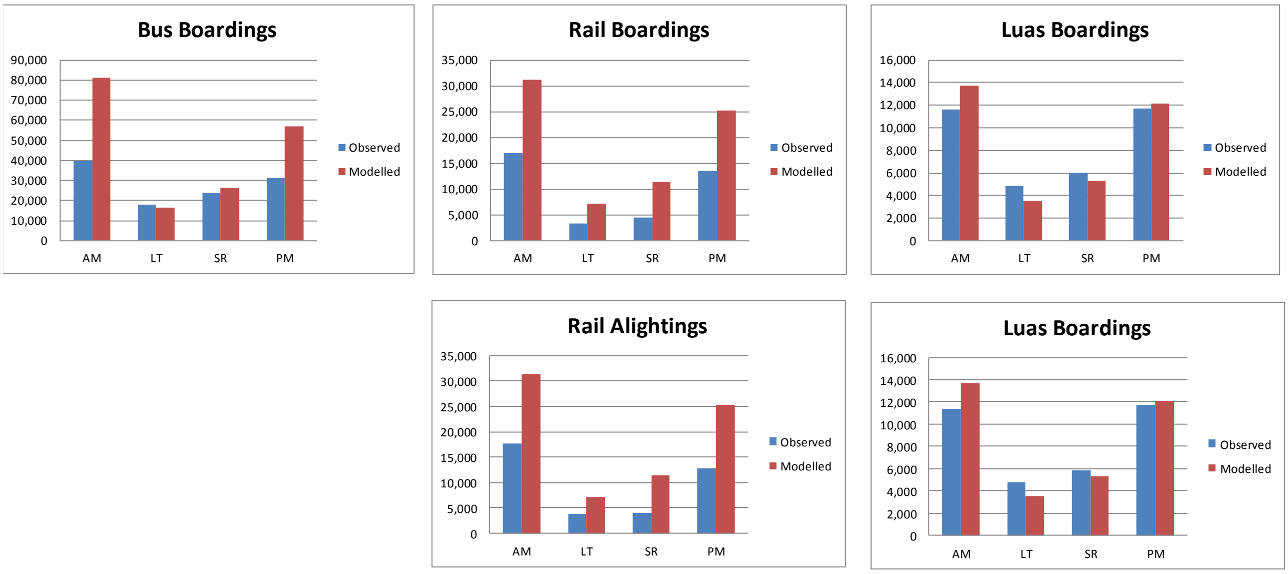


Figure 3.29: Test 11 PT boardings / alightings

3.16 Phase 1 Test 12

3.16.1 Run details

Model Version: *Model version 2.0.2: Save 12 revised*[15]
Date: *29/02/16*

For Test 12 the matrix estimated / PT factored outputs from Test 11 were used to calculate incremental values and taxi proportions and to provide new internal goods matrices.

3.16.2 Results / outputs

The demand outputs are extracted prior to the incremental stages and so the mode shares reported for Test 12 were very similar to those in Test 11 (see Figure 3.30 and the Test 12\2 Demand folder for more details). However, primarily due to the inclusion of the incrementals, there were major improvements in the flow calibration, with road calibration / validation (on percentage difference) at:

- AM 85% / 45%
- IP1 94% / 46%
- IP2 87% / 46%
- PM 82% / 41% (see the Test 12\3 Road folder for more details)

PT calibration did not improve as markedly, but most of the screenlines showed an improved fit, particularly in the morning peak (Figure 3.31). Luas boardings were close to observed levels though bus and rail figures still tended to be high (Figure 3.32 and see the Test 12\4 PT folder for more details). Walk and cycle flows were a good match although

[15] Strictly FDM Save 12 refers to the FDM at a point in time slightly before the version used in this test

modelled walk flows were still on the high side in the evening peak (see the Test 12\5 Active modes folder for more information).

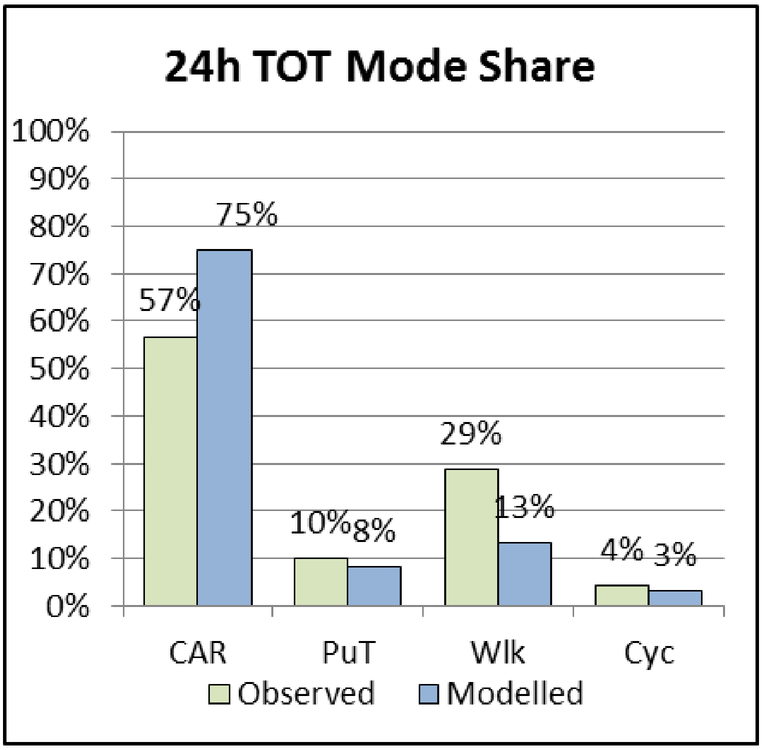
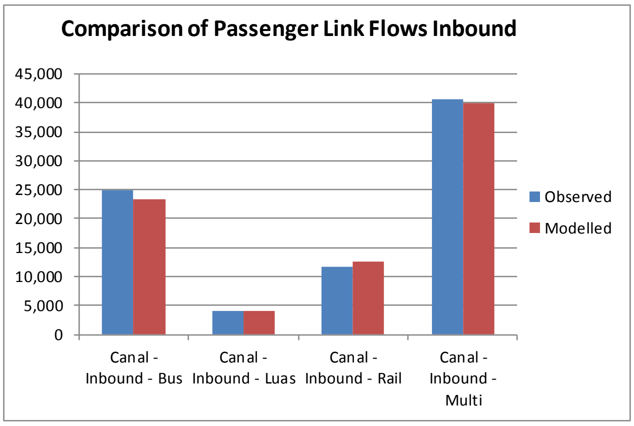
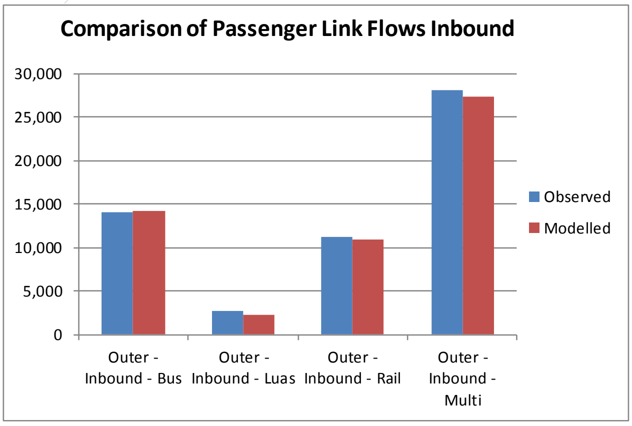
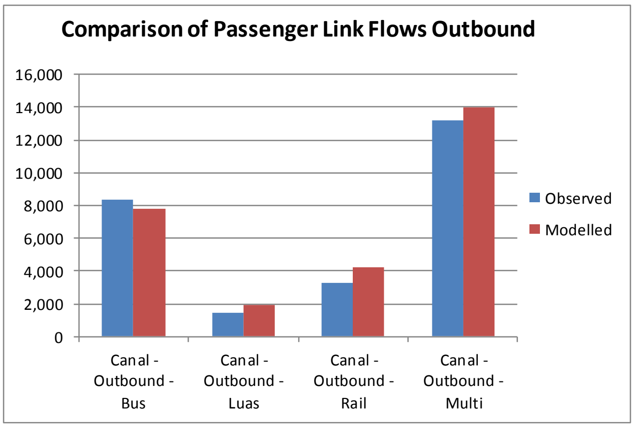


Figure 3.30: Test 12 mode split







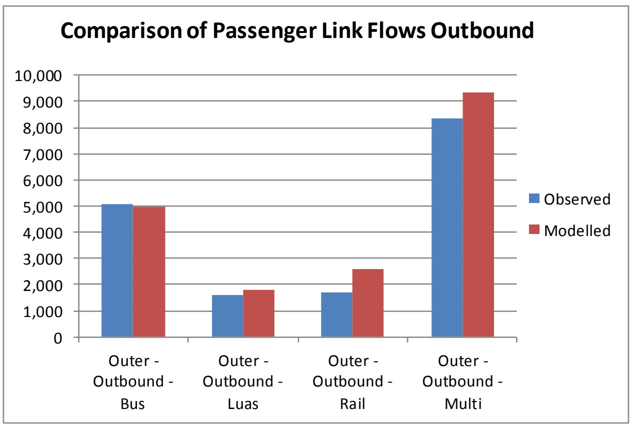


Figure 3.31: Test 12 morning peak flows on screenlines

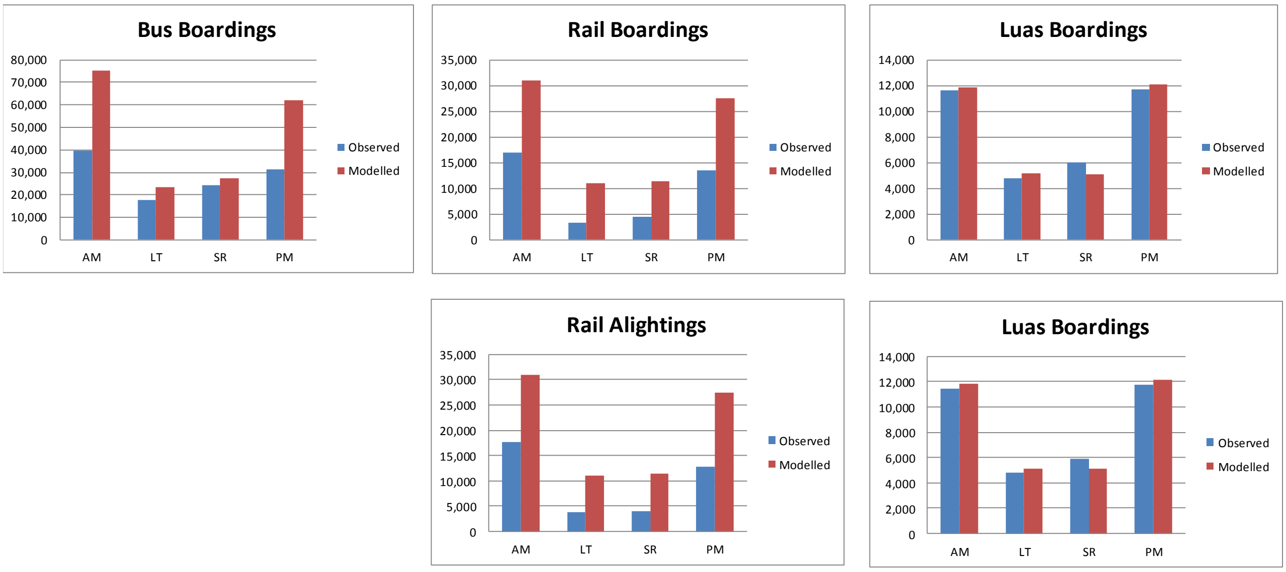


Figure 3.32: Test 12 PT boardings / alightings

3.17 Post Phase 1 Calibration and Validation Process Review

At this stage there was a review of the calibration and validation of both the ERM and the other regional models and a decision was made to revise the process by which calibration was achieved. The primary drivers for this were that it was felt to be inappropriate to factor trip ends and tour proportions merely to achieve improved calibration / validation, in the absence of a sound theoretical basis for adjustments. Some of the modifications to trip ends made during Phase 1 were considered justified and these were incorporated into NTEM. A new demand forecast, A9, was produced and incorporated into subsequent tests.

However, from Phase 2 onwards the process of calibration / validation favoured adjustments to mode split lambda, ASC and period to hour factors, with trip end factoring and tour proportion adjustments considered a secondary option. For this reason, at this stage, there was a step back in the testing process and the calibration process started over at Test 14 (Test 13 was not used).

3.18 Phase 2 Test 14

3.18.1 Run details

Model Version: *Model version 2.0.2: Save 14 revised*[16]
Date: *17/03/16*

In Test 14 the trip end and tour proportion adjustments made during Phase 1 of the calibration / validation process were removed. The new trip ends were included and the incrementals were re-set to do nothing. The model was re-run to establish a new baseline.

3.18.2 Results / outputs

At this stage, a major error was identified in the operation of the Parking Distribution module and this error was fed back to the FDM development team. As a consequence of this, there was no additional processing of the outputs from this test.

3.19 Phase 2 Test 15

3.19.1 Run details

Model Version: *Model version 2.0.3*[17]
Date: *22/04/16*

Using Version 2.0.3 of the model, with the corrected parking distribution module the test program then recommenced at Test 15 which was a revised baseline run.

3.19.2 Results / outputs

Road calibration / validation (on percentage difference) was similar to that in the previous runs at:

- AM 48% / 39%
- IP1 41% / 42%
- IP2 42% / 43%
- PM 41% / 38% (see the Test 15\3 Road folder for more details)

However, although the headline figures did not change, the output road matrices proved more suitable for matrix estimation and so matrix estimation and PT factoring were carried out. New costs were output for the next test.

16 Save 13 was not used. Strictly FDM Save 14 refers to the FDM at a point in time slightly before the version used in this test
17 Version 2.0.3 was the version which followed 2.0.2: Save 14

3.20 Phase 2 Test 16_Pre

3.20.1 Run details

Model Version: *Model version 2.0.6*[18]

Date: *26/04/16*

Test 16_Pre incorporated the new costs based on the matrix estimated / factored outputs from Test 15, as well as updated period to hour factors (PT values were reset to count based values and car values were increased) and some ASC adjustments (all PT ASC values were increased by 8). The internal goods matrix input was replaced with the latest estimated version.

3.20.2 Results / outputs

Checks on matrix totals made it clear that the changes in the mode share were only going to worsen the overall mode share and so the creation of a full demand dashboard was not considered worthwhile, but flow calibrations were extracted and the outputs were considered suitable for matrix estimation / factoring and the creation of new costs.

Road calibration / validation (on percentage difference) was as good as, if not slightly better than, the best level achieved in Phase 1 at:

- AM 47% / 39%
- IP1 39% / 43%
- IP2 45% / 44%
- PM 46% / 39% (see the Test 16_Pre\3 Road folder for more details)

Boardings and alightings were not checked but PT flows remained a mix of high and low values and there were no dramatic mismatches, which was an improvement on Phase 1. An example of the flows on the screenlines is shown in Figure 3.33 (for more details see the Test 16_Pre\4 PT folder).

18 Versions 2.0.4 and 2.0.5 were minor upgrades which fell between these two tests

Cordon	Observed	Modelled	Diff	% Diff	GEH	CR
Canal - Inbound - Bus	24,845	25,279	+434	+2%	3	0.76
Canal - Inbound - Luas	4,086	4,605	+519	+13%	8	0.65
Canal - Inbound - Rail	11,740	10,337	-1,403	-12%	13	0.88
Canal - Inbound - Multi	**40,671**	**40,221**	**-450**	**-1%**	**2**	**0.78**
Canal - Outbound - Bus	8,386	9,445	+1,059	+13%	11	0.69
Canal - Outbound - Luas	1,492	1,976	+484	+32%	12	0.70
Canal - Outbound - Rail	3,311	3,817	+506	+15%	8	0.74
Canal - Outbound - Multi	**13,189**	**15,238**	**+2,049**	**+16%**	**17**	**0.71**
Outer - Inbound - Bus	14,126	17,065	+2,939	+21%	24	0.74
Outer - Inbound - Luas	2,737	2,987	+250	+9%	5	0.55
Outer - Inbound - Rail	11,306	9,100	-2,206	-20%	22	0.80
Outer - Inbound - Multi	**28,169**	**29,152**	**+983**	**+3%**	**6**	**0.74**
Outer - Outbound - Bus	5,061	5,411	+350	+7%	5	0.70
Outer - Outbound - Luas	1,583	1,663	+80	+5%	2	0.66
Outer - Outbound - Rail	1,713	2,495	+782	+46%	17	0.66
Outer - Outbound - Multi	**8,357**	**9,569**	**+1,212**	**+15%**	**13**	**0.68**

Figure 3.33: Test 16_Pre morning peak flows on screenline

3.21 Phase 2 Test 17_Pre

3.21.1 Run details

Model Version: *Model version 2.0.6*
Date: *04/05/16*

This test was the same as Test 16_Pre but with the revised costs obtained by that previous test.

3.21.2 Results / outputs

Overall, road flows were similar to, though slightly worse than, those in Test 16_Pre at:

- AM 42% / 39%
- IP1 41% / 45%
- IP2 43% / 44%
- PM 42% / 40% (see the Test 17\3 Road folder for more details – the Pre ME values are the relevant ones)

However, journey time validation results were also extracted and were very good:

- AM 74% pass
- IP1 86% pass
- IP2 81% pass
- PM 90% pass (see the Test 17\3 Road folder for more details – the Pre ME values are the relevant ones)

PT outputs were not checked but walk flows were rather low and cycle flows were much too high (see the Test 17\5 Active modes\Pre folder for more details).

Matrix estimation and PT factoring was also carried out on the outputs of this test and new costs were produced.

3.22 Phase 2 Test 17_Post

3.22.1 Run details

Model Version: *Model version 2.0.6*
Date: *09/05/16*

This test did not incorporate the updated costs output as a result of the previous test, as the demand model needed to produce the same result as in Test 17_Pre. However, the incrementals and taxi proportions were updated based on the outputs from Test 17_Pre (the pre incremental values) and matrix estimated / factored matrices from Test 16_Pre (the desired post incremental values).

3.22.2 Results / outputs

Because the post matrix estimation / factored outputs from Test 16_Post were known to give good levels of calibration and validation these outputs were not checked in detail at this stage.

As would be expected road flows were much improved over Test 17_Pre at:

- AM 70% / 44%
- IP1 78% / 46%
- IP2 73% / 47%
- PM 66% / 43% (see the Test 17\3 Road folder for more details – the Post ME values are the relevant ones)

However, journey times tended to worsen slightly to:

- AM 69% pass
- IP1 83% pass
- IP2 83% pass
- PM 76% pass (see the Test 17\3 Road folder for more details – the Pre ME values are the relevant ones)

PT outputs were not checked but Active modes flows were and were improved, dramatically so in the case of cycling (see the Test 17\5 Active modes\Post folder for more details).

3.23 Phase 2 Test 18_Pre

3.23.1 Run details

Model Version: *Model version 2.0.6*
Date: *16/05/16*

Test 18_Pre incorporated the new costs created following the estimation of the outputs of Test 17_Pre.

3.23.2 Results / outputs

Although the overall match to the flows at this stage was good, the match to the mode shares was not and because of this there was a shift in focus to matching mode shares as well as flows. Because of this shift in focus full outputs were not extracted for this test.

Matrix estimation and PT factoring was also carried out on the outputs of this test and new costs were produced.

3.24 Phase 2 Test 19_Pre

3.24.1 Run details

Model Version: *Model version 2.0.8*[19]
Date: *02-15/06/16*

Test 19_Pre incorporated the new costs created following Test 18_Pre. Period to hour factors were restored to their initial count based level. Additionally, Test_19 Pre incorporated 20 separate sub-tests covering progressive adjustments to ASC values as the mode share was progressively improved. The overall changes in ASC values between Test 18_Pre and the last sub-test in Test 19_Pre is shown in Table 3.2.

19 Versions 2.0.7 and 2.0.8 saw the reimplementation of the parking constraint module, but there was an error in 2.0.7 and it was never issued for production runs.

Table 3.2: Changes in ASC values Test 18_Pre vs Test 19_Pre (final sub-test)

Trip purpose	Change in car ASC value	Change in PuT ASC value	Change in PnR ASC value	Change in walk ASC value	Change in cycle ASC value
P01	+45	-12	0	-13	-3
P02	+45	-12	0	-13	-3
P03	+20	+25	0	-10	0
P04	+20	+25	0	-10	0
P05	+37	-12	0	-12	-2
P06	+37	-12	0	-12	-2
P07	+77	-12	0	-12	-2
P08	+20	-7	0	-10	0
P09	+20	-7	0	-10	0
P10	+20	-7	0	-10	0
P11	+20	-12	0	-10	0
P12	+20	-12	0	-10	0
P13	+20	-12	0	-10	0
P14	+20	-7	0	-10	0
P15	+20	-7	0	-10	0
P16	+20	-7	0	-10	0
P17	+16	-12	0	-10	0
P18	+16	-12	0	-10	0
P19	+20	-12	0	-10	0
P20	+20	-12	0	-10	0
P21	+20	-12	0	-10	0
P22	+20	-12	0	-10	0
P23	+20	-12	0	-10	0
P24	+20	-12	0	-10	0
P25	+20	-12	0	-10	0
P26	+20	-12	0	-10	0
P27	+14	-12	0	-8	+5
P28	+18	+3	0	-10	0
P29	+20	-12	0	-10	0
P30	+20	-12	0	-10	0
P31	+20	-12	0	-10	0
P32	+20	-12	0	-10	0
P33	+20	-12	0	-10	0

3.24.2 Results / outputs

Only demand dashboards were produced at this stage but at the start of the Test 19_Pre subtests the mode split was poor, similar to that in Figure 3.30. By the end of this stage there was a good fit to the mode split data for all five user classes (see Figure 3.34 and the Test 19_Pre\2 Demand folder for more details).

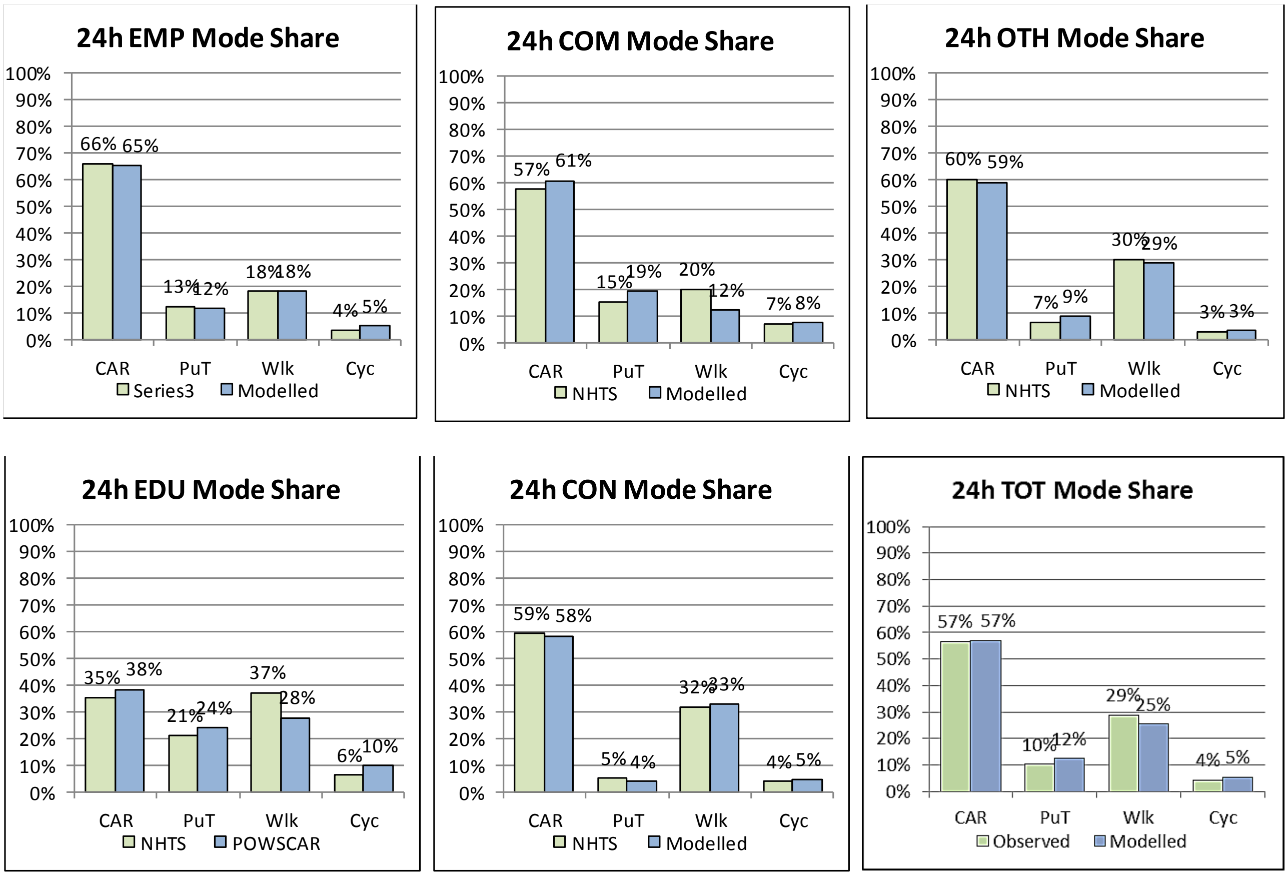


Figure 3.34: Test 19_Pre final mode splits

3.25 Phase 2 Test 20_Pre

3.25.1 Run details

Model Version: *Model version 2.0.8*

Date: *17/06/16*

In Test 20_Pre there were some adjustments to tour proportions for trip purpose 1 only to improve the directional fit of screenline flows. These were smaller than in previous passes being on the order of 3-5%.

3.25.2 Results / outputs

Mode share calibration was excellent, very close to that achieved at the final stages of Test19_Pre (see Figure 3.35 and the Test 20_Pre\2 Demand folder for more details). However, this was the first test since Test 17_Post for which road flow data had been extracted, and despite the excellent mode share calibration, road flow calibration had worsened noticeably. Full dashboards were not produced. For the dashboards which were produced (AM and IP1) the calibration / validation (on percentage difference) was:

- AM 29% / 33%
- IP1 27% / 30% (see the Test 20_Pre\3 Road folder for more details)

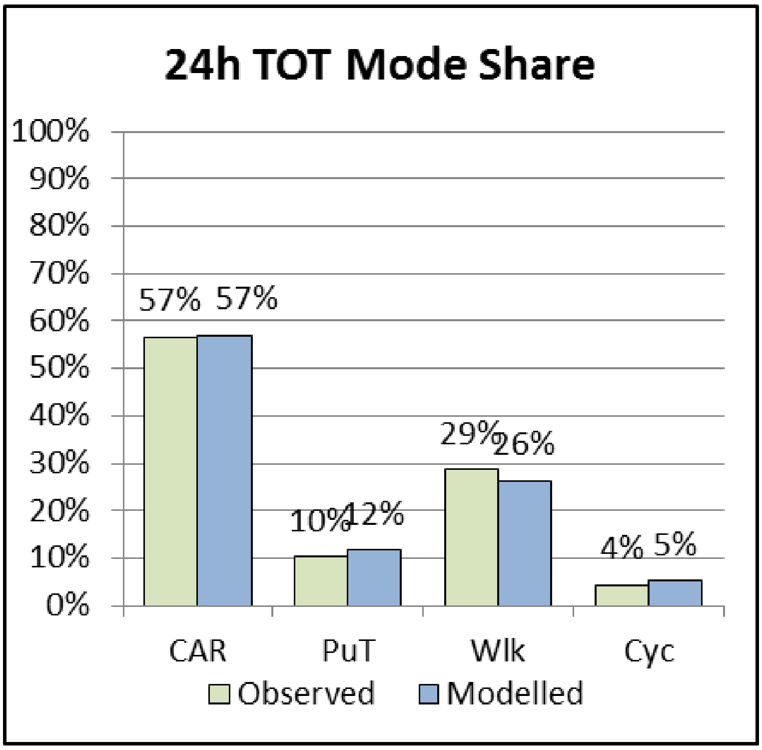


Figure 3.35: Test 20_Pre mode split

3.26 Phase 2 Test 21_Pre

3.26.1 Run details

Model Version: *Model version 2.0.8*

Date: *30/06/16*

In Test 21 there were further adjustments to some of the ASC values in order to try and improve the road calibration without affecting the mode split calibration

3.26.2 Results / outputs

Again, while the changes had very little impact on the excellent mode split calibration (see Figure 3.36 and the Test 21_Pre\2 Demand folder for more details) the road flow calibration \ validation (on percentage difference) did not improve, standing at:

- AM 30% / 33%
- IP1 27% / 30%
- IP2 23% / 28%
- PM 21% / 24% (see the Test 21_Pre\3 Road folder for more details)

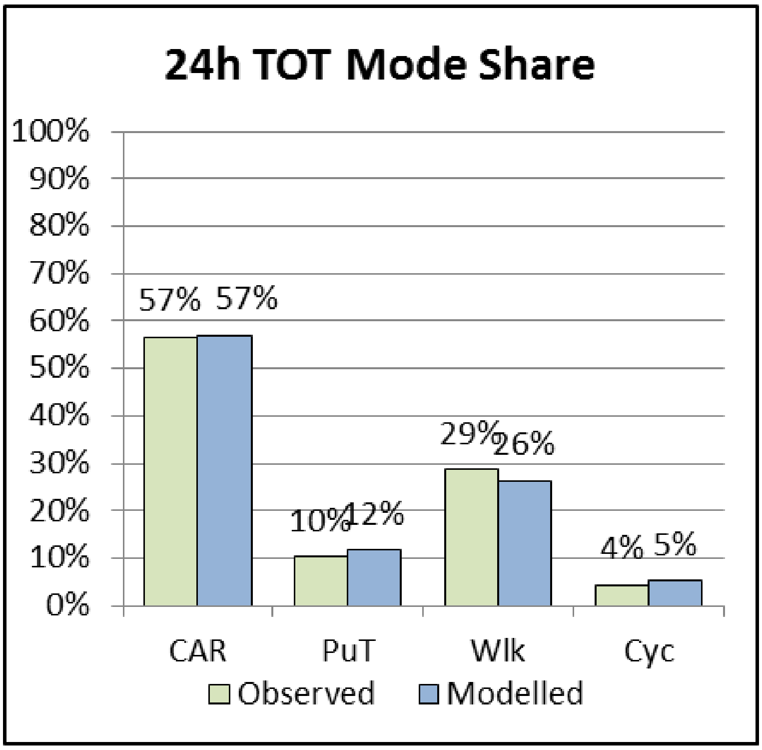


Figure 3.36: Test 21_Pre mode split

3.27 Post Phase 2 Calibration and Validation Process Review

Following Phase 2 it was observed that there was an ongoing mismatch between the amount of car traffic needed overall in order to achieve a good match to flows in the city centre and that needed to match the mode splits. It was suspected that this was due to the fact that, at this stage, the parking distribution module was unable to feed costs around to the main FDM loop. This query was passed back to the FDM development team who re-implemented the module so that it did pass costs around to the main loop. At this stage, an issue with the redistribution of trips from the free workplace parking module was also addressed.

3.28 Phase 3 Test 22_Pre

3.28.1 Run details

Model Version: *Model version 2.0.10*[20]
Date: *14/07/16*

Test 22 took the best parameters from Phase 2 Test 21_Pre and re-ran the FDM in the updated model version for the full five model loops in order to get a new baseline. At this

20 Version 2.0.9 fell between these two tests

stage the parking distribution parameters were also adjusted so as to ensure that the parking distribution module returned plausible behaviour.

3.28.2 Results / outputs

This revision did have a major impact on the car mode share (see Figure 3.37 and the Test 22_Pre\2 Demand folder for more details), primarily because the calibrated parameters were no longer suitable for the additional car cost information now being included. Clearly, recalibration would be required and so further outputs were not extracted.

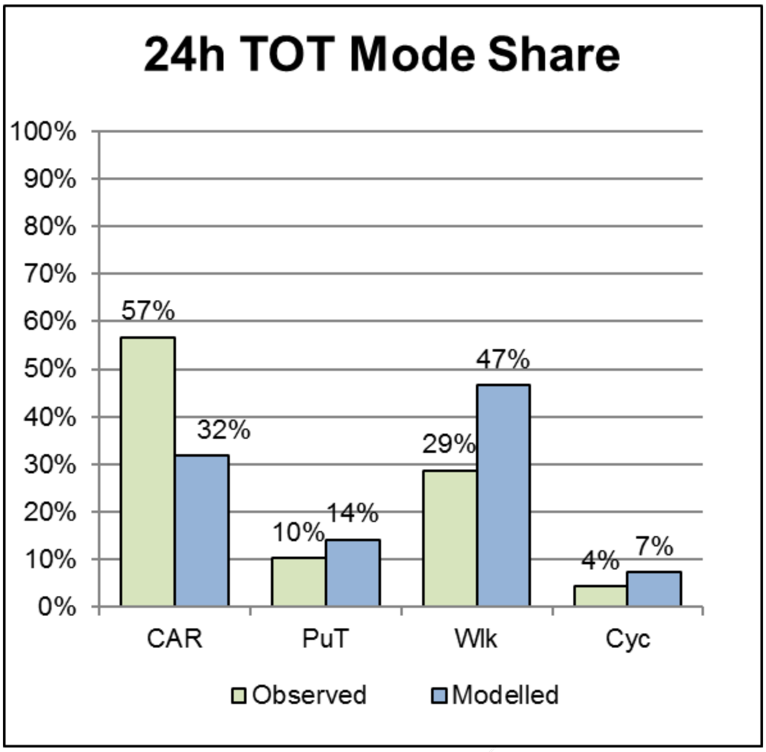


Figure 3.37: Test 22_Pre mode split

Though further outputs were not extracted, the parking distribution statistics were checked to ensure that, although there was no actual data, the modelled parking behaviour was at least plausible.

3.29 Phase 3 Test 23_Pre_ADJ0

3.29.1 Run details

Model Version: *Model version 2.0.14*[21]
Date: *03-15/08/16*

21 Versions 2.0.11 and 2.0.12 fell between these two tests. Version 2.0.13 was not used

This test used a new model version with the capability to mode split special zone flows[22]. Two initial tests were run, one using the Test 21_Pre ASC values which were known to give too little car and one from Test 12 expected to give too much. Subsequent variations worked on averages of these two sets of values to progressively improve the match between the mode share and observed flows. During this stage it became clear that a good match to the mode split and to the road flows was going to be impossible to obtain and this led to a re-examination of the mode split calibration data. This revealed that issues with the original data entry had caused a large number of records to be omitted. The data was reprocessed with these included. Later sub-tests at this stage also experimented with using different ASC values for city centre zones where there was more information in the model regarding the cost of parking.

3.29.2 Results / outputs

Due the change in the data there was not a linear improvement in the mode split calibration over this suite of subtests. However, there was a noticeable improvement in the end point (Figure 3.40) over the two start points (Figure 3.38 and Figure 3.39). More information may be found in the Test 23_Pre\2 Demand folder.

Once a reasonable level of mode split calibration was achieved road calibration / validation (on percentage difference) was also checked and was at:

- AM 40% / 42%
- IP1 42% / 45%
- IP2 35% / 42%
- PM 26% / 36% (for more information see the Test 23_Pre\3 Road folder)

PT flows were high across all screenlines as were all boarding and alighting movements (see Figure 3.41, Figure 3.42 and the Test 23_Pre\4 PT folder for examples and more information).

[22] See Annex 2 for details of the special zone setup.

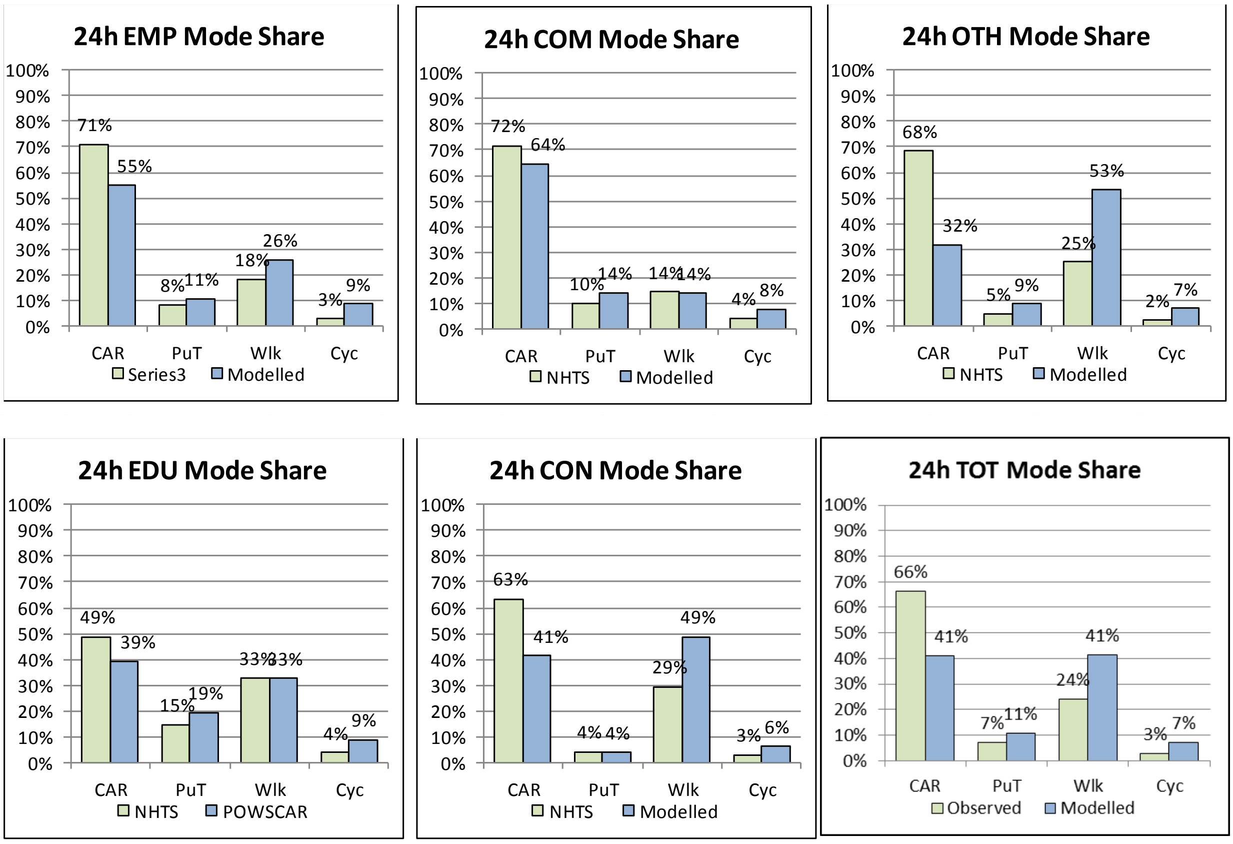


Figure 3.38: Test 23_Pre mode split: ‘Low’ start point – too little car

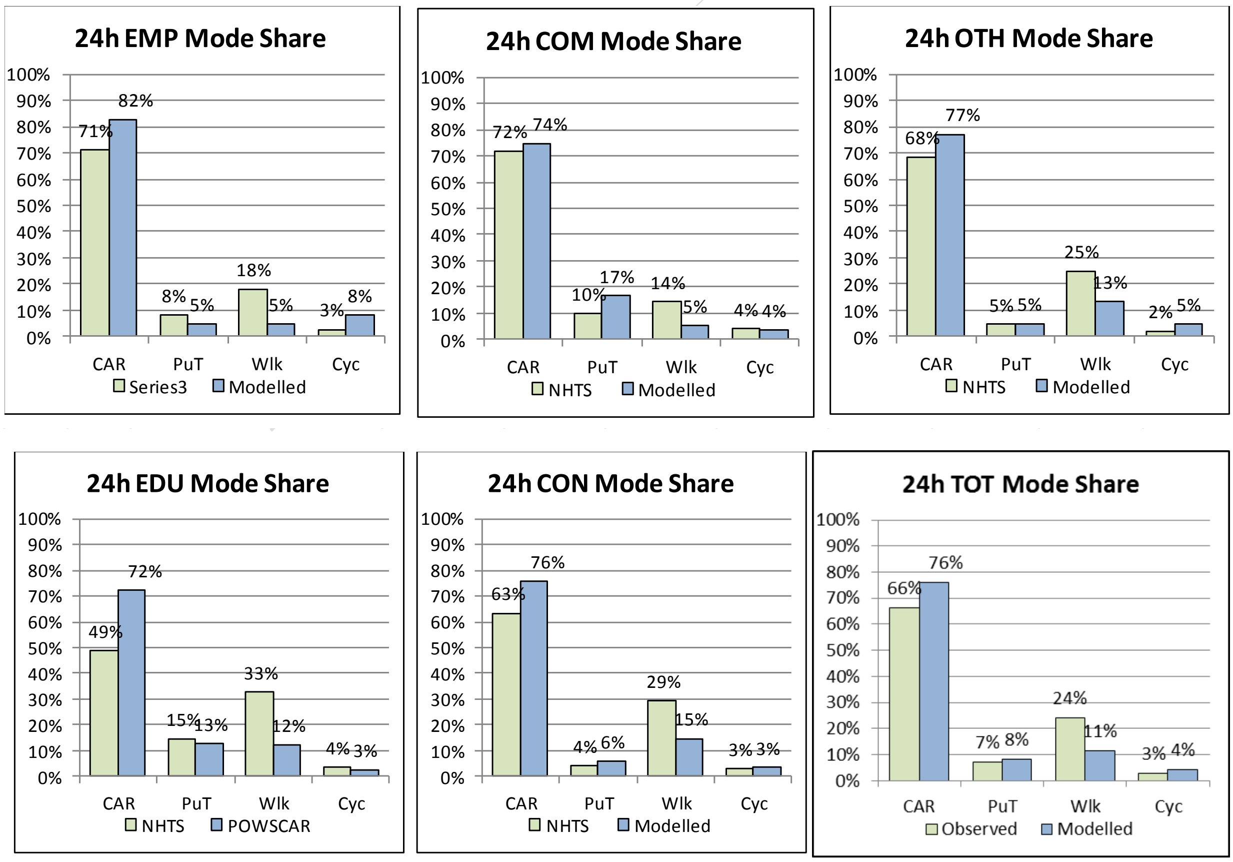


Figure 3.39: Test 23_Pre mode split: ‘High’ start point – too much car

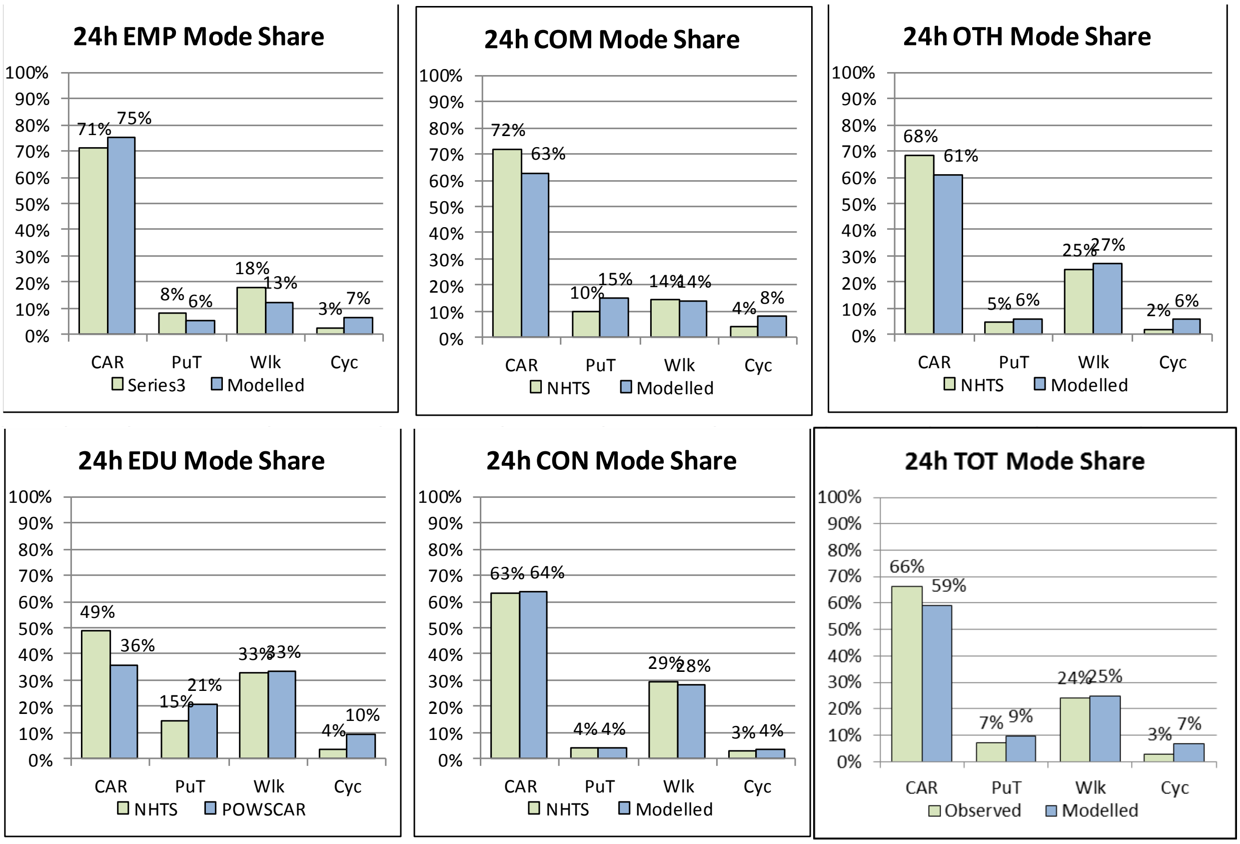


Figure 3.40: Test 23_Pre mode split: End point

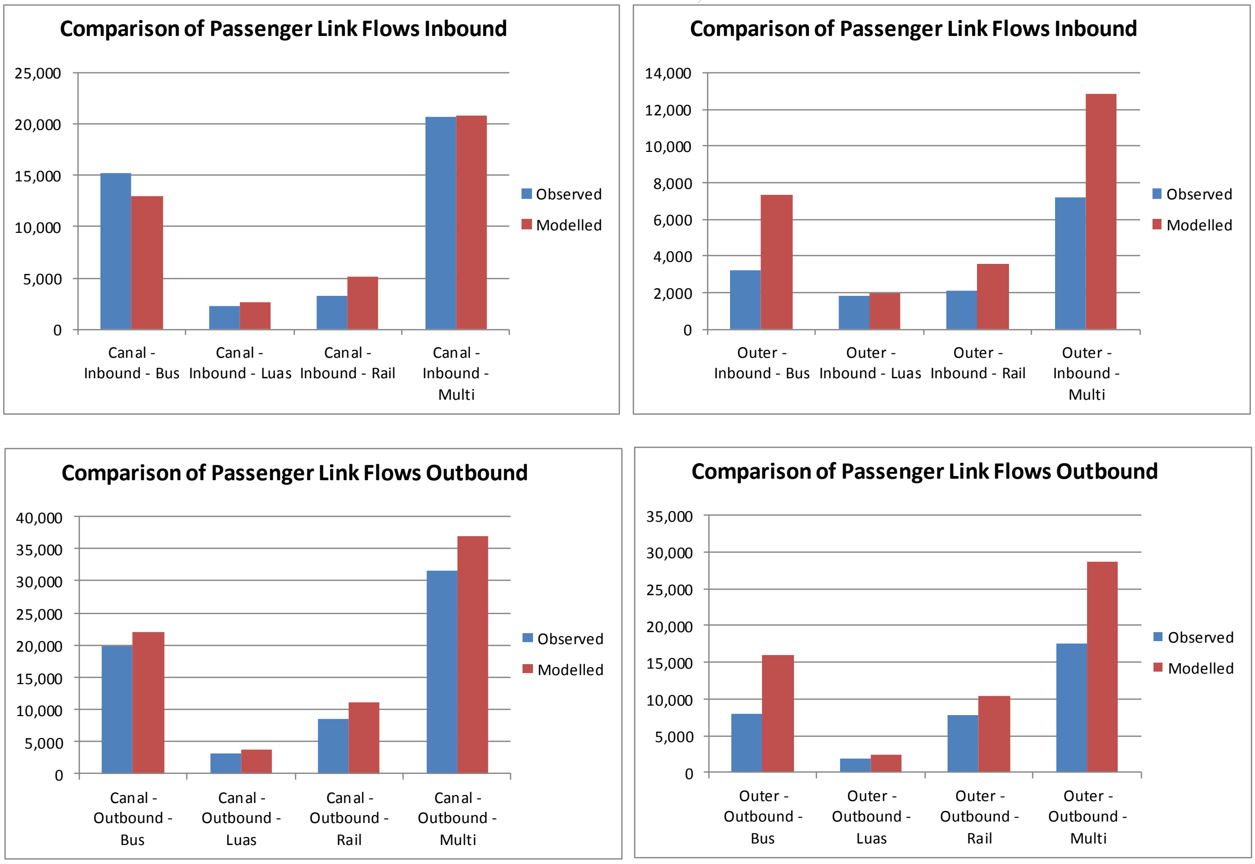


Figure 3.41: Test 23_Pre evening peak flows on screenlines

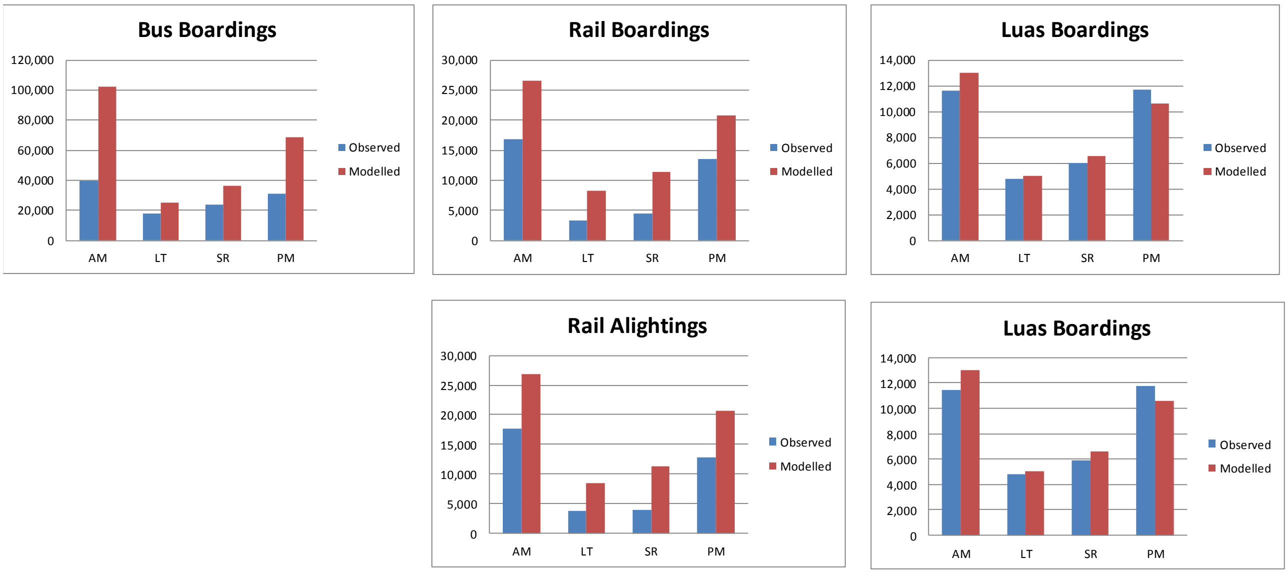


Figure 3.42: Test 23 PT boardings / alightings

3.30 Phase 3 Test 24_Pre

3.30.1 Run details

Model Version: Model version 2.0.15

Date: 19/08/16

Following Test 23_Pre a decision was made that ASC values should not vary by area unless calibration could not be achieved otherwise. For this reason, the FDM was modified to allow parking cost information to be input for a much wider range of zones without triggering the parking distribution module, which was, as an alternative, triggered by an explicit switch on each input zone record. At this stage the model was ported into the new version and estimates of appropriate ASC values were made, based on the Test 23_Pre outputs. These values are shown in Table 3.3.

Table 3.3: ASC values at the end of Test 24_Pre

Trip purpose	car ASC value	PuT ASC value	walk ASC value	cycle ASC value
P01	-5.4	31.74	22.27	25.44
P02	-7.72	35.49	26.74	51.92
P03	49.9	21.23	22.35	29.46
P04	49.9	44.09	1.5	48.45
P05	18.59	33.61	3	12.62
P06	34.68	52.37	16.61	30.14
P07	44.95	43.55	8	26.99
P08	61.9	51.28	-24.21	24.22
P09	61.9	32.09	-4.15	37.4
P10	61.9	35.69	-7.78	32.92
P11	1.14	27.11	15.5	24.06
P12	-0.55	15.42	21.76	19.9
P13	-14.77	34.06	25.13	34.59
P14	52.5	57.61	-15.2	33.82
P15	52.5	59.78	-8.05	38.71
P16	52.5	75.03	-1.72	32.97
P17	-0.31	18.44	16.6	21.26
P18	3.86	19.24	13.46	22.3
P19	53.25	25.62	4.72	35.13
P20	53.25	25.34	8.7	44.71
P21	2.76	8.24	17.69	22.05
P22	1.55	16.76	12.32	21.22
P23	53.25	65.12	-35.15	30.53
P24	0.95	27.22	15.49	19.19
P25	2.29	25.74	13.65	15.54
P26	53.25	21.11	-3.27	28.13
P27	2.95	25.89	-3.96	10.47
P28	7.67	37.97	8.18	21.1
P29	62.5	53.26	-36.33	14.41
P30	8.33	30.82	10.28	17.79
P31	61.3	33.5	-14.8	29.12
P32	4.25	26.41	13.5	19.88
P33	53.25	30.93	-1.39	29.11

3.30.2 Results / outputs

At this stage the mode split was checked and found to be comparable with Test 23_Pre (see Figure 3.43 and the Test 24_Pre\2 Demand folder for more information). Only the morning peak road dashboard was produced in detail as the road network was not considered to be close enough for good results to be achieved from estimation. The morning peak calibration / validation (on percentage difference) was 43% / 42% (for more information see the Test 24_Pre\3 Road folder).

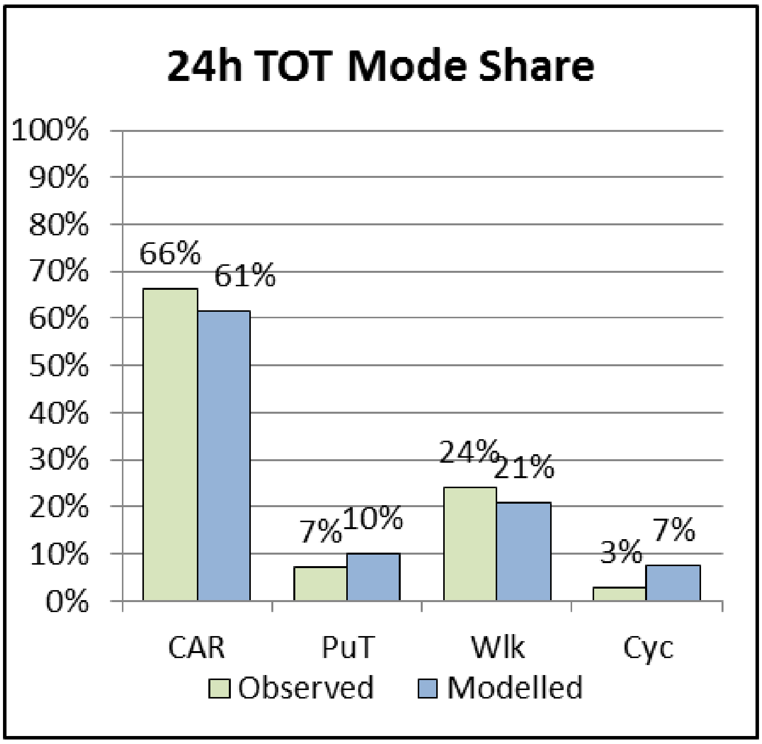


Figure 3.43: Test 24_Pre mode split

3.31 Phase 3 Test 25_Pre

3.31.1 Run details

Model Version: *Model version 2.0.15*

Date: *22/08/16*

For Test 25_Pre the tour proportion factoring introduced at Test 20_Pre was removed and there were some final adjustments to ASC values. The ASC values used in Test 25_Pre are detailed in Table 3.4.

Table 3.4: ASC values at the end of Test 25_Pre

Trip purpose	car ASC value	PuT ASC value	walk ASC value	cycle ASC value
P01	-5.4	31.74	22.27	25.44
P02	-7.72	35.49	26.74	51.92
P03	49.9	21.23	22.35	29.46
P04	49.9	44.09	1.5	48.45
P05	16.44	33.41	3.65	12.57
P06	32.53	52.17	17.26	30.09
P07	40.8	43.35	8.65	26.94
P08	60.7	50.83	-23.66	24.07
P09	60.7	31.64	-3.6	37.25
P10	60.7	35.24	-7.23	32.77
P11	0.91	27.26	16.05	24.11
P12	-0.87	15.57	22.31	19.95
P13	-15.79	34.21	25.68	34.64
P14	51.5	57.66	-14.7	33.82
P15	51.5	59.83	-7.55	38.71
P16	51.5	75.08	-1.22	32.97
P17	-0.5	18.74	16.8	21.16
P18	3.16	19.54	13.66	22.2
P19	52.1	25.77	5.27	35.18
P20	52.1	25.49	9.25	44.76
P21	2.63	8.39	18.04	22
P22	1.36	16.91	12.67	21.17
P23	52.1	65.27	-34.6	30.58
P24	0.74	27.37	15.84	19.14
P25	2.14	25.89	14	15.49
P26	52.1	21.26	-2.72	28.18
P27	3.65	25.59	-4.36	10.72
P28	6.07	36.57	8.78	20.9
P29	60.5	53.36	-35.33	14.41
P30	9.48	30.67	9.73	17.74
P31	62.45	33.35	-15.35	29.07
P32	4.17	26.56	14.05	19.93
P33	52.1	31.08	-0.84	29.16

3.31.2 Results / outputs

The mode split calibration in Test 25_Pre was good and similar to that in Test 24_Pre with all modes matched overall within a few percentage points (see Figure 3.44 and the Test 25\2 Demand\Pre folder for more information).

Road flow calibrations \ validations (on percentage difference) were reasonable at:

- AM 44% / 42%
- IP1 35% / 40%
- IP2 33% / 38%
- PM 29% / 35% (for more information see the Test 25\3 Road\Pre folder)

Public transport flows were universally on the high side as were cycle flows, but walk flows were a good match (see Figure 3.45 for an example of PT screenline flows and Figure 3.46 for boardings and alightings or the Test 25\4 PT\Pre and Test 25\5 Active modes\Pre folders for more information).

Notably, for the first time, the discrepancies in the flows were on the same order and in the same direction as the discrepancies in the mode split suggesting that further improvements could be achieved with relatively minor additional modifications, if this was desired at any future stage.

Although the outputs from this stage were not perfect, they were still passed forward for matrix estimation / factoring.

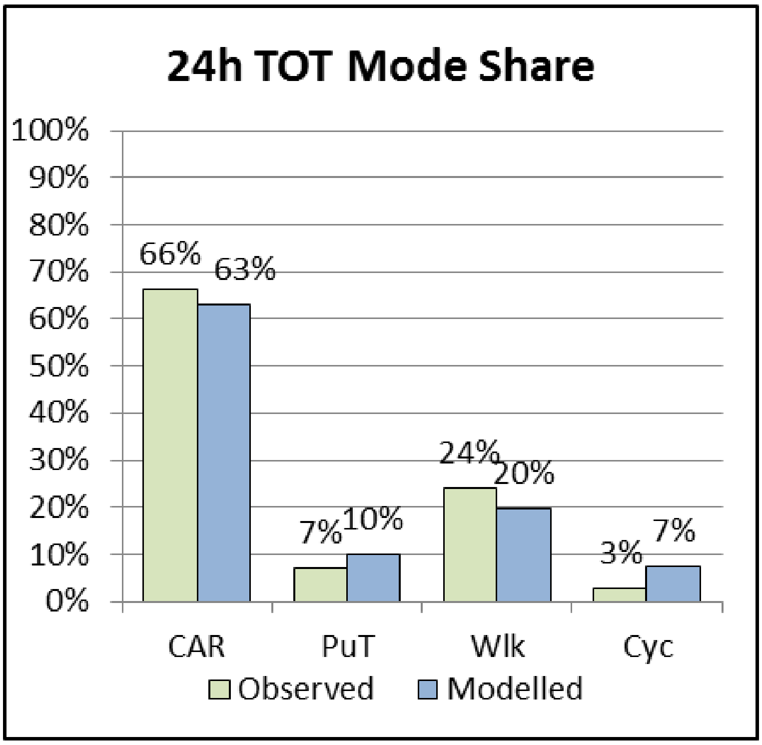


Figure 3.44: Test 25_Pre mode split

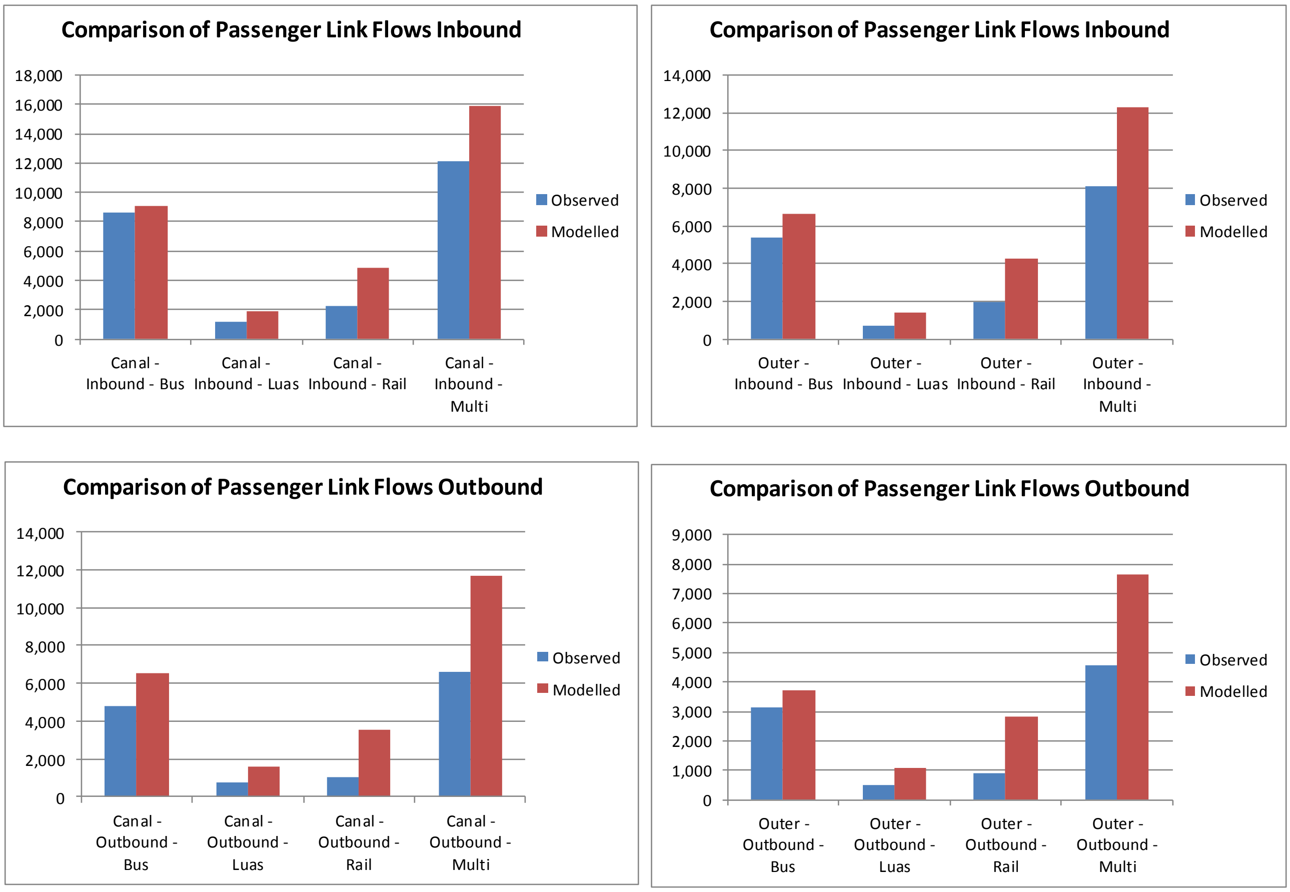


Figure 3.45: Test 25_Pre interpeak 1 peak flows on screenlines

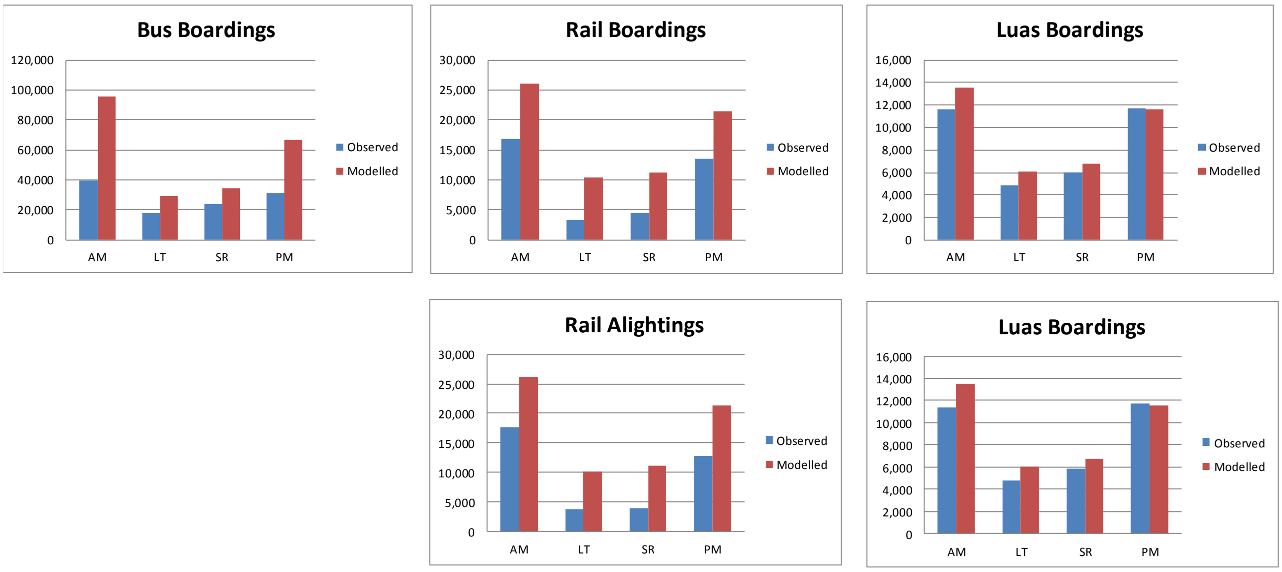


Figure 3.46: Test 25_Pre PT boardings / alightings

3.32 Phase 3 Test 25_Post

3.32.1 Run details

Model Version: *Model version 2.0.15*

Date: *26/08/16*

Test 25_Post was identical to Test 25_Pre but includes updated incrementals, taxi proportions and internal goods matrices based on the outputs of matrix estimation / factoring of the Test 25_Pre outputs.

3.32.2 Results / outputs

The mode split calibration in Test 25_Post was very similar to that in Test 25_Pre with all modes matched overall within a few percentage points (see Figure 3.47 and the Test 25\2 Demand\Post folder for more information).

Road flow calibrations \ validations (on percentage difference) were, as would be expected, much improved at:

- AM 78% / 45%
- IP1 89% / 49%
- IP2 84% / 46%
- PM 73% / 43% (for more information see the Test 25\3 Road\Post folder)

Journey time validation results were also extracted and were good:

- AM 73% pass
- IP1 81% pass
- IP2 76% pass
- PM 71% pass (see the Test 25\3 Road folder for more details – the Post ME values refer to this test and the Pre Me values to Test25_Pre)

Public transport flows still tended to be less well matched than road flows, but the match on screenlines was improved, as were bus and rail boardings / alightings. The match to Luas boardings / alightings was good (see Figure 3.48 for an example of PT screenline flows and Figure 3.49 for boardings and alightings or the Test 25\4 PT\Post folder for more information).

As they were not adjusted, cycle flows continued to be on the high side, but walk flows remained a good match (see the Test 25\5 Active modes\Post folder for more information).

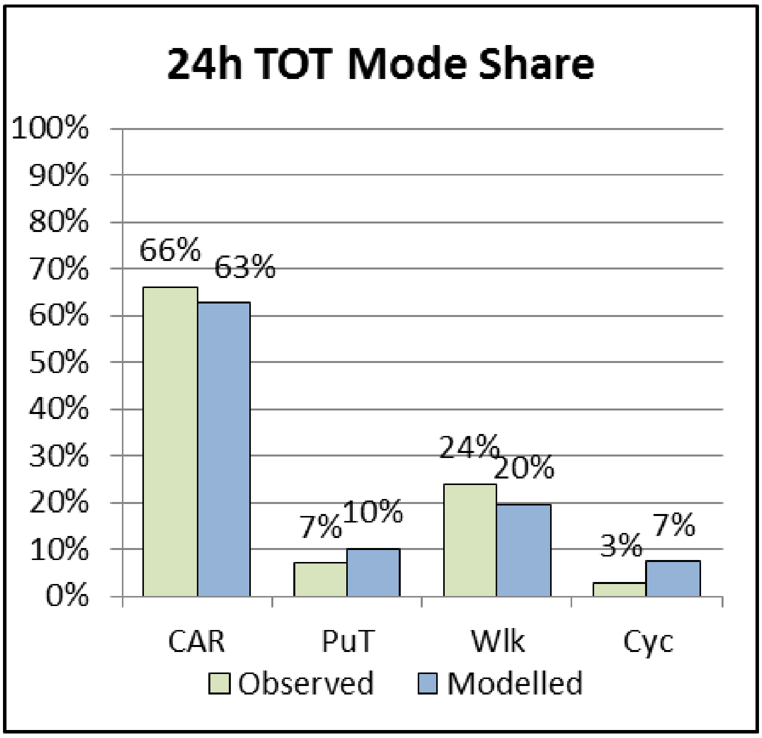


Figure 3.47: Test 25_Post mode split

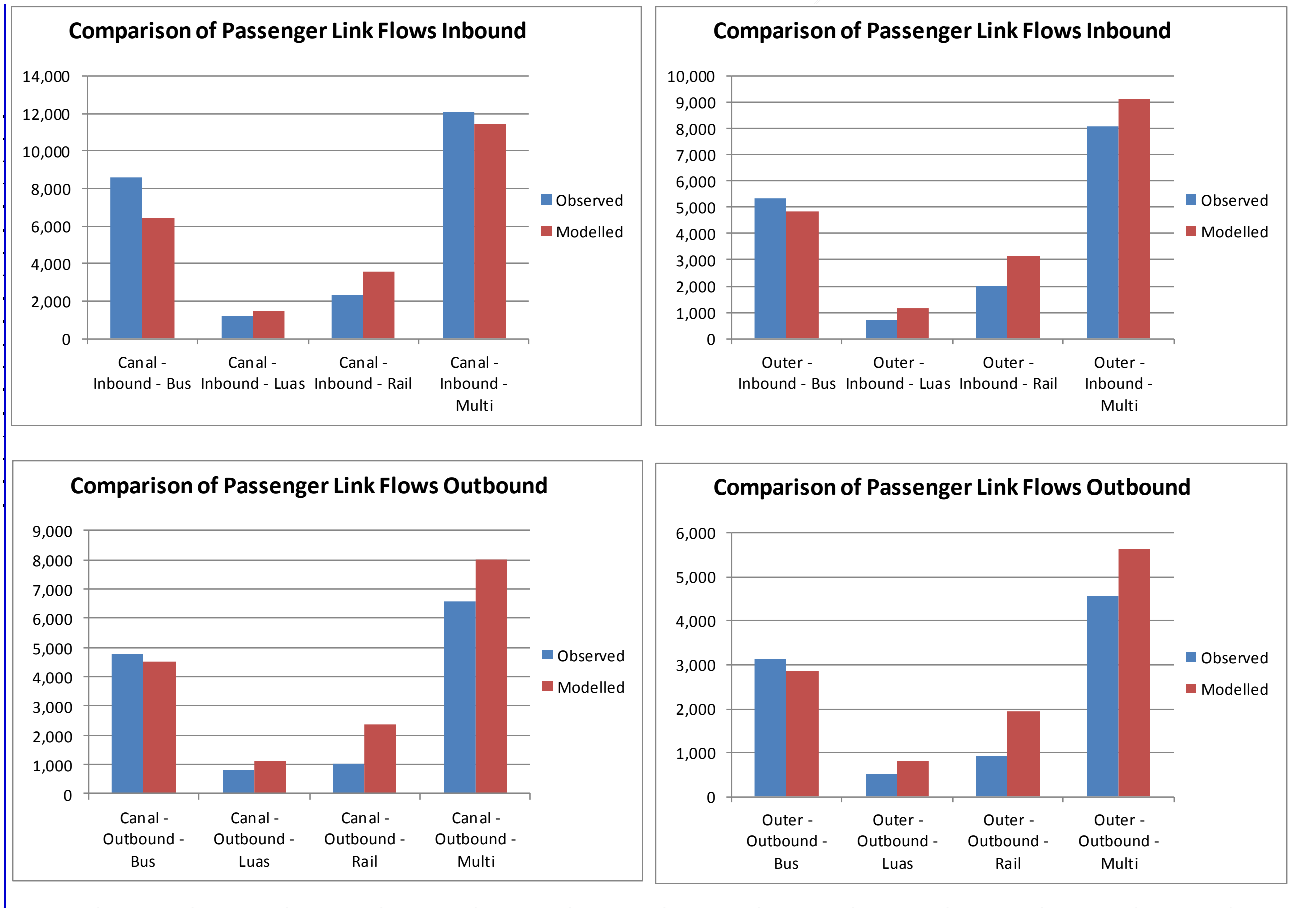


Figure 3.48: Test 25_Post interpeak 1 peak flows on screenlines

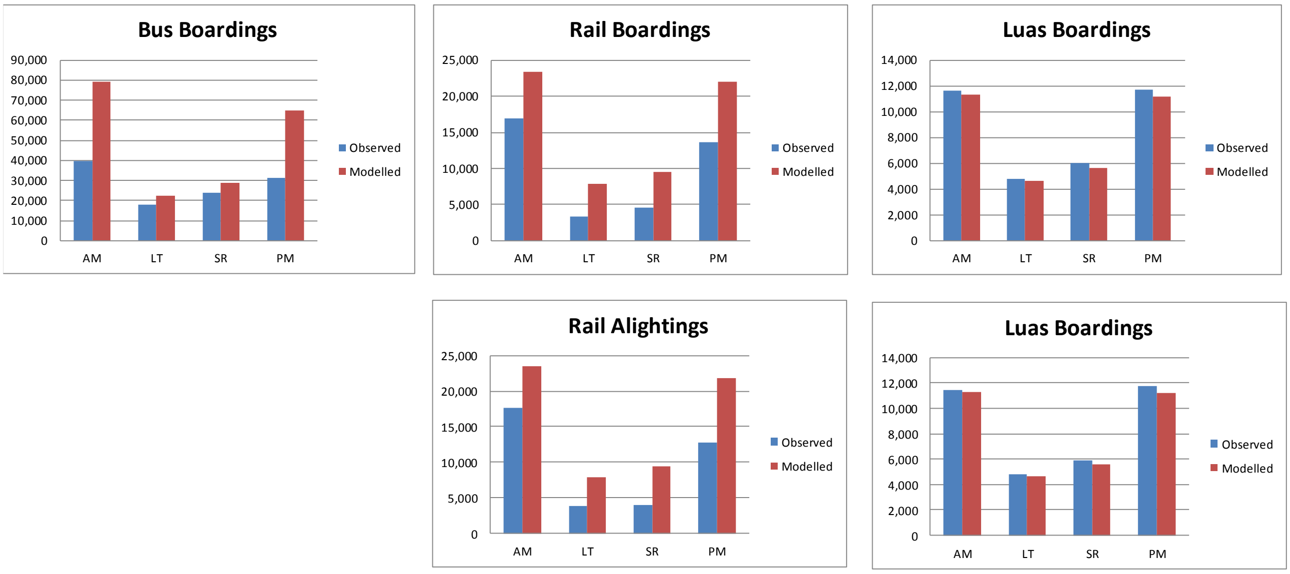


Figure 3.49: Test 25_Post PT boardings / alightings

3.33 Phase 3 Test 26_Pre

3.33.1 Run details

Model Version: *Model version 2.0.15*

Date: *28/08/16*

Following Test 25 the input cost matrices were updated to match those produced by Test 25_Post and there were some significant upgrades to the public transport network coding. These were made possible by the improved outputs from Test 25 which helped to highlight outstanding network issues.

3.33.2 Results / outputs

The only results extracted in full from Test 26_Pre were the demand results (Figure 3.50 and the Test 26_Pre\2 Demand folder). These showed an improved match between the observed and modelled car mode shares but a worse match for walk and no improvement for PT and cycle which were already high in both demand and flow terms. From this it was clear that further ASC value adjustments would be required.

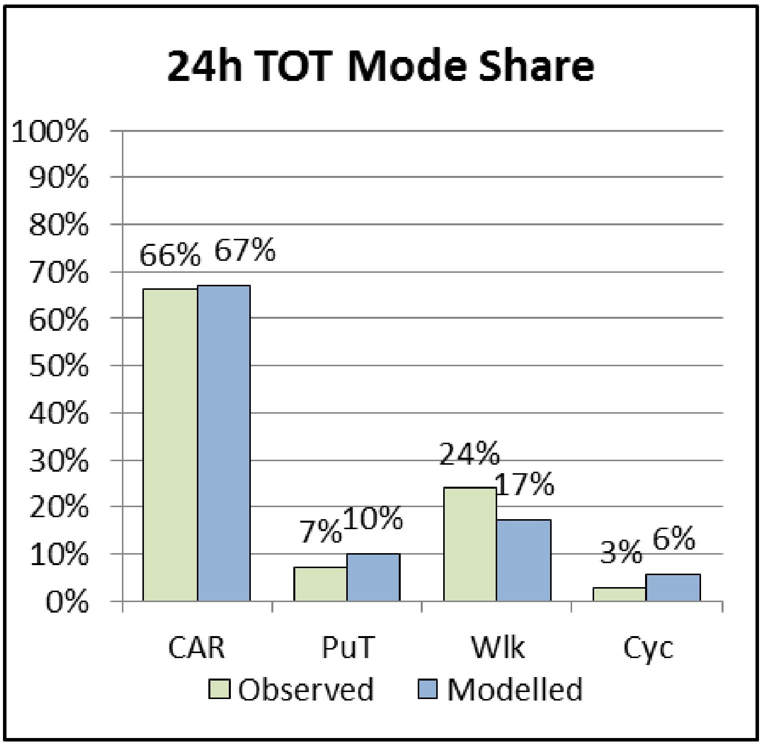


Figure 3.50: Test 26_Pre mode split

3.34 Phase 3 Test 27_Pre, Test28_Pre and associated subtests

3.34.1 Run details

Model Version: *Model version 2.0.16*
Date: *04/09/16 – 11/09/16*

These tests incorporated some minor amendments to the PT assignment method to fully capitalise on the upgrades to the PT networks. In addition, they compared a range of possible ASC values intended to reduce the excess PT and cycle use, whilst also increasing the amount of walking.

3.34.2 Results / outputs

A range of tests were undertaken across several machines and demand dashboards were obtained for each one. Three examples of the mode splits obtained are shown in Figure 3.51 and more details are available in the Test 27_Pre\2 Demand folder and the Test 28_Pre\2 Demand folder.

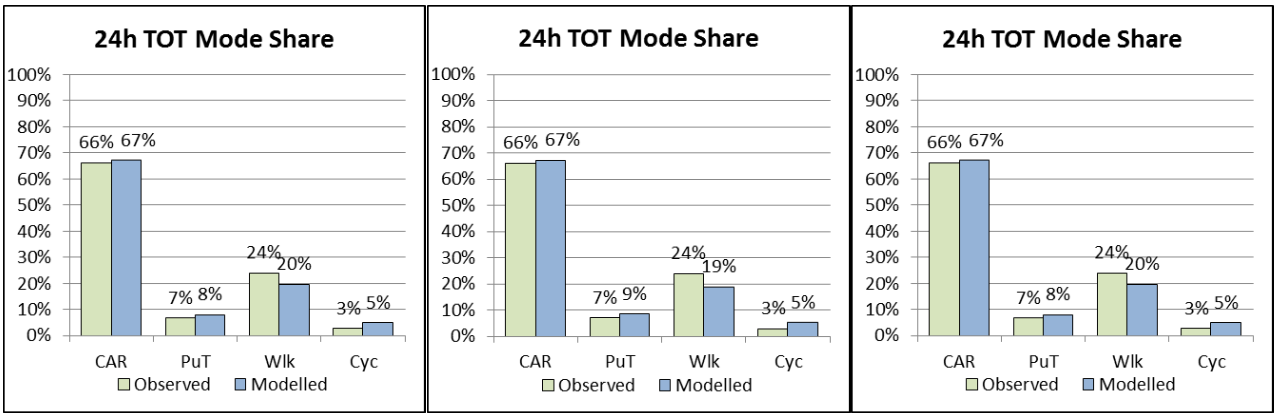


Figure 3.51: Test 27_Pre / 28_Pre /subtests mode split

3.35 Phase 3 Test 29_Pre

3.35.1 Run details

Model Version: *Model version 2.0.19*

Date: *14/09/16*

Following the previous suite of subtests the two best mode split solutions were selected and ASC values selected to improve on these, generally by splitting the difference between a slightly high result and a slightly low result. Run 29_Pre was also upgraded into model version 2.0.19 which included a number of small improvements:

- A correction of the bucket rounding process.
- Steps to dump model parameters and other inputs.
- Steps to dump more detailed outputs from the special zone steps and park and ride (which was being tested in another region at this stage).
- Improved input / output locations for demand files.
- Modifications to cope with a lack of special zones and cases where the parking distribution did not need to run as demand exceeded supply.

Park and Ride was also turned on at this stage and calibration information can be found in Annex 4.

3.35.2 Results / outputs

Test 29_Pre showed a very good match to the overall mode split and to the mode split for each user class (Figure 3.52 and the Test 29\2 Demand\Pre folder). Road calibration \ validation (on percentage difference) was somewhat improved, particularly in the PM peak, at:

- AM 49% / 42%
- IP1 39% / 42%
- IP2 41% / 41%
- PM 40% / 38% (for more information see the Test 29\3 Road folder)

Journey time outputs were good as well:

- AM 71% pass
- IP1 81% pass
- IP2 74% pass
- PM 68% pass (see the Test 29\3 Road folder for more details – the Pre ME values are the relevant ones)

Observed vs modelled comparisons for PT were also improved, as were boarding / alighting figures, particularly for buses. See Figure 3.53 for an example of the match on the screenlines, Figure 3.54 for the boarding / alighting information and Test 29\4 PT\Pre folder for more information.

Following the reduction in cycle mode share, modelled active modes flows were close to observed flows for both walking and cycling.

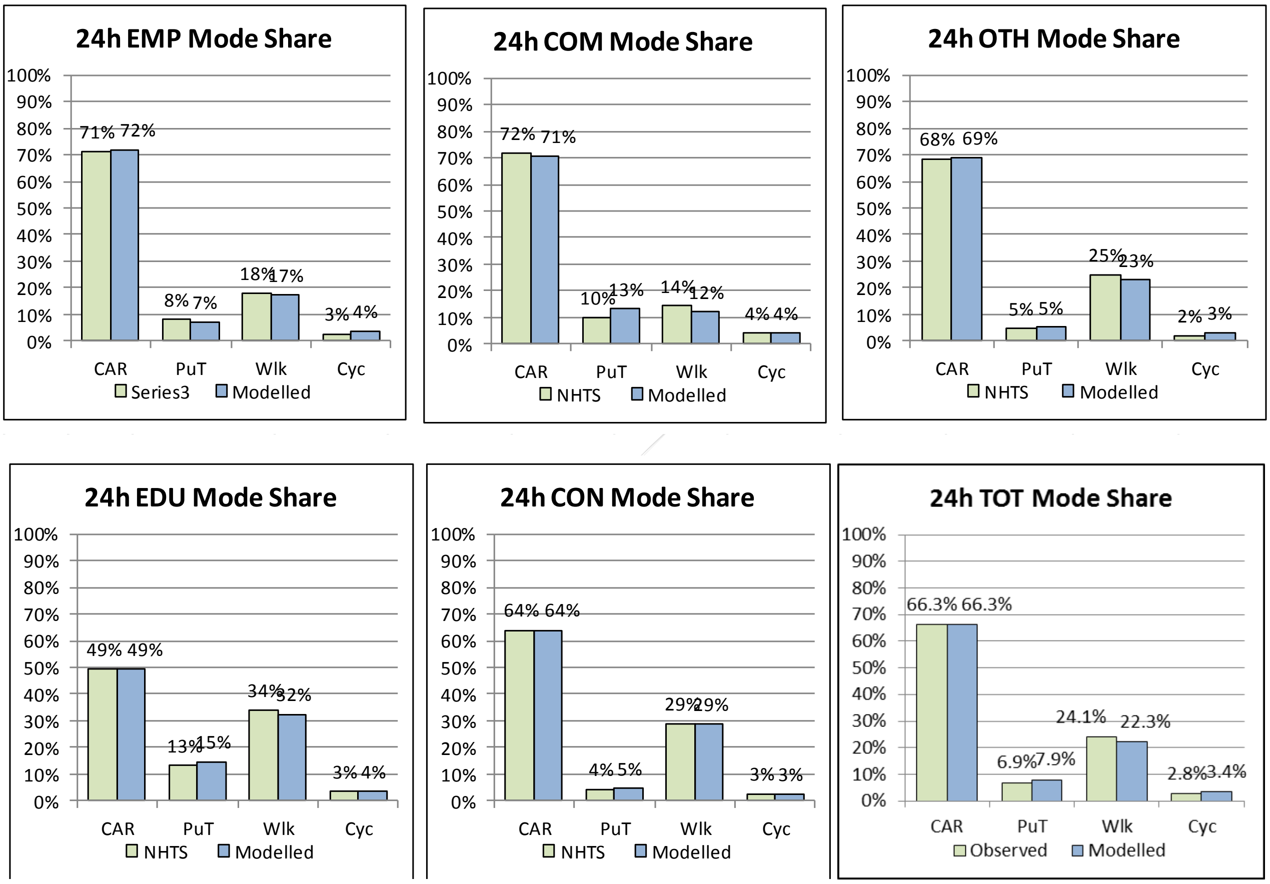


Figure 3.52: Test 29_Pre mode split

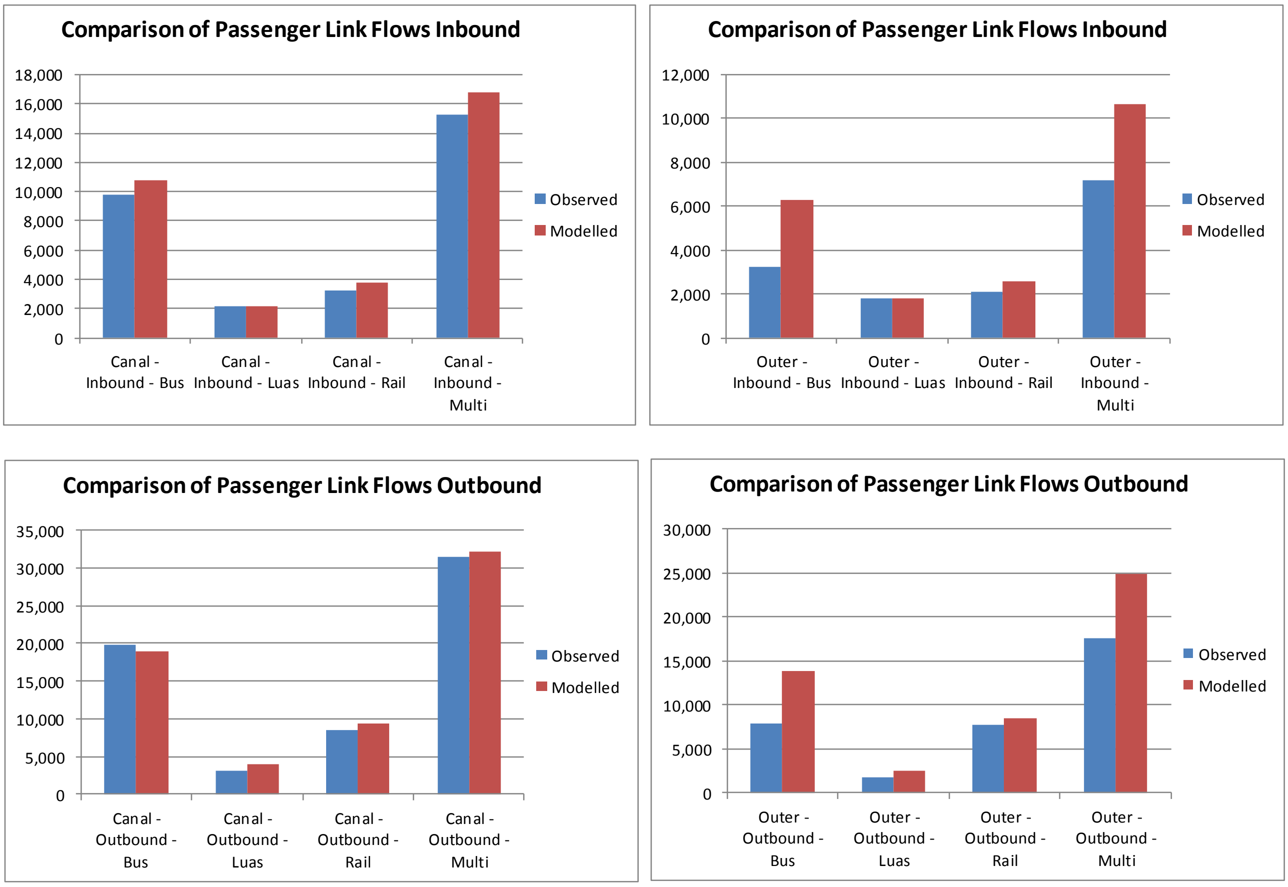


Figure 3.53: Test 29_Pre evening peak flows on screenlines

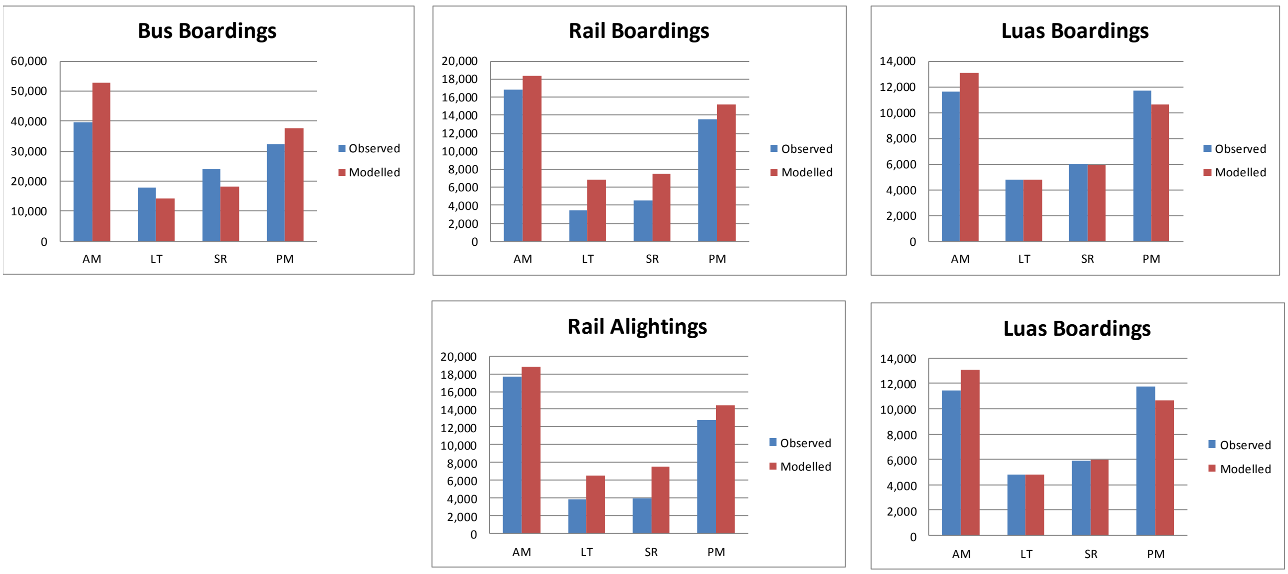


Figure 3.54: Test 29_Pre PT boardings / alightings

3.36 Phase 3 Test 29_Post

3.36.1 Run details

Model Version: *Model version 2.0.19*

Date: *21/09/16*

Test 29_Post was identical to Test 29_Pre but included updated incrementals, taxi proportions and internal good matrices based on the outputs of matrix estimation / factoring of the Test 29_Pre outputs.

3.36.2 Results / outputs

The mode split from Test 29_Post was close to that for Test 29_Pre and well matched to the observed data (see Figure 3.55 and the Test 29\2 Demand\Post folder for more information). The result is not identical to Test 29_Pre because after the first loop of the model the costs are updated. When the incrementals are included the costs used in the final loop are different from those used when there are no incrementals and this explains the small differences. As would be expected the road calibration / validation values (on percentage difference) are much improved and were, overall, very good at:

- AM 77% / 46%
- IP1 85% / 48%
- IP2 84% / 48%
- PM 74% / 43% (for more information see the Test 29\3 Road folder)

The journey time results were also good:

- AM 74% pass
- IP1 81% pass
- IP2 77% pass
- PM 76% pass (see the Test 29\3 Road folder for more details – the Post ME values are the relevant ones)

The correspondences between observed and modelled PT flows on screenlines were good, and an improvement on the Test 29_Pre results and on all previous tests. Reasonable correspondences between observed and modelled boardings / alightings were also obtained, including in the bus and rail cases which were previously problematic. Figure 3.56 gives an example of the match for the PM screenlines and Figure 3.57 shows the boarding / alighting figures. More information can be found in the Test 29\4 PT\Post folder. Modest incremental corrections were applied to walk and cycle flows and the overall outputs were within12% overall for walking and 10% overall for cycling (for full details see the Test 29\5 Active Modes\ Post folder).

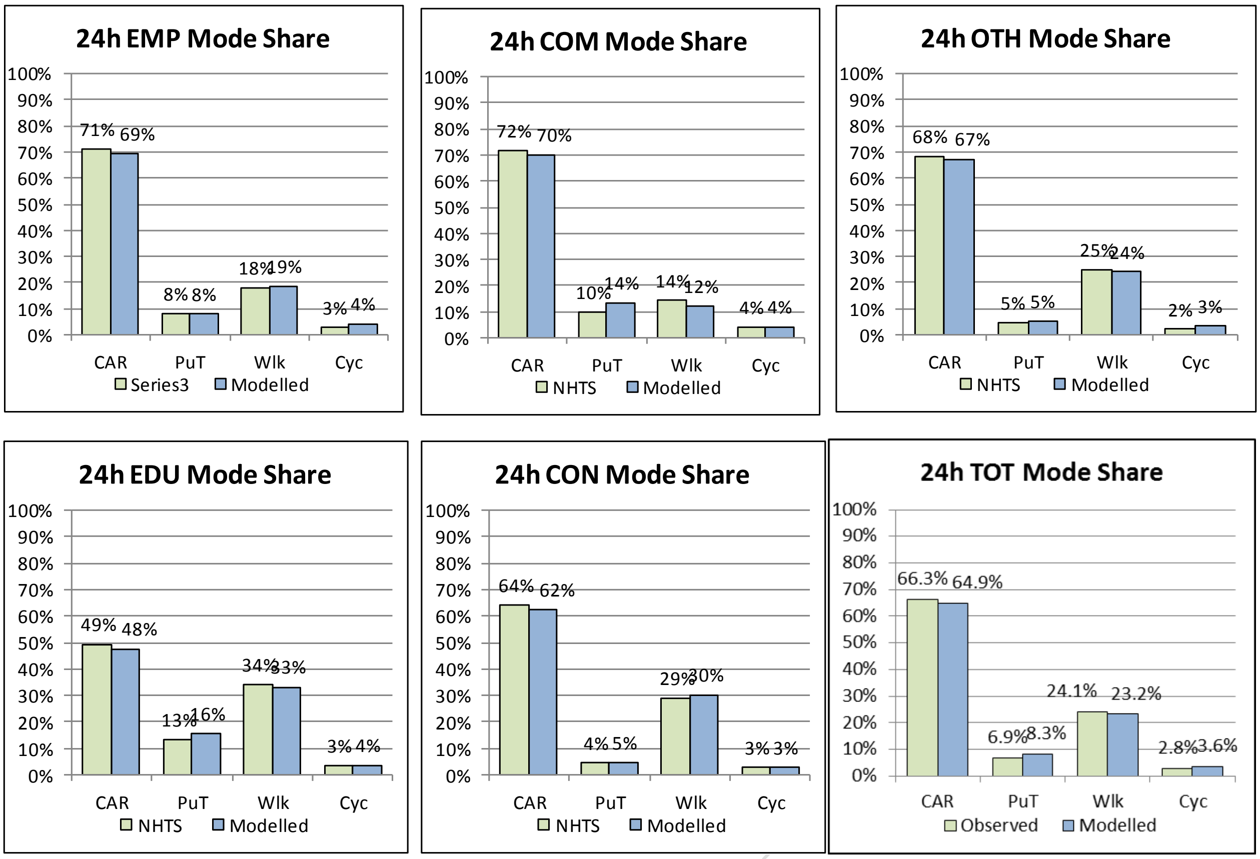


Figure 3.55: Test 29_Post mode split

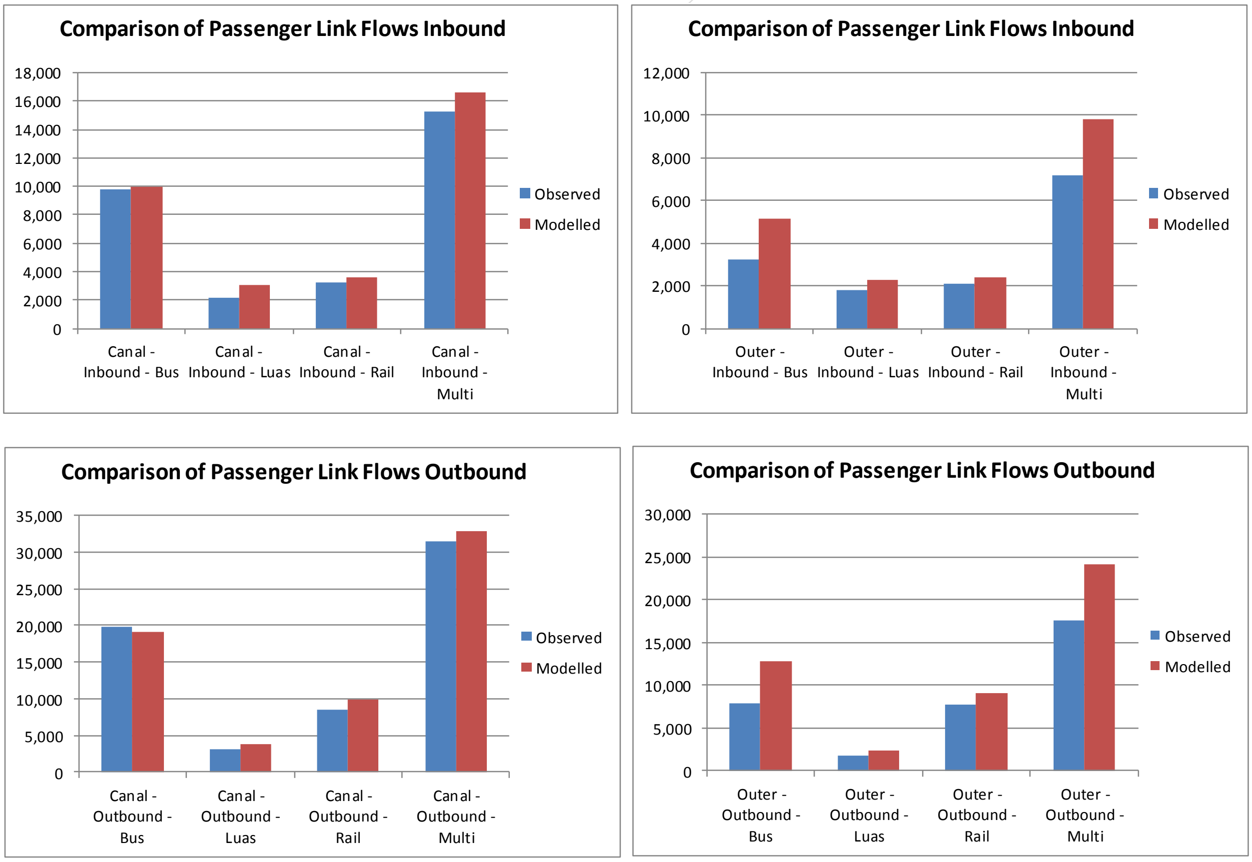


Figure 3.56: Test 29_Post evening peak flows on screenlines

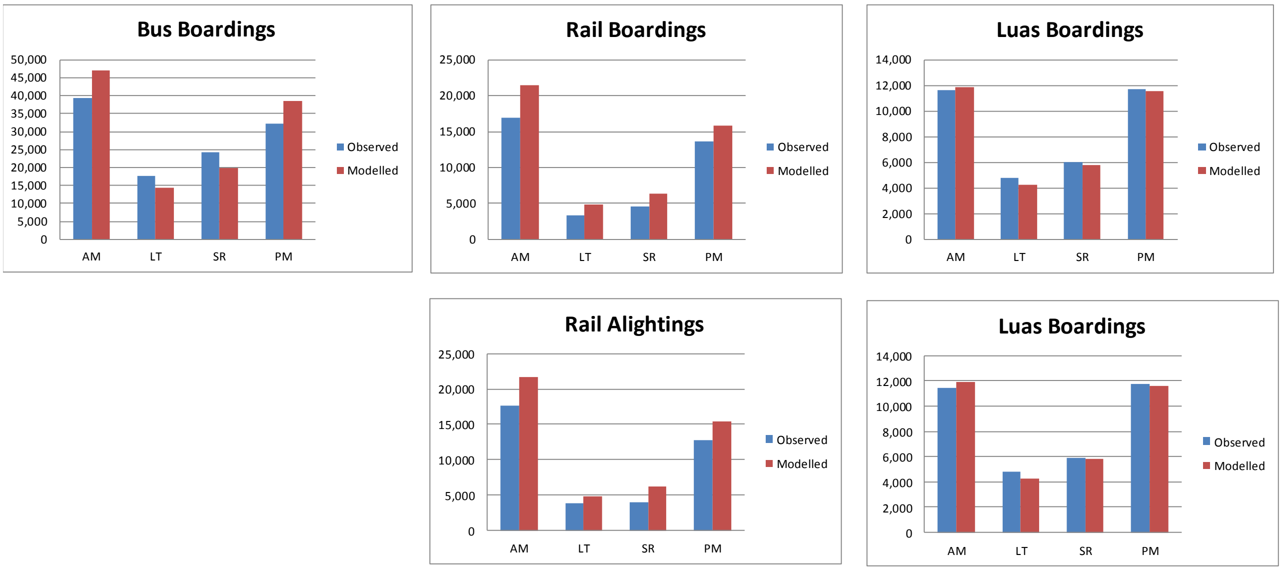


Figure 3.57: Test 29_Post PT boardings / alightings

3.37 Version upgrade and looping to convergence

3.37.1 Model version

As testing in the ERM used versions up to 2.0.19 there was no need to recalibrate in converting to 2.0.23 and so the model was merely re-run in the release version, 2.0.23.

4 Final calibration / validation results

4.1 Introduction

The finalised parameters used in the demand model are given in Annex 3 and this chapter gives details of the final calibration and validation, across a whole range of model outputs, including the direct demand model indicators (modal split, generalised cost and trip length distributions, intrazonal trip numbers, and time period distributions). It then considers less direct indicators, such as the change in the matrices required to match flows on the ground and the size of the incremental matrices needed to correct the directly output demand matrices to their equivalent estimated / factored partners, as well as the output road and PT movements.

Active modes have not been considered in much detail due to a lack of data but information on the development of the ERM Active Modes model can be found in ERM Active Modes Model Development Report (see Section 1.4).

4.2 Full results in electronic format

This chapter gives a detailed summary of the contents of the final demand, road and PT dashboards. However, where more information is desired the full dashboards are contained in the following folders in the accompanying electronic information package:

- Demand: z Final\2 Demand
- Road: z Final\3 Road
- PT: z Final\4 PT
- Active Modes: z Final\5 Active Modes

4.3 Demand calibration

4.3.1 Modal Split

Figure 4.1 shows the observed and modelled mode shares for the full 24 hour period for the five user classes and for all trips combined. The match is very good across all five user classes and for the totals.

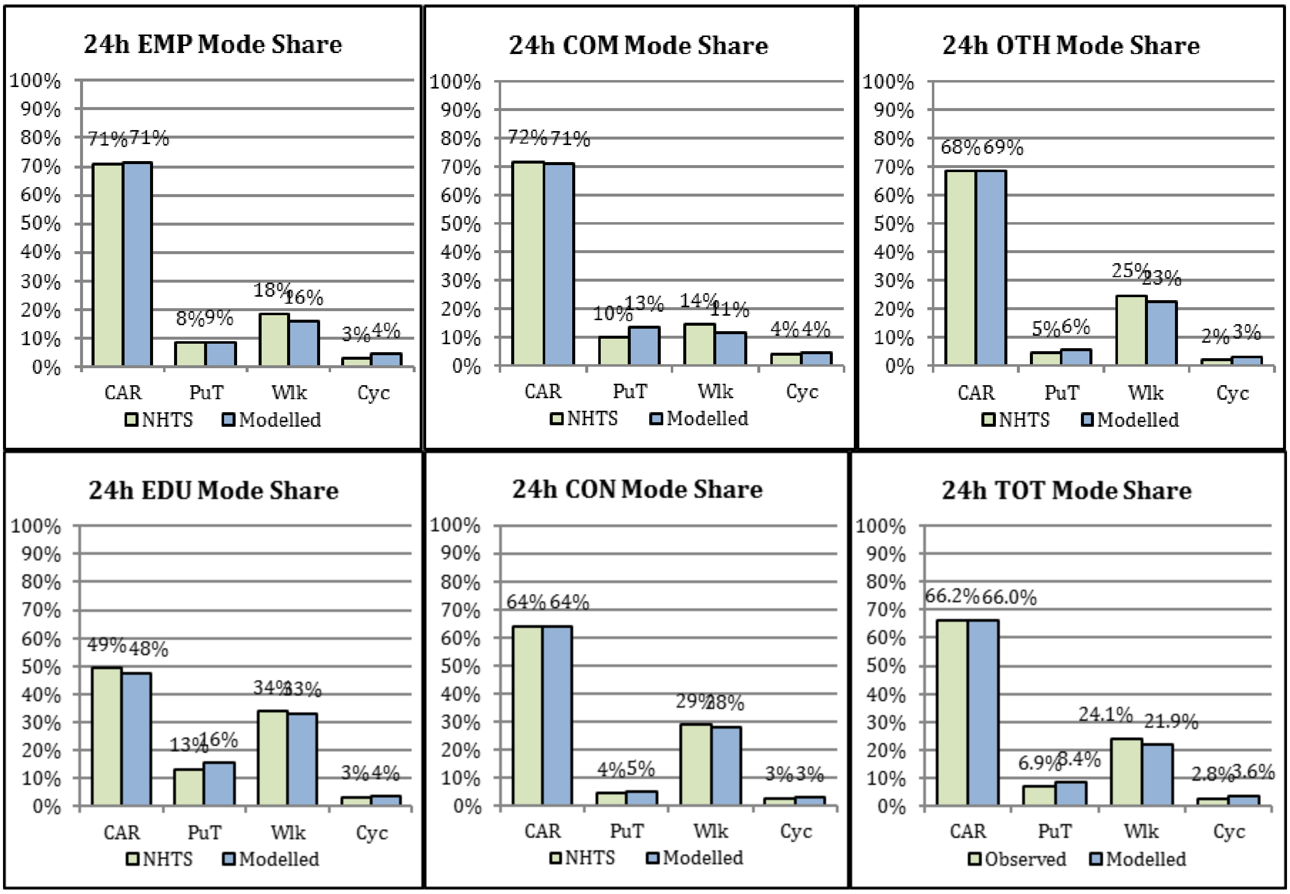


Figure 4.1: Final mode split (24 hr)

4.3.2 Generalised cost distributions

Figure 4.2 and Figure 4.3 show the generalised cost curves for the five user classes across the four daytime time periods. In general, the pattern of modelled trip lengths is a good match to the generalised cost data, particularly for car, walk and cycle trips. PT trips are less well matched, particularly for the EMP user class.

4.3.3 Trip length distribution

Figure 4.4 shows the comparison between the observed and modelled trip lengths for the COM and EDU user classes (data is unavailable for the other classes). The data includes some implausibly long walk and cycle trips, but if these are ignored then the overall pattern of modelled trip lengths is similar to that observed, particularly where the number of observed trips are higher.

4.3.4 Intrazonal Trips

Intrazonal costs are calculated by the model and IZM adjustments are applied to the costs in order to match observed and modelled intrazonal trip rates. Intrazonal demands (as a proportion of total demand) for each time period are shown in Figure 4.5 to Figure 4.8. These show a good correspondence between the modelled and observed intrazonal proportions. PT trips in some groups are not as well matched as in the general case, but both the observed and modelled proportions are small and so this should not have a large impact on the model overall.

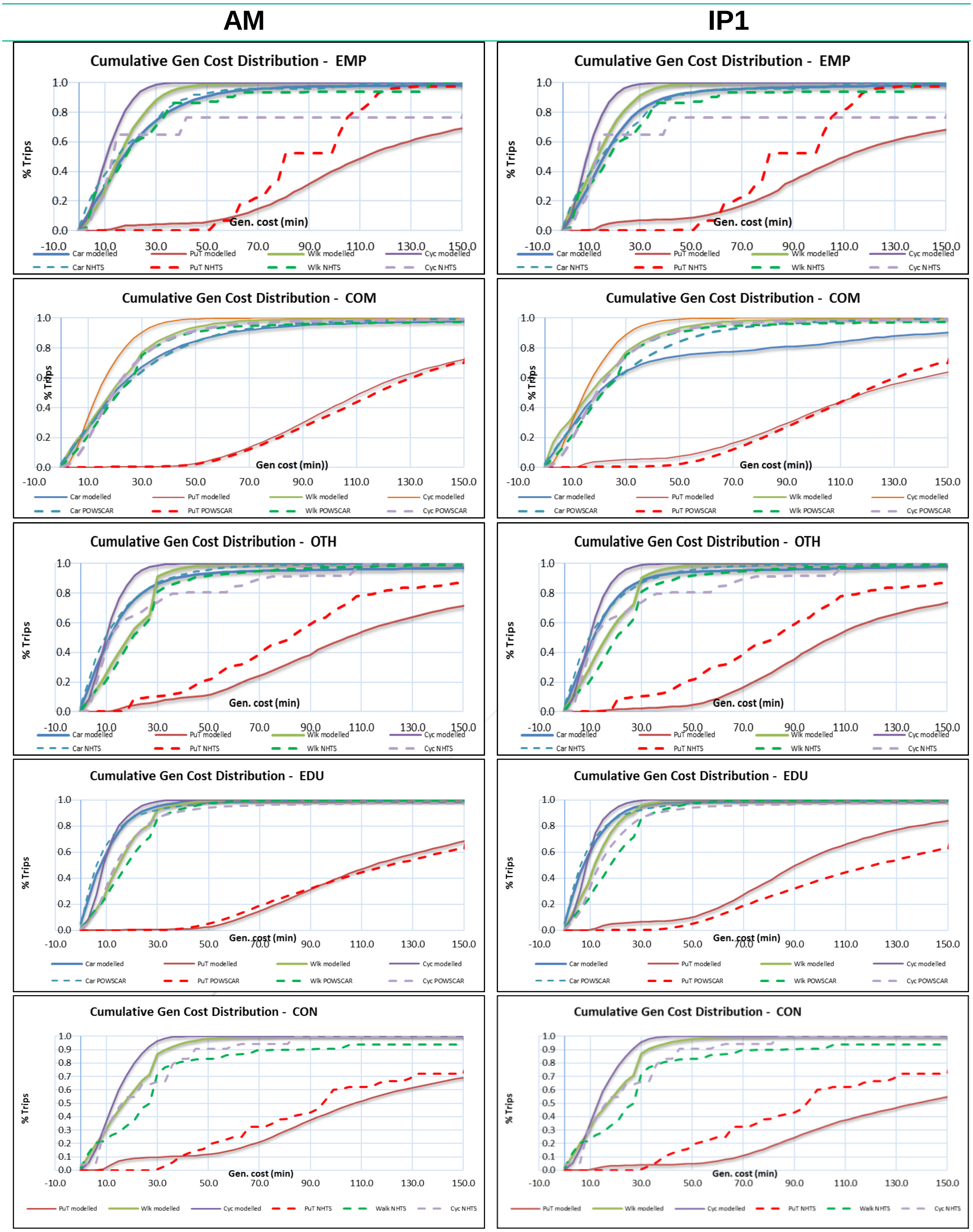


Figure 4.2: Cumulative trip length distributions (AM and IP1)

IP2 | PM

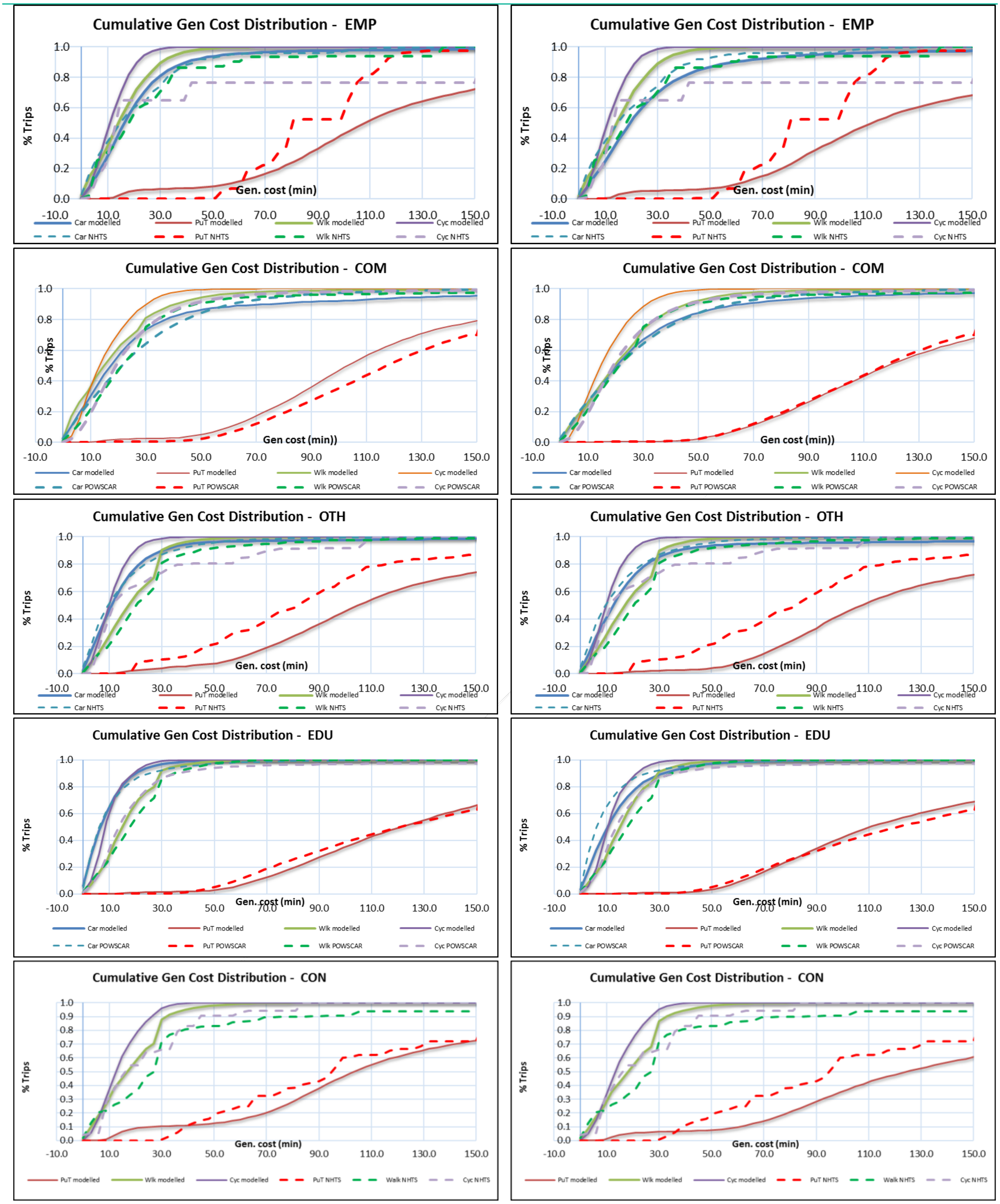


Figure 4.3: Cumulative trip length distributions (IP2 and PM)

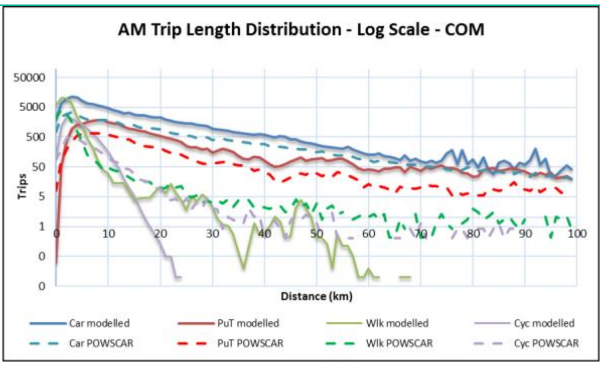
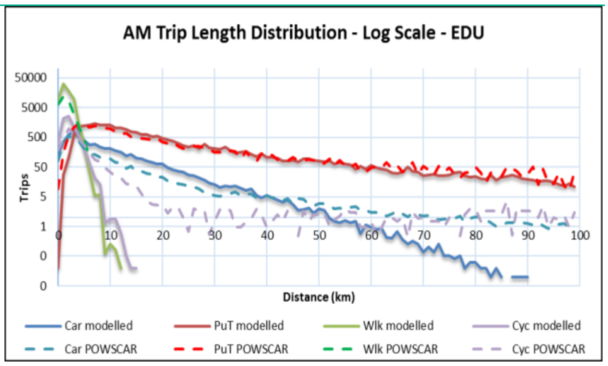
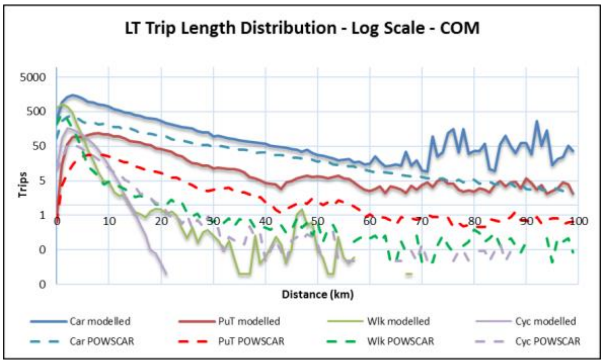
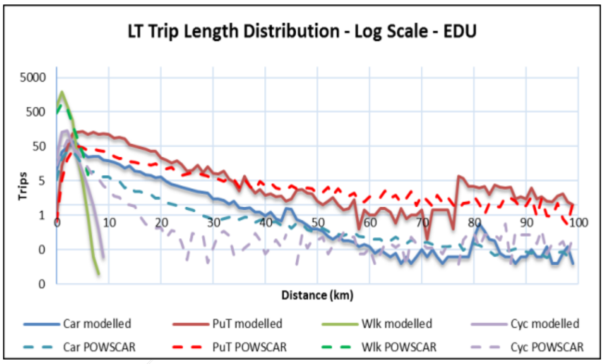
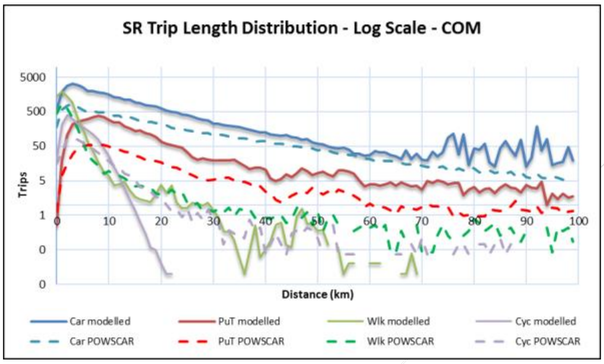
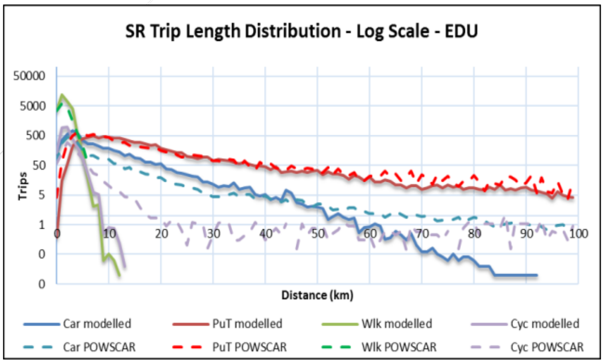
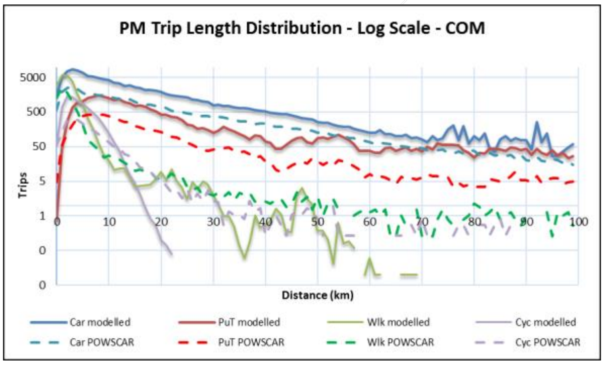
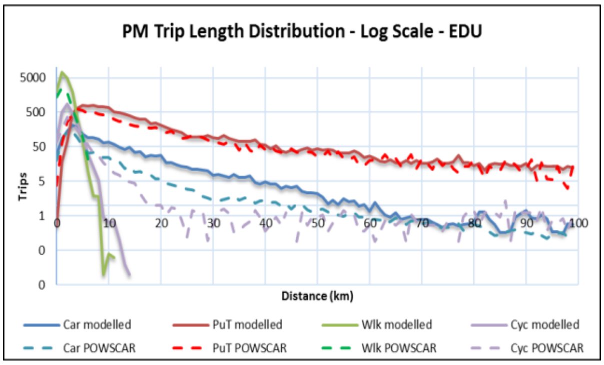
TP	COM	EDU
AM		
IP1		
IP2		
PM		

Figure 4.4: Trip lengths for COM and EDU

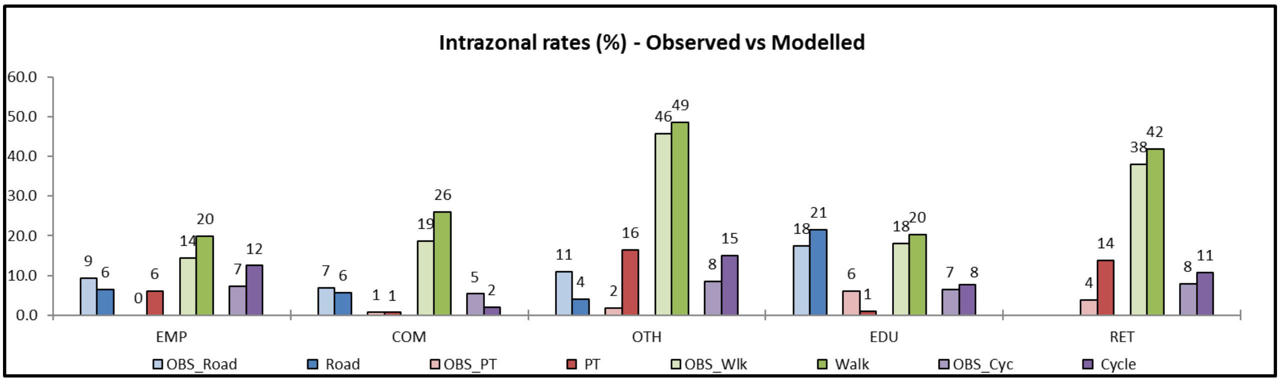


Figure 4.5: AM Intrazonal Trip Rate Proportion

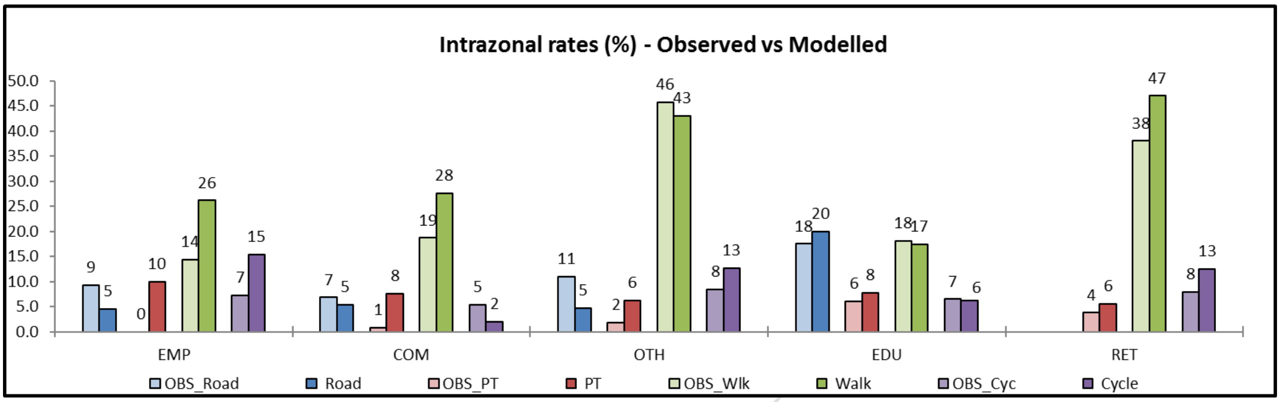


Figure 4.6: IP1 Intrazonal Trip Rate Proportion

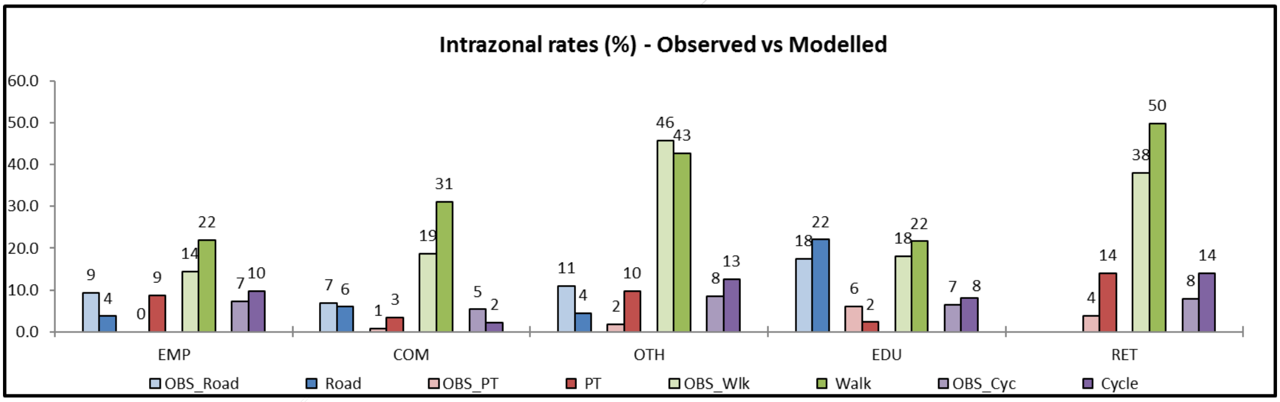


Figure 4.7: IP2 Intrazonal Trip Rate Proportion

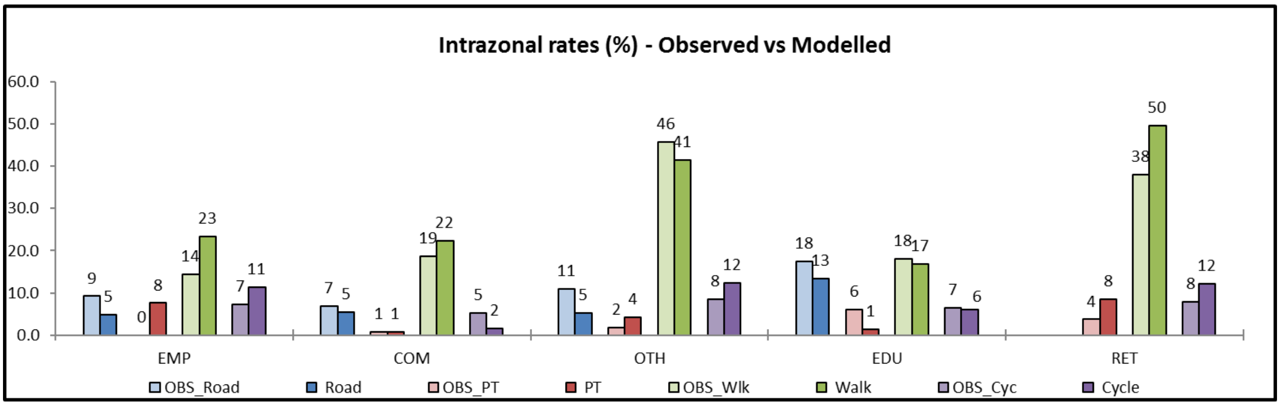


Figure 4.8: PM Intrazonal Trip Rate Proportion

4.3.5 Time period distribution

Figure 4.9 shows a comparison between the number of modelled trips in each time period and the number observed in the NHTS data. The total number of modelled trips in each time period compares well with the observed number of trips, with differences of 7% or less in every case, with the exception of the OP which has 14% more modelled productions than are in the NHTS data.

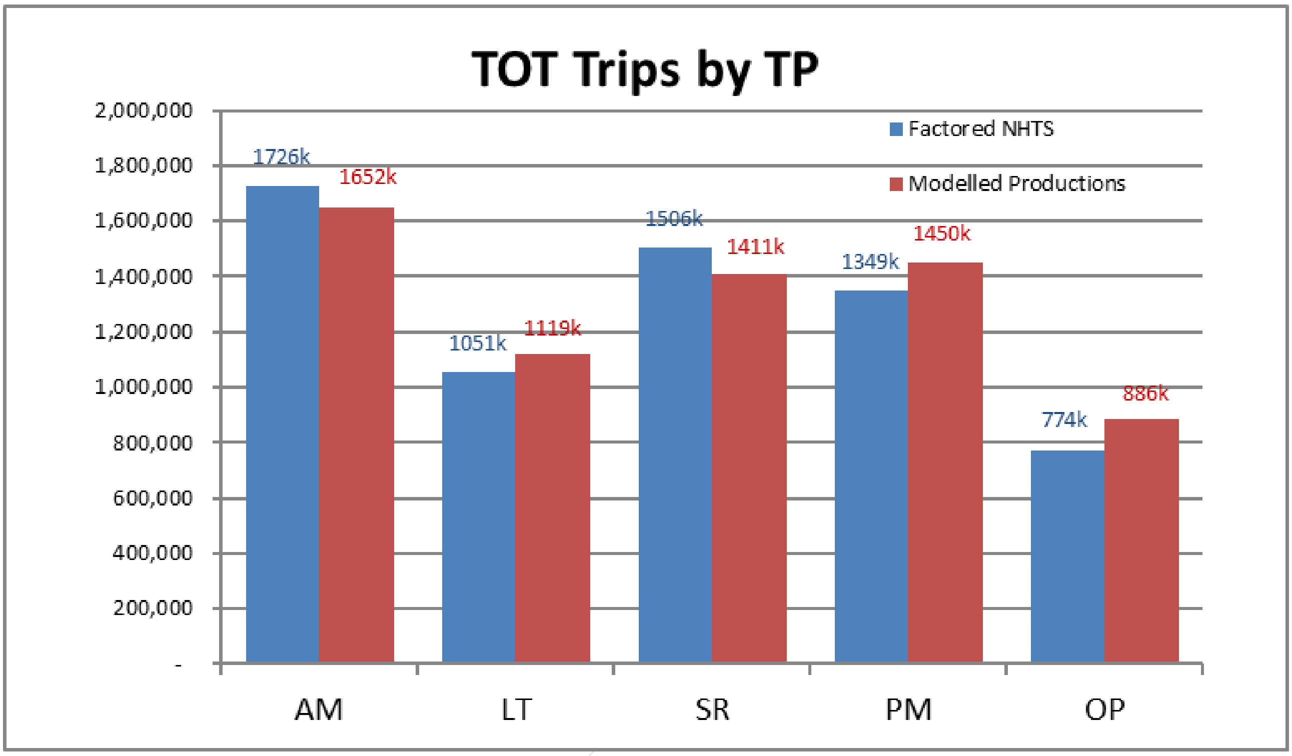


Figure 4.9: Total Trips by Time Period

The number of observed and modelled trips by each mode in each time period (Figure 4.10) also compares well, with car trips generally slightly underestimated, and PT, walking and cycling trips generally slightly overestimated. Overall though, the patterns correspond well.

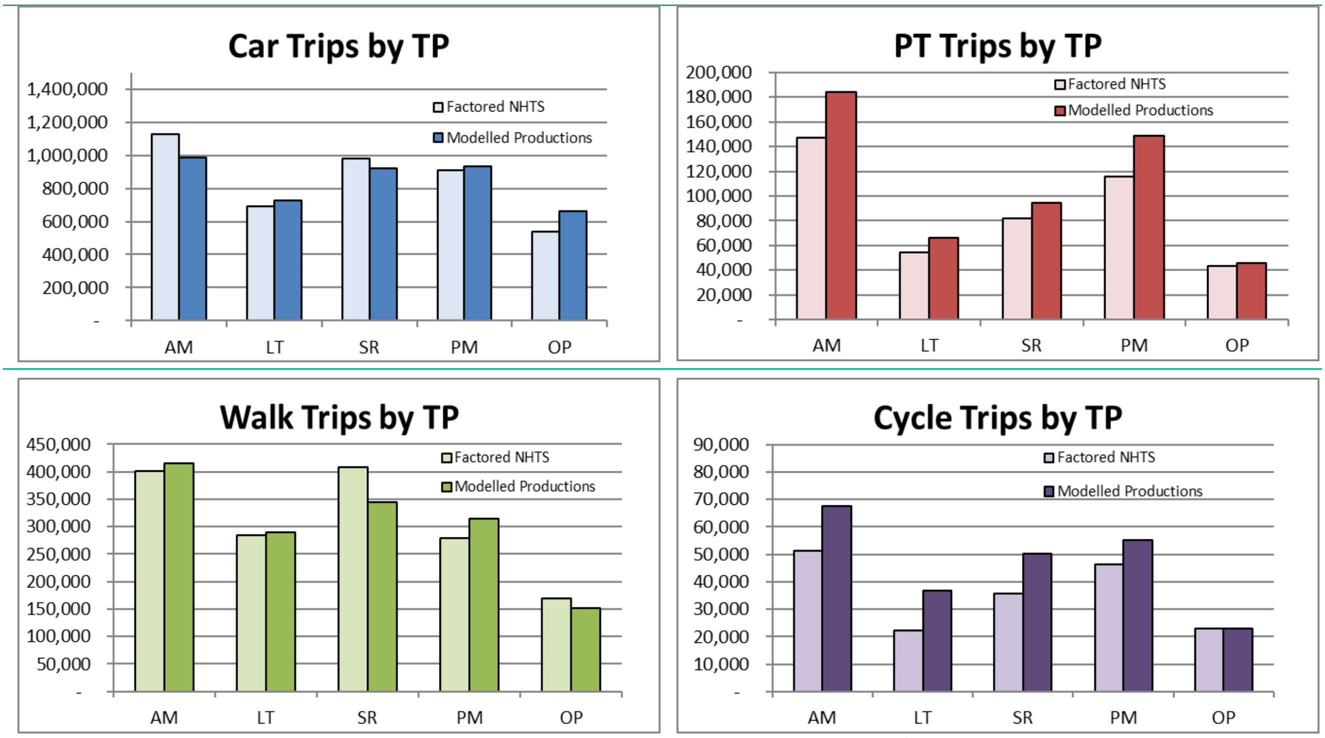


Figure 4.10: Total Trips by Time Period and Mode

4.4 Correcting calibrated demand to match observed movements on the ground

4.4.1 Limitations of demand model calibration

Experience and the intended purpose of the modelling system are factors in deciding whether or not the demand model outputs should be adjusted before assignment so as to improve the match between modelled and observed link flows and / or journey times.

In some cases, it is appropriate to introduce a process like matrix estimation, or some alternative method of matrix factoring, to ‘revise’ the demand model outputs and so produce assignments which mimic real world movements more exactly. Although this can help to achieve targets for network calibration, it often results in matrices that are unacceptably different from those output directly by the demand model, limiting the scope for successful modelling of future movements.

Therefore, any process of estimation / factoring needs to limit the divergence between the demand model outputs and the assignment matrices. Once this is held to within tolerable levels, then calibrated trip length distribution and mode share data from the demand model, among others, should still be respected by road and public transport assignment and the forecasting reliability of the demand model should be improved.

In this model two measures of matrix change are applied:

- Sector to sector movements – these check for changes in the overall ‘shape’ of the matrix and ensure that there are not unacceptably large changes in large scale model flows.
- R-squared analyses – these compare prior and post cell and trip end values to see how close they lie to the x=y line (which would indicate that there had been no change at all).

4.4.2 Sector to sector movements

In the ideal case the amount of change between the directly output demand matrices and the estimated / factored matrices would be small. A comparison of sector to sector movements before and after matrix estimation / factoring is shown in Figure 4.11 (for road) and Figure 4.12 (for PT). While there are some larger differences in individual cells the overall changes in the trip ends are smaller, only exceeding 5% for road in a handful of cases.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	TOTAL
-13%	-13%	20%	-6%	-10%	12%	11%	20%	57%	-18%	2%	22%	-1%	6%	60%	1%	26%	-20%	-33%	-27%	-47%	-32%	44%	-33%	-10%	30%	10%	-9%	-32%	24%	22%	32%	-10%	-2%
-20%	3%	5%	-4%	-12%	-9%	-27%	-7%	44%	-20%	17%	67%	8%	20%	25%	18%	19%	-14%	-37%	-61%	-22%	-17%	18%	-5%	-30%	-12%	13%	-12%	21%	24%	15%	12%	6%	-1%
-4%	47%	7%	-64%	-9%	-47%	32%	73%	-1%	4%	23%	-13%	-44%	20%	31%	24%	-1%	6%	11%	60%	-54%	10%	7%	-34%	46%	54%	12%	-26%	-2%	3%	-21%	-27%	-14%	-11%
-20%	-59%	-23%	16%	0%	-68%	18%	23%	37%	51%	-62%	-19%	-62%	-52%	66%	1%	-16%	33%	21%	4%	-68%	76%	37%	-50%	22%	-3%	-28%	-29%	14%	0%	-16%	0%	-13%	-7%
-9%	-10%	-1%	36%	5%	2%	-20%	6%	62%	3%	9%	16%	1%	23%	24%	-6%	34%	-2%	-40%	-12%	-29%	9%	35%	-29%	15%	5%	29%	-13%	6%	12%	20%	-16%	-4%	-2%
-28%	-9%	-36%	-10%	-26%	26%	-13%	7%	6%	25%	16%	65%	44%	46%	10%	9%	8%	22%	14%	-19%	20%	39%	6%	32%	-24%	68%	61%	11%	10%	57%	29%	12%	12%	3%
-5%	11%	-23%	45%	-2%	-9%	-1%	-14%	26%	24%	-15%	32%	-12%	-7%	21%	27%	21%	13%	3%	-20%	1%	-2%	6%	40%	-23%	25%	2%	16%	-21%	8%	-10%	12%	1%	1%
30%	27%	19%	18%	29%	7%	-10%	11%	49%	20%	-11%	31%	-35%	-29%	77%	1%	-3%	-45%	1%	45%	-7%	11%	-6%	44%	-1%	-10%	-35%	4%	-7%	6%	-11%	5%	-6%	-4%
23%	-21%	59%	74%	-1%	15%	8%	-25%	14%	10%	18%	-16%	91%	21%	52%	-36%	5%	12%	37%	-71%	9%	-22%	7%	-13%	-51%	-14%	5%	-22%	-35%	46%	-3%	28%	-30%	-6%
-34%	-34%	-9%	6%	-14%	-30%	4%	18%	9%	-4%	-22%	26%	-7%	-6%	99%	23%	-20%	-3%	-6%	-35%	8%	-15%	4%	72%	-24%	33%	10%	-4%	-13%	0%	2%	-4%	3%	-6%
2%	3%	17%	-3%	-23%	-14%	-10%	8%	-4%	-28%	2%	50%	54%	9%	-6%	-5%	-1%	-10%	-4%	-40%	28%	-6%	0%	10%	-19%	23%	-3%	-4%	-11%	51%	-8%	0%	0%	0%
-21%	-3%	7%	12%	-3%	35%	22%	34%	-19%	-4%	36%	3%	34%	8%	20%	-9%	-14%	-33%	-49%	24%	1%	-10%	-4%	-19%	-17%	53%	1%	-8%	-15%	4%	-2%	-3%	-1%	-3%
-20%	6%	-52%	-60%	-40%	-14%	23%	-33%	48%	34%	-16%	118%	-9%	-15%	1%	22%	24%	25%	32%	54%	-12%	27%	35%	-18%	0%	16%	-12%	-4%	12%	24%	1%	19%	-3%	-6%
0%	16%	10%	-6%	-15%	-31%	13%	-19%	2%	-7%	-7%	3%	-11%	-1%	-22%	-22%	0%	-18%	-15%	6%	-6%	-24%	-2%	-6%	-36%	7%	6%	-12%	1%	-1%	-7%	13%	-9%	-4%
29%	83%	-4%	104%	25%	39%	11%	-25%	71%	120%	6%	59%	-2%	1%	-3%	7%	0%	-10%	14%	31%	8%	5%	12%	-1%	-20%	-11%	-30%	-12%	-13%	-5%	-10%	-23%	-8%	-2%
-36%	-7%	-31%	-10%	-12%	-10%	14%	-19%	15%	-34%	1%	-13%	14%	11%	4%	10%	-7%	-23%	-4%	2%	4%	-28%	2%	-21%	-19%	-15%	-10%	6%	15%	41%	26%	30%	7%	-4%
12%	-20%	6%	-10%	-14%	2%	1%	1%	-23%	-14%	2%	-24%	49%	11%	7%	-3%	-3%	-4%	7%	2%	16%	-18%	0%	-9%	-19%	15%	18%	26%	-3%	5%	2%	-1%	13%	-2%
-9%	-27%	-16%	-43%	-22%	-32%	-6%	-53%	32%	-11%	-11%	79%	37%	31%	35%	53%	11%	1%	1%	-27%	82%	-13%	62%	103%	4%	19%	13%	-6%	-11%	60%	28%	57%	-1%	-4%
-35%	-55%	-56%	-8%	-47%	-51%	17%	49%	19%	-16%	-31%	-17%	23%	-5%	3%	-15%	-20%	14%	-2%	-18%	9%	12%	-1%	14%	-32%	-17%	-40%	-4%	-2%	15%	-13%	1%	-12%	-4%
-41%	-27%	32%	-27%	-8%	-21%	-24%	36%	-21%	-29%	-6%	-12%	28%	8%	42%	-9%	-21%	-16%	41%	4%	19%	11%	-6%	24%	11%	0%	-35%	7%	-9%	23%	-4%	3%	-9%	-5%
-40%	21%	-53%	-89%	-61%	-53%	16%	4%	35%	-28%	-36%	109%	-25%	-43%	10%	-2%	-7%	-6%	27%	42%	14%	15%	47%	13%	-17%	30%	-25%	21%	-17%	11%	-19%	7%	10%	-6%
28%	30%	20%	-49%	4%	36%	37%	80%	13%	-30%	29%	71%	67%	21%	36%	0%	1%	-13%	-21%	-39%	40%	8%	33%	43%	-29%	62%	-22%	4%	-25%	42%	-3%	17%	-16%	-9%
34%	33%	4%	81%	46%	25%	-14%	42%	-3%	-25%	-3%	7%	2%	0%	0%	-5%	-11%	-1%	46%	85%	26%	39%	-7%	-7%	24%	0%	-33%	-6%	-12%	-14%	-9%	-22%	-2%	-2%
-18%	47%	-24%	3%	-15%	-15%	52%	-8%	11%	49%	0%	6%	-1%	-15%	17%	-25%	-18%	-27%	-15%	20%	-3%	-16%	19%	-2%	7%	-10%	-21%	-12%	-23%	-33%	-16%	-28%	-9%	-4%
53%	107%	31%	77%	60%	42%	34%	79%	78%	-32%	101%	72%	100%	64%	53%	6%	-13%	-15%	4%	5%	79%	-9%	-37%	75%	13%	14%	1%	30%	-14%	-8%	-11%	-24%	-24%	-6%
79%	14%	43%	-9%	0%	-3%	9%	-24%	6%	42%	25%	77%	2%	-11%	-18%	20%	57%	-18%	-5%	18%	-16%	-32%	1%	-5%	-44%	-27%	-8%	-15%	-29%	146%	-13%	-2%	-24%	1%
-17%	15%	22%	-6%	-13%	9%	36%	-25%	10%	-5%	-8%	22%	13%	1%	-11%	-4%	13%	-31%	-20%	-2%	-1%	-31%	-5%	-6%	-35%	10%	-2%	-3%	-4%	11%	-17%	4%	-5%	-2%
-32%	-21%	12%	-19%	0%	-27%	26%	-14%	44%	15%	-12%	-2%	-16%	-2%	-18%	7%	13%	7%	-4%	5%	11%	-1%	-3%	0%	-19%	-12%	-4%	0%	-1%	5%	0%	2%	0%	0%
22%	4%	0%	6%	14%	-1%	-4%	-39%	-20%	2%	-14%	-5%	-2%	-5%	-13%	1%	-5%	-13%	-20%	15%	12%	-9%	15%	8%	7%	-5%	-4%	4%	0%	0%	2%	0%	1%	0%
37%	20%	1%	0%	10%	6%	11%	14%	27%	41%	44%	34%	-3%	21%	7%	66%	24%	12%	7%	17%	30%	-22%	65%	-8%	8%	115%	12%	7%	0%	0%	0%	0%	1%	1%
-3%	-7%	8%	-56%	5%	-7%	10%	-20%	36%	8%	-23%	37%	-4%	6%	-16%	29%	14%	-21%	7%	17%	31%	12%	26%	0%	-2%	20%	4%	3%	3%	0%	0%	0%	0%	1%
8%	18%	-1%	0%	-2%	6%	4%	13%	-5%	20%	65%	26%	-36%	51%	2%	61%	24%	16%	9%	32%	76%	8%	30%	-5%	30%	4%	4%	3%	0%	0%	0%	0%	0%	0%
-16%	-7%	-2%	-13%	-2%	-13%	11%	-1%	27%	23%	-6%	3%	-4%	0%	-11%	-9%	4%	-17%	-7%	21%	9%	-8%	1%	7%	9%	-12%	0%	1%	0%	0%	-1%	-1%	1%	0%
-13%	-7%	-4%	-10%	-11%	-9%	0%	-5%	3%	-4%	-1%	2%	-2%	1%	6%	-2%	1%	-4%	-4%	-6%	1%	-2%	1%	0%	-2%	3%	-3%	-1%	0%	0%	0%	0%	0%	-1%

Figure 4.11: 24 hour road matrix sector changes with matrix estimation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	TOTAL
-17%	2%	23%	5%	-2%	0%	12%	5%	-20%	-1%	-22%	-12%	6%	-17%	8%	-15%	-18%	-5%	-4%	-2%	-6%	-4%	20%	0%	-4%	52%	1%	4%	-5%	17%	-1%	14%	5%	-2%
-4%	-25%	100%	18%	2%	4%	18%	4%	-27%	7%	-19%	-6%	5%	-23%	62%	-18%	-21%	-2%	-1%	-4%	-2%	-2%	23%	-4%	-29%	2%	-7%	-1%	1%	10%	-10%	12%	6%	-2%
-21%	-24%	-26%	0%	-23%	-26%	-12%	-26%	0%	-31%	10%	-41%	-13%	3%	10%	-7%	-28%	-26%	-12%	-28%	-7%	-29%	13%	-1%	-25%	14%	12%	-2%	11%	12%	7%	-8%	10%	-4%
0%	0%	22%	-21%	13%	-5%	3%	46%	-12%	1%	-27%	38%	-4%	27%	52%	-12%	-12%	-5%	11%	105%	-58%	24%	25%	3%	-9%	44%	2%	37%	-13%	-71%	40%	198%	20%	10%
-1%	-1%	-34%	-18%	-12%	4%	12%	2%	-26%	-6%	-12%	-7%	7%	-19%	2%	-16%	-25%	-7%	-5%	-7%	-7%	-1%	13%	-7%	-11%	-38%	-3%	0%	-14%	1%	-12%	0%	-1%	-5%
-3%	-4%	-32%	-13%	0%	-17%	15%	12%	-16%	2%	-8%	-17%	4%	-22%	23%	-19%	-17%	-3%	-5%	-4%	-3%	-4%	21%	-3%	-1%	1%	2%	-2%	5%	13%	-3%	4%	7%	-1%
11%	11%	0%	2%	19%	10%	-15%	-2%	-7%	9%	-18%	-12%	1%	-31%	7%	-25%	-19%	2%	10%	-3%	-5%	4%	15%	3%	11%	-4%	-9%	3%	31%	8%	20%	-22%	15%	7%
4%	-1%	-13%	-12%	3%	16%	-4%	-14%	-12%	2%	-15%	-20%	-8%	-29%	-50%	-31%	-19%	-6%	-6%	-31%	1%	-7%	5%	1%	0%	7%	-2%	-9%	14%	91%	-26%	133%	7%	0%
-14%	-23%	0%	-22%	-11%	-12%	-17%	-24%	-5%	-5%	-31%	-16%	7%	-21%	41%	-19%	-8%	-13%	-16%	-8%	-27%	-23%	5%	-6%	-11%	-8%	16%	13%	-31%	-25%	-10%	12%	3%	-7%
-7%	-3%	-18%	-14%	-9%	-5%	0%	-9%	-19%	-6%	-14%	0%	-1%	-12%	-11%	-16%	-25%	-4%	0%	-9%	-3%	8%	17%	-5%	3%	-1%	1%	12%	11%	-21%	1%	27%	9%	-2%
-9%	-5%	-16%	-34%	5%	12%	-12%	8%	-24%	11%	-21%	6%	10%	-15%	16%	-18%	-20%	7%	1%	-8%	-8%	9%	33%	0%	-6%	-15%	7%	6%	-1%	35%	5%	25%	9%	2%
-12%	-8%	-35%	19%	-8%	-18%	-15%	-17%	-19%	6%	-29%	-8%	1%	5%	-16%	9%	-6%	5%	29%	-7%	-26%	-12%	-2%	-11%	-22%	-17%	4%	12%	-37%	21%	-3%	4%	0%	-5%
29%	37%	12%	6%	47%	27%	-4%	-6%	0%	14%	8%	-5%	-18%	-1%	1%	6%	30%	14%	26%	22%	-10%	45%	29%	-5%	-12%	-6%	1%	12%	33%	-14%	37%	-28%	22%	19%
-11%	-13%	-21%	-30%	-6%	-5%	2%	-11%	-24%	6%	-6%	-1%	-17%	-21%	0%	41%	2%	6%	6%	-3%	-9%	-26%	3%	-6%	0%	-1%	9%	2%	69%	128%	-6%	0%	15%	-4%
5%	2%	-22%	-9%	4%	6%	2%	0%	-10%	-2%	-8%	-25%	-5%	-18%	-25%	-17%	-24%	12%	-11%	0%	31%	6%	55%	18%	100%	18%	-6%	10%	23%	-67%	-7%	239%	30%	13%
-13%	-17%	-4%	-4%	-16%	-21%	-3%	3%	-18%	-4%	-32%	7%	-13%	-23%	3%	-17%	-1%	-2%	18%	-11%	-35%	-10%	8%	-10%	25%	-13%	4%	9%	-18%	-67%	-19%	260%	2%	-9%
-11%	-15%	-4%	3%	-11%	-6%	-6%	-19%	-8%	-2%	-26%	-4%	6%	3%	4%	-11%	-20%	4%	8%	1%	-34%	0%	20%	13%	-21%	-14%	14%	14%	64%	44%	-4%	-44%	10%	-6%
-11%	-14%	-16%	4%	-13%	-15%	-7%	-7%	-19%	1%	-23%	-5%	-16%	-20%	-5%	-22%	-30%	-10%	-2%	-10%	-34%	-7%	15%	-25%	5%	15%	-15%	2%	7%	4%	-9%	4%	-2%	-8%
-4%	-6%	33%	-4%	-4%	-8%	-3%	-2%	-19%	-2%	-23%	17%	-5%	-12%	5%	-2%	-17%	-5%	-3%	-2%	0%	-2%	33%	5%	13%	0%	5%	11%	9%	-8%	12%	16%	8%	-2%
-3%	-10%	-17%	36%	-7%	-4%	-12%	-36%	-3%	-8%	-18%	-16%	-20%	0%	-32%	-30%	-12%	-12%	-17%	-30%	0%	18%	17%	25%	13%	-8%	-17%	6%	-16%	-74%	59%	-65%	1%	-9%
68%	69%	-22%	19%	80%	72%	5%	40%	-13%	30%	5%	35%	-9%	-2%	-31%	79%	-11%	31%	48%	-12%	-28%	183%	104%	-12%	72%	8%	6%	10%	110%	24%	36%	-16%	20%	37%
-11%	-11%	15%	-9%	-2%	-13%	3%	1%	-14%	18%	-27%	2%	14%	-35%	-1%	-25%	-19%	-3%	1%	30%	-30%	-21%	16%	-1%	64%	34%	-22%	22%	84%	0%	-59%	0%	0%	0%
60%	56%	43%	48%	48%	48%	27%	12%	29%	35%	39%	17%	53%	14%	51%	1%	17%	23%	35%	17%	30%	13%	-7%	4%	5%	54%	20%	18%	49%	-40%	17%	205%	23%	29%
46%	49%	27%	11%	52%	37%	3%	2%	17%	35%	0%	24%	-7%	-10%	-3%	8%	14%	13%	34%	45%	-18%	81%	-1%	-12%	9%	-14%	-10%	6%	21%	9%	4%	353%	30%	23%
7%	0%	-14%	762%	-4%	21%	9%	-4%	-12%	-4%	-17%	1%	35%	551%	-57%	-19%	-11%	0%	-12%	21%	-36%	-19%	10%	-6%	-28%	500%	0%	119%	0%	0%	-16%	0%	7%	-1%
-33%	-5%	-77%	24%	-61%	-56%	-41%	8%	1%	-40%	-17%	-1%	-20%	44%	-55%	4%	2%	-48%	-32%	-52%	-15%	21%	16%	-16%	17%	-20%	11%	-9%	14%	6%	2%	9%	12%	-5%
0%	-5%	20%	-17%	4%	8%	2%	11%	2%	14%	3%	10%	-1%	2%	34%	-1%	12%	5%	11%	-23%	0%	-22%	17%	-7%	-34%	13%	-16%	4%	7%	253%	-4%	-12%	-1%	2%
18%	14%	9%	32%	16%	32%	29%	43%	5%	24%	0%	15%	15%	-1%	33%	9%	13%	8%	8%	23%	-2%	3%	29%	-4%	25%	-3%	-1%	0%	15%	-25%	0%	4%	3%	9%
23%	17%	26%	-18%	11%	34%	39%	0%	-27%	22%	-6%	24%	15%	9%	10%	53%	-30%	13%	33%	9%	14%	-2%	59%	4%	-31%	11%	-5%	12%	-8%	-9%	0%	0%	3%	8%
30%	28%	10%	-40%	40%	55%	43%	-16%	45%	60%	9%	26%	0%	10%	460%	-3%	50%	40%	32%	29%	3%	0%	78%	29%	0%	-3%	-75%	1%	8%	-2%	4%	0%	0%	2%
32%	16%	4%	82%	21%	43%	66%	12%	3%	36%	-6%	6%	27%	3%	66%	-5%	0%	39%	36%	61%	21%	-6%	26%	4%	-29%	22%	0%	7%	0%	3%	-7%	-11%	2%	7%
34%	27%	9%	89%	33%	45%	112%	82%	19%	34%	-3%	30%	26%	-29%	31%	26%	58%	32%	23%	6%	89%	0%	170%	-5%	9%	69%	-25%	10%	1%	1%	1%	-20%	2%	8%
30%	23%	30%	26%	24%	45%	47%	11%	0%	34%	6%	16%	25%	1%	53%	10%	6%	27%	24%	28%	6%	3%	41%	6%	10%	16%	-4%	4%	1%	2%	2%	3%	-1%	11%
5%	6%	4%	7%	4%	14%	8%	0%	-11%	6%	-11%	-3%	6%	-12%	26%	-11%	-14%	-1%	1%	-6%	-8%	-2%	15%	-4%	-4%	6%	-2%	3%	0%	0%	-2%	2%	3%	2%

Figure 4.12: 24 hour PT matrix sector changes with matrix factoring

4.4.3 R-squared Analysis

The R-squared statistic was used throughout calibration as a measure to check the changes to the road model matrices caused by estimation. Table 4.1 gives the matrix estimation change calibration guidelines, as specified in TAG Unit M3-1, Section 8.3, Table 5.

Table 4.1: Significance of Matrix Estimation Changes

Measure	Significance Guideline
Matrix zonal cell value	Slope within 0.98 and 1.02; Intercept near zero; R^2 in excess of 0.95.
Matrix zonal trip ends	Slope within 0.99 and 1.01; Intercept near zero; R^2 in excess of 0.98.

The following sections provide an overview of the R-squared results for each model time period. Further details are provided in the ERM Road Model Development Report.

AM

Table 4.2 gives the R-squared values for each individual user class in the AM time period.

Table 4.2: AM Matrix Change R-squared Analysis

User Class	Emp. Business	Commute	Education	Other
Cell R-Squared	0.93	0.92	0.99	0.94
Cell Slope	0.93	0.93	0.99	0.98
Cell Y-Intercept	0.00	0.00	0.00	0.00
Trip End R-Squared	0.97	0.98	0.99	0.99
Trip End Slope	0.99	0.98	0.98	0.96
Trip End Y-Intercept	0.43	1.54	0.03	1.87

At the cell level the OTH class is inside the guideline range in the slope and Y-intercept groups though it does fall slightly short in the R-squared category. The values for the EMP and COM classes in both the R-squared and slope categories are outside the suggested range. The EDU class passes on all measures.

At the trip end level all groups pass in the R-squared category apart from EMP which narrowly fails. The EMP group does pass in the slope category however the other three groups are outside the suggested range for slope. EMP and EDU pass the Y-intercept category while COM and OTH fall outside the “Near 0” range.

IP1

Table 4.3 gives the R-squared values for each individual user class in the IP1 time period.

Table 4.3: IP1 Matrix Change R-squared Analysis

User Class	Emp. Business	Commute	Education	Other
Cell R-Squared	0.81	0.78	0.96	0.94
Cell Slope	0.93	0.80	0.96	0.97
Cell Y-Intercept	0.00	0.00	0.00	0.00
Trip End R-Squared	0.95	0.98	0.97	0.99
Trip End Slope	0.95	0.98	0.99	0.96
Trip End Y-Intercept	0.62	0.76	0.01	3.05

In IP1 the OTH class accounts for around 70% of the matrix and, at the cell level, has very good R-squared and Y-intercept results. The slope, at 0.97, is slightly outside the suggested range but it is recognised that, for large and fully synthetic prior matrices, the WebTAG slope guidance is likely to be very hard to meet. The EMP and COM matrices account for around 6-9% of the total trips each and also meet the guidance for the Y-intercept measure. They give R-squared and slope results which are somewhat outside the guideline level, particularly for COM, but which still indicate quite modest matrix changes. The EDU values lie inside the suggested range for the Y-intercept measure, and slightly outside in the R-squared or slope categories but this matrix accounts for less than 1% of the total trips in the IP1 in any case.

At the trip end level, the COM and EDU classes lie very close to the suggested range on all measures with EMP and OTH falling slightly behind.

IP2

Table 4.4 gives the R-squared values for each individual user class in the IP2 time period.

Table 4.4: IP2 Matrix Change R-squared Analysis

User Class	Emp. Business	Commute	Education	Other
Cell R-Squared	0.87	0.89	0.98	0.97
Cell Slope	0.89	0.91	0.99	0.98
Cell Y-Intercept	0.00	0.00	0.00	0.00
Trip End R-Squared	0.97	0.97	0.99	0.99
Trip End Slope	0.97	0.97	1.01	0.98
Trip End Y-Intercept	0.49	0.96	0.00	1.88

In IP2 the bulk of the matrix (66%) comes from the OTH group. At the cell level, this meets the guidance on the R-squared, Y-intercept and slope measures. The EDU group also passes on all measures while EMP and COM pass on the intercept measure and are slightly outside the guideline level for both R-squared and slope.

At the trip end level the EDU class falls inside the suggested ranges for all of the measures while the EMP, COM and OTH groups fall inside these ranges for the Y-intercept and R-squared measures and are very close to the suggested range for the slope criterion.

PM

Table 4.5 gives the R-squared values for each individual user class in the PM time period.

Table 4.5: PM Matrix Change R-squared Analysis

User Class	Emp. Business	Commute	Education	Other
Cell R-Squared	0.77	0.91	0.95	0.94
Cell Slope	0.92	0.92	0.96	0.97
Cell Y-Intercept	0.00	0.00	0.00	0.00
Trip End R-Squared	0.96	0.98	0.98	0.99
Trip End Slope	1.00	0.98	1.02	0.98
Trip End Y-Intercept	0.70	0.99	0.00	1.31

At the cell level in the PM all of the user classes meet the Y-intercept guidance and all except EMP are inside, or close to, the suggested range for R-squared. All fall somewhat short on the slope measure though the OTH value is close to the suggested range. At the trip end level in the EMP group the values are inside the suggested range for the Y-intercept and slope measures, and very close to the suggested level for the R-squared criteria. In the COM, EDU and OTH groups they are inside the suggested range for the R-squared and Y-intercept measures and very close on the slope measure.

Overall

Although the values obtained do not fall universally inside the ranges suggested by WebTAG, these ranges are primarily intended to be appropriate for assessing the change between observed matrices built from data and post estimated / factored matrices which would be expected to be very similar. In this case the prior matrices are fully synthetic and it is, perhaps, inevitable that larger changes may be required. In addition, it is considered more difficult to meet the WebTAG guidelines in large matrices and the matrices in this case are very large indeed.

It is considered that, despite the slight disparities between the values obtained and those suggested by WebTAG, they are still indicative of manageable levels of matrix change and are a by-product of the trade-off between minimising the change in the matrices and achieving acceptable results on the other calibration and validation criteria, such as flows and journey times. While the model could have been set up to further limit matrix change, and to meet all the WebTAG guidelines here, this would have resulted in unacceptably poor calibration and validation on flows, journey times and other network measures and would have reduced its overall robustness and suitability for use.

4.4.4 Application of estimation / factoring information to the demand model

The information gained from matrix estimation / PT factoring is input into the demand model using incremental matrices. These give the difference between the directly calculated demand and the estimated / factored demand and so, in the base case, these effectively reproduce the estimated / factored matrices. Once this has taken place the levels of calibration in the road and PT networks can be meaningfully considered. The incremental values should only form a small part of the assignment matrix and their scale is indicated in Table 4.6. The car, walk and cycle incrementals are all very small. PT values are moderately sized in the AM, but still not much more than one tenth of the total and they are smaller in the other peaks, particularly in the SR (IP2) and PM. Taxi incrementals tend to be larger but this is to be expected as taxi movements are very uncertain.

Table 4.6: Scale of incremental matrices (incremental total as % assigned total)

	AM	LT	SR	PM
Taxi	11%	6%	6%	10%
Car	1%	0%	1%	2%
PT	-12%	-7%	-2%	-1%
Walk	0%	0%	0%	0%
Cycle[23]	0%	0%	0%	0%

4.5 Road calibration and validation

The development, calibration and validation of the road model is described in detail in the ERM Road Model Development Report (see Section 1.4) but the level of flow and journey time calibration / validation reported by the road dashboards is also a key consideration in the assessment of the demand model calibration and so the results are summarised here.

Road calibration / validation (on percentage difference) was good with overall values for all links falling out at:

- AM 78% / 46%
- IP1 89% / 48%
- IP2 86% / 48%
- PM 75% / 43%

Journey time validation was also good at:

- AM 73% pass
- IP1 85% pass
- IP2 76% pass
- PM 69% pass

4.6 Public transport calibration and validation

The development, calibration and validation of the public transport model is described in detail in the ERM PT Model Development Report (see Section 1.4) but the level of passenger movement and journey time calibration / validation reported by the PT dashboards is also a key consideration in the assessment of the demand model calibration and so the results are summarised here.

Figure 4.13 to Figure 4.16 show the modelled versus observed flows for the PT screenlines. Overall there is a good match - although outbound flows on the outer cordon

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[23] Strictly Walk and Cycle use multiplicatative incrementals and so their scale is calculated slightly differently to the others.

in the SR and PM time periods tend to be modelled as rather high, the overall match in the flow patterns is good. The modelled Bus flows are generally lower than observed flows across both cordons and this trend can distinctively be seen in the LT (IP1) time period.

Cordon	Observed	Modelled	Diff	% Diff	GEH	CR
Canal - Inbound - Bus	24,845	23,416	-1,429	-6%	9	0.82
Canal - Inbound - Luas	4,086	4,583	+497	+12%	8	0.85
Canal - Inbound - Rail	11,740	12,265	+525	+4%	5	0.86
Canal - Inbound - Multi	**40,671**	**40,264**	**-407**	**-1%**	**2**	**0.83**
Canal - Outbound - Bus	8,386	8,178	-208	-2%	2	0.76
Canal - Outbound - Luas	1,492	2,058	+566	+38%	13	0.72
Canal - Outbound - Rail	3,311	3,737	+426	+13%	7	0.89
Canal - Outbound - Multi	**13,189**	**13,973**	**+784**	**+6%**	**7**	**0.78**
Outer - Inbound - Bus	14,126	17,099	+2,973	+21%	24	0.73
Outer - Inbound - Luas	2,737	3,139	+402	+15%	7	0.82
Outer - Inbound - Rail	11,306	11,513	+207	+2%	2	0.92
Outer - Inbound - Multi	**28,169**	**31,751**	**+3,582**	**+13%**	**21**	**0.81**
Outer - Outbound - Bus	5,061	4,401	-660	-13%	10	0.65
Outer - Outbound - Luas	1,583	1,890	+307	+19%	7	0.84
Outer - Outbound - Rail	1,713	2,167	+454	+27%	10	0.75
Outer - Outbound - Multi	**8,357**	**8,458**	**+101**	**+1%**	**1**	**0.71**

Figure 4.13: PT screenlines: AM time period

Cordon	Observed	Modelled	Diff	% Diff	GEH	CR
Canal - Inbound - Bus	8,589	7,243	-1,346	-16%	15	0.65
Canal - Inbound - Luas	1,226	1,522	+296	+24%	8	0.81
Canal - Inbound - Rail	2,295	2,393	+98	+4%	2	0.83
Canal - Inbound - Multi	**12,110**	**11,158**	**-952**	**-8%**	**9**	**0.70**
Canal - Outbound - Bus	4,776	4,190	-586	-12%	9	0.73
Canal - Outbound - Luas	781	918	+137	+18%	5	0.85
Canal - Outbound - Rail	1,029	1,349	+320	+31%	9	0.74
Canal - Outbound - Multi	**6,586**	**6,457**	**-129**	**-2%**	**2**	**0.74**
Outer - Inbound - Bus	5,355	4,705	-650	-12%	9	0.67
Outer - Inbound - Luas	715	895	+180	+25%	6	0.80
Outer - Inbound - Rail	2,000	2,084	+84	+4%	2	0.76
Outer - Inbound - Multi	**8,070**	**7,684**	**-386**	**-5%**	**4**	**0.70**
Outer - Outbound - Bus	3,144	2,719	-425	-14%	8	0.58
Outer - Outbound - Luas	506	605	+99	+20%	4	0.84
Outer - Outbound - Rail	922	1,185	+263	+29%	8	0.75
Outer - Outbound - Multi	**4,572**	**4,509**	**-63**	**-1%**	**1**	**0.64**

Figure 4.14: PT screenlines: LT time period

Cordon	Observed	Modelled	Diff	% Diff	GEH	CR
Canal - Inbound - Bus	7,686	7,566	-120	-2%	1	0.72
Canal - Inbound - Luas	1,049	1,605	+556	+53%	15	0.65
Canal - Inbound - Rail	1,348	1,945	+597	+44%	15	0.66
Canal - Inbound - Multi	**10,083**	**11,116**	**+1,033**	**+10%**	**10**	**0.70**
Canal - Outbound - Bus	8,155	7,938	-217	-3%	2	0.77
Canal - Outbound - Luas	1,308	1,933	+625	+48%	16	0.68
Canal - Outbound - Rail	2,172	3,001	+829	+38%	16	0.72
Canal - Outbound - Multi	**11,635**	**12,872**	**+1,237**	**+11%**	**11**	**0.75**
Outer - Inbound - Bus	3,238	4,030	+792	+24%	13	0.62
Outer - Inbound - Luas	655	1,007	+352	+54%	12	0.65
Outer - Inbound - Rail	1,166	1,429	+263	+23%	7	0.69
Outer - Inbound - Multi	**5,059**	**6,466**	**+1,407**	**+28%**	**19**	**0.64**
Outer - Outbound - Bus	4,543	5,679	+1,136	+25%	16	0.61
Outer - Outbound - Luas	925	1,212	+287	+31%	9	0.76
Outer - Outbound - Rail	1,902	2,683	+781	+41%	16	0.71
Outer - Outbound - Multi	**7,370**	**9,574**	**+2,204**	**+30%**	**24**	**0.65**

Figure 4.15: PT screenlines: SR time period

Cordon	Observed	Modelled	Diff	% Diff	GEH	CR
Canal - Inbound - Bus	9,835	9,794	-41	-0%	0	0.69
Canal - Inbound - Luas	2,205	3,153	+948	+43%	18	0.70
Canal - Inbound - Rail	3,211	3,522	+311	+10%	5	0.85
Canal - Inbound - Multi	**15,251**	**16,469**	**+1,218**	**+8%**	**10**	**0.72**
Canal - Outbound - Bus	19,857	18,968	-889	-4%	6	0.82
Canal - Outbound - Luas	3,156	3,868	+712	+23%	12	0.82
Canal - Outbound - Rail	8,507	9,797	+1,290	+15%	13	0.80
Canal - Outbound - Multi	**31,520**	**32,633**	**+1,113**	**+4%**	**6**	**0.82**
Outer - Inbound - Bus	3,242	5,043	+1,801	+56%	28	0.59
Outer - Inbound - Luas	1,804	2,357	+553	+31%	12	0.77
Outer - Inbound - Rail	2,132	2,323	+191	+9%	4	0.82
Outer - Inbound - Multi	**7,178**	**9,723**	**+2,545**	**+35%**	**28**	**0.69**
Outer - Outbound - Bus	7,944	12,697	+4,753	+60%	47	0.57
Outer - Outbound - Luas	1,825	2,356	+531	+29%	12	0.77
Outer - Outbound - Rail	7,773	8,806	+1,033	+13%	11	0.85
Outer - Outbound - Multi	**17,542**	**23,859**	**+6,317**	**+36%**	**44**	**0.69**

Figure 4.16: PT screenlines: PM time period

Figure 4.17 shows bus, rail and Luas boarding and alightings (alighting data for bus passengers is not of sufficiently good quality to be used in calibration) across the four daytime time periods. While the correspondence is not perfect, particularly for bus and rail in the AM, the overall match is very good.

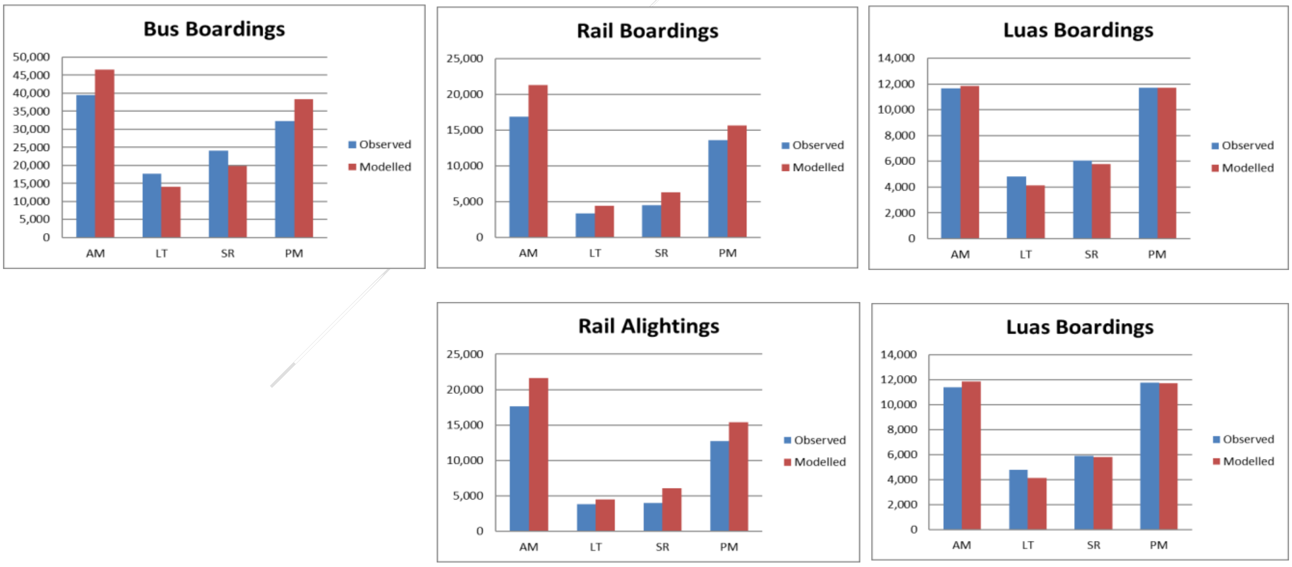

Figure 4.17: PT boardings / alightings by time period

In the ERM PT validation information was also obtained by looking at modelled versus observed journey times and the overall output from this process across all time periods is shown in Figure 4.18. The values cluster around the x=y line indicating that there is a good overall fit between observed and modelled journey times in the PT network.

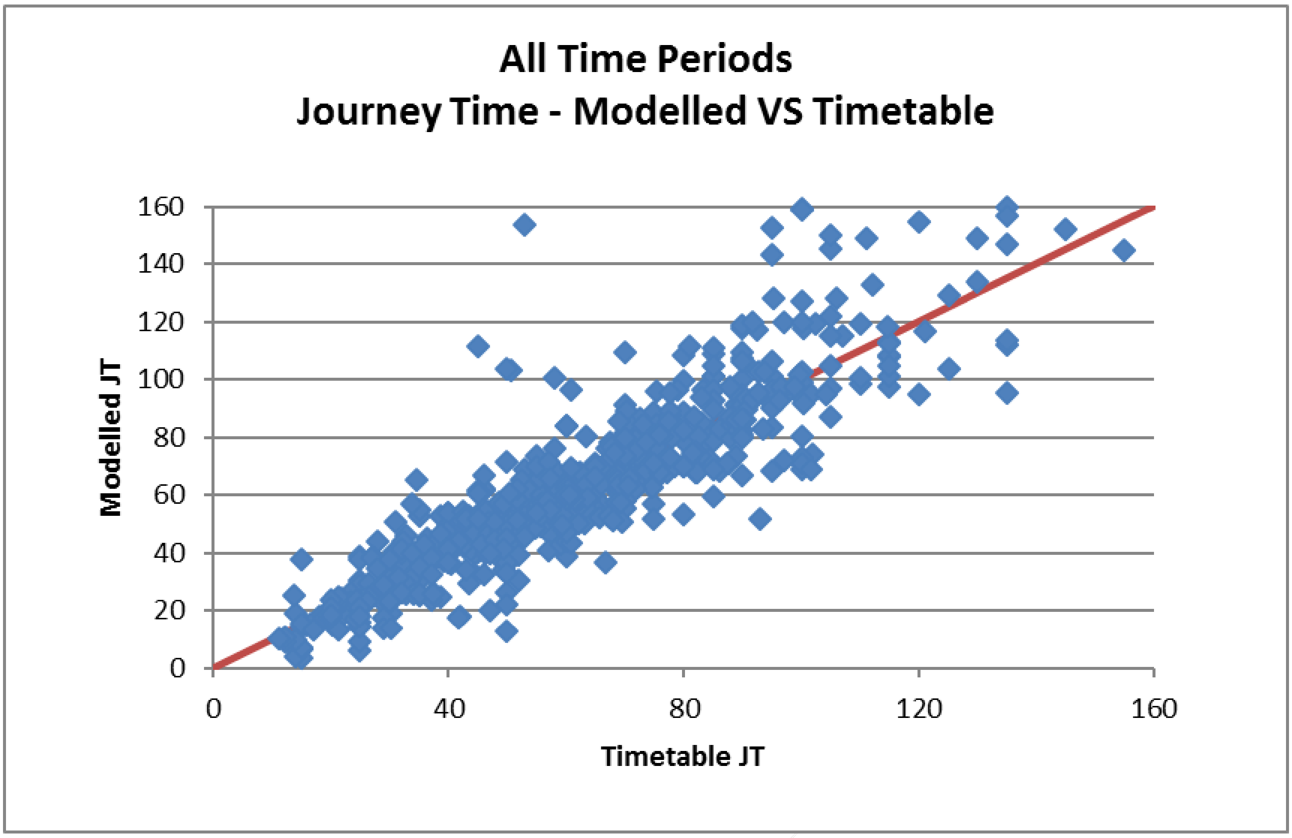

Figure 4.18: PT travel time validation

Finally, for the Luas, DART and local rail services detailed boarding / alighting information enabled line loadings to be derived and compared to modelled line loadings. Figure 4.19 shows an example of this comparison (the remainder can be found in the z Final\4 PT folder). The match between observed and modelled passenger loadings is generally good.

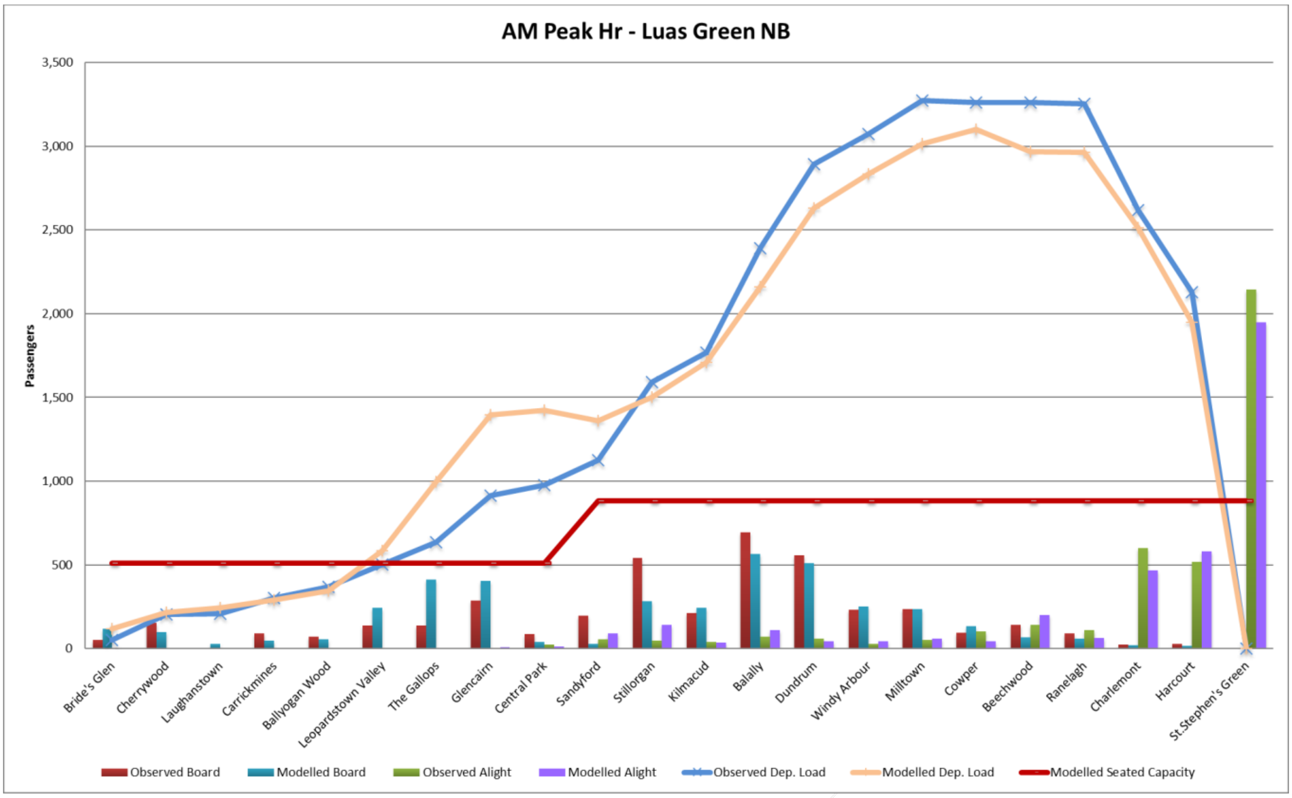

Figure 4.19: PT loading (AM peak, Luas Green Line, Northbound)

4.7 Active modes validation

The development, calibration and validation of the active modes model is described in detail in the ERM Active Modes Model Development Report (see Section 1.4) but the level of active modes calibration / validation reported by the active modes dashboards is also a consideration in the assessment of the demand model calibration and so the results are summarised here.

Table 4.7 to Table 4.10 show the comparison between the observed and modelled walk and cycle flows for the available movements. The figures are of the right order, but there are considerable local variations and both walk and cycle flows are overestimated at the screenline level. This could have been addressed by applying an incremental correction, but as the incremental correction for active modes is, more or less, arbitrary this would not greatly improve the operation of the model as a whole, though it would have improved the levels of flow calibration for the active modes.

Table 4.7: Active modes calibration / validation (AM peak inbound walk flows)

Location	Modelled	Count	Diff	GEH
Ringsend Road	753	737	16	0.6
Grand Canal Street Upper	803	630	173	6.4
Northumberland Road	350	288	62	3.5
Huband Bridge	48	170	-122	11.7
Baggot Street Lower	632	552	80	3.3
Leeson Street Lower	1,021	477	544	19.9
Charlemont Street	502	488	14	0.6
Richmond Street South	881	817	64	2.2
Clanbrassil Street Upper	392	363	29	1.5
Donore Avenue	376	57	319	21.7
Dolphin's Barn Street	323	118	205	13.8
Herberton Road	191	97	94	7.9
South Circular Road	80	105	-25	2.6
Old Kilmainham Road	232	49	183	15.4
Kilmainham Lane	127	42	85	9.3
St Johns Road West	40	35	5	0.9
Conyngham Road	49	122	-73	7.9
Chesterfield Avenue	14	77	-63	9.4
North Road	45	53	-8	1.2
Blackhorse Avenue	330	105	225	15.2
Old Cabra Road	130	113	17	1.5
Annamoe Road	259	97	162	12.1
Charleville Road	74	67	7	0.9
N3 at Dalymount	513	273	240	12.1
Phibsborough Road	419	422	-3	0.2
Royal Canal Bank	245	75	170	13.4
Lower Dorset Street	938	645	293	10.4
Russell Street at the bridge	259	135	124	8.9
Summerhill Parade at the bridge	461	253	208	11.0
North Strand Road at Newcomen Bridge	633	436	197	8.5
Ossary Road	258	132	126	9.0
Sheriff Street Upper at the bridge	384	210	174	10.1
Northwall Quay at the bridge	397	355	42	2.1
TOTAL	**12,159**	**8,596**	**3,5643**	**35.0**

Table 4.8: Active modes calibration / validation (PM peak outbound walk flows)

Location	Modelled	Count	Diff	GEH
Ringsend Road	459	478	-19	0.9
Grand Canal Street Upper	488	427	61	2.9
Northumberland Road	250	227	23	1.5
Huband Bridge	29	104	-75	9.2
Baggot Street Lower	400	406	-6	0.3
Leeson Street Lower	778	284	494	21.4
Charlemont Street	345	293	52	2.9
Richmond Street South	587	529	58	2.5
Clanbrassil Street Upper	289	211	78	4.9
Donore Avenue	223	33	190	16.8
Dolphin's Barn Street	199	74	125	10.7
Herberton Road	146	68	78	7.6
South Circular Road	59	87	-28	3.2
Old Kilmainham Road	168	55	114	10.8
Kilmainham Lane	89	38	52	6.5
St Johns Road West	16	21	-5	1.2
Conyngham Road	17	62	-45	7.1
Chesterfield Avenue	4	53	-49	9.2
North Road	72	38	34	4.6
Blackhorse Avenue	205	59	146	12.7
Old Cabra Road	82	66	16	1.8
Annamoe Road	244	79	165	13.0
Charleville Road	62	42	20	2.8
N3 at Dalymount	392	201	191	11.1
Phibsborough Road	281	348	-67	3.8
Royal Canal Bank	169	32	137	13.6
Lower Dorset Street	609	518	91	3.9
Russell Street at the bridge	194	107	87	7.1
Summerhill Parade at the bridge	291	180	111	7.2
North Strand Road at Newcomen Bridge	427	368	59	2.9
Ossary Road	178	113	65	5.4
Sheriff Street Upper at the bridge	281	73	208	15.7
Northwall Quay at the bridge	172	253	-81	5.5
TOTAL	**8,205**	**5,924**	**2,281**	**27.1**

Table 4.9: Active modes calibration / validation (AM peak inbound cycle flows)

Location	Cycle flow	Count	Diff	GEH
Ringsend Road	167	136	31	2.6
Grand Canal Street Upper	129	100	29	2.7
Northumberland Road	166	163	3	0.2
Huband Bridge	9	81	-72	10.7
Baggot Street Lower	195	160	35	2.6
Leeson Street Lower	914	349	565	22.5
Charlemont Street	227	230	-3	0.2
Richmond Street South	510	473	37	1.7
Clanbrassil Street Upper	248	330	-82	4.8
Donore Avenue	75	44	31	4.0
Dolphin's Barn Street	311	47	264	19.7
Herberton Road	133	76	57	5.6
South Circular Road	45	40	5	0.7
Old Kilmainham Road	23	20	3	0.6
Kilmainham Lane	31	36	-5	0.8
St Johns Road West	20	41	-21	3.8
Conyngham Road	72	55	17	2.2
Chesterfield Avenue	19	121	-102	12.2
North Road	18	20	-2	0.4
Blackhorse Avenue	87	29	58	7.6
Old Cabra Road	180	70	110	9.9
Annamoe Road	57	21	36	5.8
Charleville Road	14	28	-14	3.0
N3 at Dalymount	112	74	38	3.9
Phibsborough Road	384	155	229	13.9
Royal Canal Bank	0	34	-34	8.3
Lower Dorset Street	547	279	268	13.2
Russell Street at the bridge	71	55	16	2.1
Summerhill Parade at the bridge	62	95	-33	3.8
North Strand Road at Newcomen Bridge	713	440	273	11.4
Ossory Road	76	20	56	8.1
Sheriff Street Upper at the bridge	41	21	20	3.6
Northwall Quay at the bridge	237	92	145	11.3
TOTAL	**5,893**	**3,935**	**1,958**	**27.9**

Table 4.10: Active modes calibration / validation (PM peak outbound cycle flows)

Location	Cycle flow	Count	Diff	GEH
Ringsend Road	115	96	19	1.8
Grand Canal Street Upper	55	85	-30	3.6
Northumberland Road	177	101	76	6.4
Huband Bridge	4	49	-45	8.7
Baggot Street Lower	351	95	256	17.1
Leeson Street Lower	359	204	155	9.2
Charlemont Street	197	196	1	0.1
Richmond Street South	244	258	-14	0.9
Clanbrassil Street Upper	211	263	-52	3.4
Donore Avenue	50	41	9	1.4
Dolphin's Barn Street	190	60	130	11.6
Herberton Road	80	49	31	3.9
South Circular Road	9	26	-17	4.1
Old Kilmainham Road	31	18	13	2.7
Kilmainham Lane	25	23	2	0.5
St Johns Road West	13	36	-23	4.6
Conyngham Road	24	38	-14	2.5
Chesterfield Avenue	38	99	-61	7.4
North Road	17	19	-2	0.5
Blackhorse Avenue	46	18	28	4.8
Old Cabra Road	98	39	59	7.1
Annamoe Road	40	14	26	4.9
Charleville Road	5	14	-9	2.9
N3 at Dalymount	101	57	44	4.9
Phibsborough Road	201	90	111	9.2
Royal Canal Bank	0	22	-22	6.6
Lower Dorset Street	377	180	197	11.8
Russell Street at the bridge	48	56	-8	1.1
Summerhill Parade at the bridge	44	68	-24	3.2
North Strand Road at Newcomen Bridge	439	309	130	6.7
Ossory Road	51	18	33	5.5
Sheriff Street Upper at the bridge	67	26	41	5.9
Northwall Quay at the bridge	76	63	13	1.5
TOTAL	**3,783**	**2,731**	**1,052**	**18.4**

4.8 Overview

Though there is still room for improvement, overall, for a model of this scale and on this level of complexity the level of calibration / validation is considered to be very good:

- Mode splits are very good at both the total trip and user class level.
- Generalised cost and trip length distributions are good, particularly in those areas of the curves where the majority of the trips occur.

- Intrazonal trip numbers show a good match between modelled and observed values.
- Despite a slightly high OP figure, the time period distribution is good, at the total trip and individual mode level.
- Sector-to-sector matrix changes resulting from matrix estimation / factoring are at an acceptable level.
- R-squared measurements, slopes, and intercepts indicate that matrix changes at the cell and trip end level are acceptably modest, particularly in the context of a fully synthetic prior matrix and the trade-off between limiting matrix change and meeting network calibration / validation measures.
- Though slightly larger for the AM, PT incrementals form only a small proportion of the overall assignment matrices.
- Road calibration / validation is good.
- PT calibration / validation is reasonable.
- Active modes calibration / validation is reasonable, particularly in view of the limited data available.

5 Realism Testing

5.1 Overview

The preceding chapters discuss how the base year scenario of the model was calibrated and validated which reflects its ability to reproduce current conditions. However, in order to estimate how accurately the model will be able to predict future conditions, it is important to run realism tests before undertaking true forecast year runs. WebTAG recommends a series of three standard realism tests[24], namely:

- Car fuel cost elasticity;
- PT fare elasticity; and,
- Car journey time elasticity.

Elasticities are a measure of the size of changes to demand which result from a given change in generalised cost and are defined as:

$$e = \frac{\ln(T_1) - \ln(T_0)}{\ln(C_1) - \ln(C_0)}$$

Where:

T_0 is the demand of the initial condition (calibrated base);
T_1 is the demand with the change in place;
C_0 is the generalised cost of the initial condition (calibrated base); and,
C_1 is the generalised cost with the change in place.

Elasticities are derived based on a global summation of relevant costs and demands across the entire simulated area, as the overall demand is tied to the trip ends and hence cannot change. Consequently, the car fuel and car journey time tests will consider car costs and demands and the PT fare tests will consider PT costs and demands.

The values which models need to produce to be acceptable under WebTAG guidance are shown in Table 5.1.

Table 5.1: Realism Test Acceptability Criteria

Test	Valid Range	Notes
Fuel	-0.25 to -0.35	Should vary by purpose and certain individual purposes may be outside the range. Discretionary travel should be more elastic and employers' business should be less elastic.
Fare	-0.20 to -0.90	Can be as elastic as -2.0 for some long-term models[25]
Time	0.00 to -0.20	

[24] Chapter 6.4, *TAG Unit M2 – Variable Demand Modelling*, January 2014, Retrieved 1st October 2014 from https://www.gov.uk/government/publications/webtag-tag-unit-m2-variable-demand-modelling

[25] Long-term models represent a steady-state condition where all changes are in place and the initial shock of their introduction has stabilised. The FDM reflects long-term conditions.

5.2 Running the realism tests

5.2.1 Car fuel cost elasticity

The car fuel cost is input to the model via the Value of Distance parameter in the SATURN networks. This parameter was multiplied by 1.1 and the road assignment was re-run and re-skimmed in order to provide new base cost inputs. The model was then re-run through a single FDM loop in order to examine its response.

5.2.2 PT fare elasticity

The PT fares enter the model through a fares matrix and a number of fare tables. The costs in these were scaled by a factor of 1.1 and then a standalone PT assignment was undertaken (with the initial base year road assignment as the underlying network). New costs were skimmed from this run and input to the model as revised base costs. The model was then run through a single FDM loop and the outputs examined.

5.2.3 Car journey time elasticity

As the majority of the generalised cost of car travel is made up of the time component (due to the comparative magnitude of the generalised cost equation parameters), a good approximation to the change required by this test can be obtained by multiplying the input base cost matrices for cars by 1.1 and then running the model through a single FDM loop.

5.3 Results

5.3.1 Car fuel cost elasticity

The elasticities obtained from the car fuel cost test are shown in Table 5.2.

Table 5.2: Car fuel cost elasticities

User class	AM	LT	SR	PM	OP*	24 Hour
EMP	0.03	-0.05	-0.03	0.01	-0.05	**-0.02**
COM	-0.14	-0.21	-0.20	-0.14	-0.19	**-0.16**
OTH	-0.16	-0.19	-0.17	-0.22	-0.19	**-0.19**
EDU	-0.12	-0.23	-0.16	-0.15	-0.22	**-0.15**
RET**	-0.21	-0.19	-0.18	-0.21	-0.20	**-0.19**
Total	**-0.14**	**-0.18**	**-0.16**	**-0.18**	**-0.19**	**-0.17**

*** LT distance skim used for OP**
**** OTH distance skim used for RET**

Values are universally above the WebTAG range indicating low levels of elasticity in relation to fuel prices. It is believed that this is likely to be linked to high levels of congestion in Dublin which mean that journey time is the main component of the cost of travelling by car. This means that the time component of the cost outweighs the distance (fuel) component and results in a lower sensitivity to distance-based costs, including fuel.

WebTAG does not make specific reference to trips on Employers Business and it seems reasonable that EMP trips would be less sensitive to changes in fuel cost than is usual as the cost of staff time is generally much higher than the direct cost of business travel. Positive elasticities for AM and PM are due to the bad convergence of the model and should be negative values instead.

Employers Business trips are less elastic than other trips which corresponds with their less discretionary nature.

5.3.2 PT fare elasticity

Public Transport fare elasticities are shown in Table 5.3.

Table 5.3: PT fare elasticities

User class	AM	LT	SR	PM	24 Hour
EMP	-0.24	-0.35	-0.36	-0.28	**-0.30**
COM	-0.22	-0.29	-0.30	-0.21	**-0.23**
OTH	-0.47	-0.52	-0.50	-0.57	**-0.51**
EDU	-0.10	0.03	-0.14	-0.10	**-0.10**
RET*	0.05	0.01	0.01	0.02	**0.02**
Total	**-0.25**	**-0.35**	**-0.34**	**-0.29**	**-0.29**

*** Concessionary travel**

At the time period level and for EMP, COM and OTH all values are within the preferred, -0.2 to -0.9, range recommended by Web TAG. Lower fare elasticities for EDU trips are not considered problematic as these users pay reduced fares. Similarly, RET users do not pay fares and so their fare elasticity should be zero and the results obtained are close to that level.

5.3.3 Car journey time elasticity

Table 5.4 shows the response of the model to car journey time changes.

Table 5.4: Car journey time elasticities

User class	AM	LT	SR	PM	24 Hour
EMP	-0.28	-0.29	-0.32	-0.38	-0.31
COM	-0.11	-0.07	-0.04	-0.13	-0.10
OTH	-0.11	-0.09	-0.08	-0.10	-0.10
EDU	-0.44	-0.49	-0.40	-0.64	-0.45
RET	-0.02	-0.04	-0.09	-0.13	-0.06
Total	**-0.17**	**-0.10**	**-0.13**	**-0.14**	**-0.14**

At the time-period level and for the COM, OTH and RET groups all of the values lie inside the preferred range. For the EMP and EDU groups the response is more elastic than would be expected. It is likely that the reasons for this are similar to those given in relation to the car fuel cost elasticities and related to congestion in the network and the greater impact of time related costs over distance related costs.

6 Conclusion and recommendations

6.1 Introduction

This report has described the calibration and validation of the FDM component of the Eastern Regional Model. This section summarises the strengths and weakness of the model revealed by this process and gives a set of recommendations for further enhancements.

6.2 Calibration methodology – key points

- The ERM FDM used the standard FDM release version 2.0.19 (re-run in v2.0.23) in combination with region specific inputs and appropriate road, PT, and active modes networks.
- All modules are in use and turned on except macro time of day which has yet to be fully implemented.
- The process of FDM calibration for the ERM has followed a repeatable method developed for all of the regional models.
- Calibration / validation outputs are presented in a common, dashboard format.

6.3 Calibration and validation outcomes – key points

The model was calibrated to local conditions using data derived from the 2011 POWSCAR and 2012 NHTS data sets.

- **Modal Split:** 24-hour mode share was calibrated to NHTS data and is good overall, lying within 3 percentage points of the observed data, for the individual user classes and within 2 percentage points overall.
- **Generalised Cost Distribution:** Generalised cost curves were calibrated to POWSCAR and NHTS data and are well matched for car, walk and cycle trips. PT trips are less well matched, but only at high costs where there are comparatively few trips.
- **Trip Length Distribution:** Trip length distributions for COM and EDU were compared to observed (POWSCAR) trip length distributions. The match is reasonably good, particularly in those areas of the curves where the majority of trips occur.
- **Intrazonal Trips:** The proportion of intrazonal trips was calibrated to observed data for each mode, time period and purpose and the modelled pattern is a good match to the observed pattern.
- **Time Period Distribution:** Total trips by time period, and trips by time period and mode were calibrated to observed data and the overall match is very good though

AM PT, walk and cycle trips are somewhat high while car trips are somewhat low and PT and cycle trips tend to be high in all time periods except the OP.

- **Sector-to-sector values:** Pre and post correction sector to sector comparisons indicate that the degree of correction required by the assignment matrices is reasonable.
- **R-squared measurements, slopes and intercepts:** These indicate that matrix changes at the cell and trip end level are acceptably modest, particularly in the context of a fully synthetic prior matrix and the trade-off between limiting matrix change and meeting network calibration / validation measures.
- **Incremental values:** Though slightly larger for the PT in the AM, incrementals generally form only a small proportion of the overall assignment matrices.
- **Road calibration and validation:** Flow calibration (compared to counts) is good with calibrations above 75% and validations above 43% in all cases. Journey time validation is also good at 69-85%. The development, calibration and validation of the road model is covered in more detail in the ERM Road Model Development Report.
- **PT calibration and validation:** The level of PT calibration is reasonable. The development, calibration and validation of the PT model is covered in more detail in the ERM PT Model Development Report.
- **Active modes calibration and validation:** Given the limited data available the calibration and validation of the active modes model is reasonable. However, the development of the active modes model is covered in more detail in the ERM Active Modes Model Development Report.
- **Realism tests:** The response of the model to the realism tests is considered reasonable.

6.4 Recommendations for further development

It is considered that the model in its current state is sufficiently calibrated to be fit for purpose. However, no model is ever ‘finished’ in the sense that no further improvements can be made. In the case of this model, the greatest scope for improvement would come from incremental improvements to the road and PT calibration / validation.

Annex 1 Full list of required input files

Group	Input file
NDFM outputs and tour proportions	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Dem_Zone_Zone_HGV.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Dem_Zone_Zone_M1.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Dem_Zone_Zone_M2.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Dem_Zone_Zone_M3.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Work_Zone_Zone_M1.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Work_Zone_Zone_M2.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Work_Zone_Zone_M3.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Prods_CA.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Blue_White_Collar.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Emp_Split.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\One_Way_NonRetired.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\One_Way_Retired.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Two_Way_Attractions_NonRetired.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Two_Way_Attractions_Retired.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Two_Way_Productions_NonRetired.CSV
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Two_Way_Productions_Retired.CSV
	{CATALOG_DIR}\Params\Trip_End_Parameters\Base_Prod_Tour_Proportions.MAT
	{CATALOG_DIR}\Params\Trip_End_Parameters\Base_Attr_Tour_Proportions.MAT
Special demands	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Internal_Goods.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\AM_SpecialZones.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\LT_SpecialZones.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\OP_SpecialZones.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\PM_SpecialZones.MAT
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\SR_SpecialZones.MAT
	{CATALOG_DIR}\Runs\{Model Year}\{Run ID}\Input\Special_Zones\SZ_data.csv
Base cost matrices	{CATALOG_DIR}\Params\BaseGenCosts\AM_ALL_D0.GCM
	{CATALOG_DIR}\Params\BaseGenCosts\LT_ALL_D0.GCM
	{CATALOG_DIR}\Params\BaseGenCosts\SR_ALL_D0.GCM
	{CATALOG_DIR}\Params\BaseGenCosts\PM_ALL_D0.GCM
	{CATALOG_DIR}\Params\BaseGenCosts\OP_ALL_D0.GCM
	{CATALOG_DIR}\Params\BaseGenCosts\EMP_M3.AGC
	{CATALOG_DIR}\Params\BaseGenCosts\COM_M3.AGC
	{CATALOG_DIR}\Params\BaseGenCosts\OTH_M3.AGC
	{CATALOG_DIR}\Params\BaseGenCosts\EDU_M3.AGC
	{CATALOG_DIR}\Params\BaseGenCosts\RET_M3.AGC
Zone information files	{CATALOG_DIR}\Params\Zone_Conversion\Seq_2_Hier.exe
	{CATALOG_DIR}\PARAMS\SYNTHESIS_SECTOR_V1_1.TXT
	{CATALOG_DIR}\Params\Trip_End_Parameters\SECTOR_LIST.DBF
	{CATALOG_DIR}\Params\Trip_End_Parameters\ZONE_LIST.DBF
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\Zone_Areas.DBF
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\Zone_Lookup.csv
	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\SA_Zones_Sector.DBF

Group	Input file
Mode and destination choice parameters MDC for 01-29 One Way for 30-33	{CATALOG_DIR}\Params\MDC_Params\P??_ALPHA.MAT
	{CATALOG_DIR}\Params\MDC_Params\P??_BETA.MAT
	{CATALOG_DIR}\Params\MDC_Params\P??_LAMBDA.MAT
	{CATALOG_DIR}\Params\MDC_Params\P??_ASC.MAT
	{CATALOG_DIR}\Params\MDC_Params\P??_IZM.MAT
	{CATALOG_DIR}\Params\OneWay_Params\P??_ALPHA.MAT"
	{CATALOG_DIR}\Params\OneWay_Params\P??_BETA.MAT"
	{CATALOG_DIR}\Params\OneWay_Params\P??_LAMBDA.MAT"
	{CATALOG_DIR}\Params\OneWay_Params\P??_ASC.MAT"
	{CATALOG_DIR}\Params\OneWay_Params\P??_IZM.MAT"
Parking information	{CATALOG_DIR}\Params\GenCost_Params\Parking_VoT.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{Run ID}\Input\FWPP_{Run ID}{Model Year}.CSV
	{CATALOG_DIR}\Runs\{Model Year}\{Run ID}\Input\PCharge_{Run ID}{Model Year}.CSV
	{CATALOG_DIR}\Runs\{Model Year}\{Run ID}\Input\PDist_{Run ID}{Model Year}.CSV
	{CATALOG_DIR}\Runs\{Model Year}\{Run ID}\Input\PDistParams_{Run ID}{Model Year}.DAT
	{CATALOG_DIR}\Runs\{Model Year}\{Run ID}\Input\PnRSites_{Run ID}{Model Year}.CSV
Greenfield inputs	{CATALOG_DIR}\Runs\{Model Year}\2 Demand\{Growth}\Greenfield_Allocation.txt
	{CATALOG_DIR}\Params\Greenfield\Generic_Greenfield_Zone_File.MAT
	{CATALOG_DIR}\Runs\{Year}\2 Demand\{Growth}\GField\GField_Zone_?.csv
Road networks (AM, LT/IP1, SR/IP2, PM or OP)	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\Saturn.dat
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\DefaultOptions.dat
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\DefaultParams.dat
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\SATURN.BUS
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\saturn.111
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_Signals.111
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\saturn.222
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\saturn.333
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\saturn_??.444
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_9UC_Tolls_2011.444
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\saturn.555
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_NRA_JT_2014.666 *(except OP)*
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\JT20{Model Year}_??.666
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_additional.777
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_Bridges.777
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_Inner.777
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_M50.777
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_M50_ATC.777
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_Outer.777 *(AM only)*
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\3 Road\??\??_PreLd.PLD *(except OP)*

Group	Input file
PT network files (factor files for EMP, COM, OTH, EDU, RET and ZOD)	{CATALOG_DIR}\Params\4 PT \4 PT_VOT_Table.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\FARES.MAT
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\FARES_AM.FAR
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\FARES_LT.FAR
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\FARES_PM.FAR
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\FARES_SR.FAR
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\NTL_GENERATE_SCRIPT.txt
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\4 PT_Dump_Links.csv
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\SELECT_LINK_SPEC.TXT
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Additional_PT\SYSTEM_FILE.PTS
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Factor_Files\???_NO_VOT_AM.FAC
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Factor_Files\???_NO_VOT_LT.FAC
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Factor_Files\???_NO_VOT_PM.FAC
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Factor_Files\???_NO_VOT_SR.FAC
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Lines\Bus_{RunID}_{Model Year}.LIN
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Lines\New_Mode_{RunID}_{Model Year}.LIN
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Lines\Rail_{RunID}_{Model Year}.LIN
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\BRT_FareZones.DBF
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\DBus_FareZones.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Luas_Links.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Luas_Nodes.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Metro_Links.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Metro_Nodes.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Rail_Links.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Rail_Nodes.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Walk_Links.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\4 PT\Walk_Nodes.dbf
Active modes	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\AMM\CYCLE_DATA.dbf
	{CATALOG_DIR}\Runs\{Model Year}\{RunID}\Input\Networks\AMM\PED_ONLY.DBF
Finalisation files	{CATALOG_DIR}\Params\AssPrep\CarUserToCarDriver.PRM
	{CATALOG_DIR}\Params\AssPrep\PeriodToHour.PRM
	{CATALOG_DIR}\Params\AssPrep\AM_Incrementals.INC
	{CATALOG_DIR}\Params\AssPrep\LT_Incrementals.INC
	{CATALOG_DIR}\Params\AssPrep\SR_Incrementals.INC
	{CATALOG_DIR}\Params\AssPrep\PM_Incrementals.INC
	{CATALOG_DIR}\Params\AssPrep\OP_Incrementals.INC
	{CATALOG_DIR}\Params\AssPrep\TaxiProps.MAT
	{CATALOG_DIR}\Params\AssPrep\Taxi_Incrementals.INC
Preliminary test / dummy files	{CATALOG_DIR}\Params\Active_Assignment \Dummy_Active_Assign.AAM
	{CATALOG_DIR}\Params\Empty.prn
	{CATALOG_DIR}\Params\FWPP\Dummy_FWPP.MAT
	{CATALOG_DIR}\Params\PnR\PnR_Blank_Costs.AGC
	{CATALOG_DIR}\Params\PnR\PnR_Start_File.CSV
	{CATALOG_DIR}\Params\4 PT \4 PT_Assignment_Test.PTM
	{CATALOG_DIR}\Params\3 Road\Dummy_Demand.UFM
	{CATALOG_DIR}\Params\3 Road\Matrix_LowFlow.UFM
	{CATALOG_DIR}\Params\3 Road\SATALL_KR_1ITER.DAT

Annex 2 Special Zones

A2.1 Introduction

This section provides a brief overview of the production of the input matrices for the special zones module. These are distinct for each time period and give trips in the peak / average hour to and from the special zones in the EMP and OTH user classes.

A2.2 Initial matrix creation

A2.2.1 Airport matrices

Survey data collected by DAA records trip origins and destinations as well as journey purposes. Although subsequent work has suggested that the recording of the origin and destination locations is somewhat crude this data was used directly to give trip matrices which were factored to give appropriate flows for Version 1 of the model.

A2.2.2 Dublin Port and Dun Laoghaire matrices

Detailed survey data was not available for Dublin Port or Dun Laoghaire but annual estimates of total car and PT usage was available in published documents. Taxi, Kiss & Sail, and EMP movements were assumed to be zero leaving only OTH car RORO usage and OTH PT usage to correspond with the total car and PT usage estimates. The estimated total usage values were used in combination with the sailing schedules to estimate appropriate arrival and departure totals in each time period. Trip distributions were taken from the corresponding airport matrices.

A2.3 Subsequent matrix processing

For this stage of the work the matrix estimated / factored matrices for Version 1 were taken, disaggregated to the new zone system and used as inputs here.

Prior to Test 23_Pre_Adj0 the various layers in the special zone input matrices were combined to give the new input format required by the revised special zones module to enable it to carry out its own internal mode split.

Annex 3 Final demand model parameter values

The data included is as follows:

- Table A3.1:Production tour proportions by purpose
- Table A3.2:Attraction tour proportions by purpose
- Table A3.3:Finalised distribution and mode split parameters
- Table A3.4:Finalised period to hour factors
- Table A3.5:Finalised parking distribution calibration parameters
- Table A3.6:Finalised special zone calibration parameters

Table A3.1: Production tour proportions by purpose

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17	T18	T19	T20	T21	T22	T23	T24	T25
P01	0.00420	0.03162	0.12827	0.52208	0.07904	0.00000	0.01078	0.02352	0.02000	0.02000	0.00000	0.00000	0.01067	0.03300	0.01500	0.00000	0.00000	0.00000	0.00714	0.02040	0.00416	0.00200	0.02000	0.03774	0.03774
P02	0.00420	0.03162	0.12827	0.52208	0.07904	0.00000	0.01078	0.02352	0.02000	0.02000	0.00000	0.00000	0.01067	0.03300	0.01500	0.00000	0.00000	0.00000	0.00714	0.02040	0.00416	0.00200	0.02000	0.03774	0.03774
P03	0.01575	0.03774	0.08888	0.53560	0.10712	0.00000	0.00000	0.02156	0.02900	0.01500	0.00000	0.00000	0.01455	0.02900	0.04400	0.00000	0.00000	0.00000	0.00714	0.04488	0.01560	0.00700	0.00000	0.01530	0.00000
P04	0.01575	0.03774	0.08888	0.53560	0.10712	0.00000	0.00000	0.02156	0.02900	0.01500	0.00000	0.00000	0.01455	0.02900	0.04400	0.00000	0.00000	0.00000	0.00714	0.04488	0.01560	0.00700	0.00000	0.01530	0.00000
P05	0.00840	0.06018	0.70195	0.17576	0.03536	0.00000	0.00784	0.00000	0.00000	0.00000	0.00000	0.00000	0.01649	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00816	0.00000	0.00000	0.00000	0.00000	0.00000
P06	0.00000	0.04896	0.60297	0.30160	0.03328	0.00000	0.00000	0.01568	0.00000	0.00000	0.00000	0.00000	0.00000	0.01600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
P07	0.02415	0.00000	0.07070	0.43472	0.09672	0.00000	0.00000	0.04508	0.13900	0.00000	0.00000	0.00000	0.00000	0.00000	0.02300	0.00000	0.00000	0.00000	0.00000	0.09486	0.00000	0.00000	0.00000	0.00000	0.09486
P08	0.00840	0.06018	0.70195	0.17576	0.03536	0.00000	0.00784	0.00000	0.00000	0.00000	0.00000	0.00000	0.01649	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00816	0.00000	0.00000	0.00000	0.00000	0.00000
P09	0.00000	0.00000	0.28482	0.71968	0.00000	0.00000	0.00000	0.02548	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
P10	0.00000	0.09282	0.22927	0.35464	0.04680	0.00000	0.00000	0.02254	0.02300	0.02300	0.00000	0.00000	0.00000	0.04500	0.06800	0.00000	0.00000	0.00000	0.02346	0.04590	0.00000	0.00000	0.00000	0.00000	0.04590
P11	0.32970	0.06018	0.10302	0.09256	0.01768	0.00000	0.05194	0.03234	0.00700	0.00300	0.00000	0.00000	0.20176	0.03600	0.00300	0.00000	0.00000	0.00000	0.04386	0.00714	0.00000	0.00000	0.00000	0.00000	0.02652
P12	0.32970	0.06018	0.10302	0.09256	0.01768	0.00000	0.05194	0.03234	0.00700	0.00300	0.00000	0.00000	0.20176	0.03600	0.00300	0.00000	0.00000	0.00000	0.04386	0.00714	0.00000	0.00000	0.00000	0.00000	0.02652
P13	0.32970	0.06018	0.10302	0.09256	0.01768	0.00000	0.05194	0.03234	0.00700	0.00300	0.00000	0.00000	0.20176	0.03600	0.00300	0.00000	0.00000	0.00000	0.04386	0.00714	0.00000	0.00000	0.00000	0.00000	0.02652
P14	0.32970	0.06018	0.10302	0.09256	0.01768	0.00000	0.05194	0.03234	0.00700	0.00300	0.00000	0.00000	0.20176	0.03600	0.00300	0.00000	0.00000	0.00000	0.04386	0.00714	0.00000	0.00000	0.00000	0.00000	0.02652
P15	0.32970	0.06018	0.10302	0.09256	0.01768	0.00000	0.05194	0.03234	0.00700	0.00300	0.00000	0.00000	0.20176	0.03600	0.00300	0.00000	0.00000	0.00000	0.04386	0.00714	0.00000	0.00000	0.00000	0.00000	0.02652
P16	0.32970	0.06018	0.10302	0.09256	0.01768	0.00000	0.05194	0.03234	0.00700	0.00300	0.00000	0.00000	0.20176	0.03600	0.00300	0.00000	0.00000	0.00000	0.04386	0.00714	0.00000	0.00000	0.00000	0.00000	0.02652
P17	0.05775	0.04488	0.04949	0.03224	0.01040	0.00000	0.09408	0.04802	0.01000	0.00500	0.00000	0.00000	0.06014	0.08100	0.00500	0.00000	0.00000	0.00000	0.15606	0.11934	0.00000	0.00000	0.00000	0.00000	0.23562
P18	0.05250	0.07650	0.01919	0.04576	0.01976	0.00000	0.09212	0.11662	0.01900	0.00600	0.00000	0.00000	0.09118	0.10600	0.00000	0.00000	0.00000	0.00000	0.09588	0.09588	0.00000	0.00000	0.00000	0.00000	0.17238
P19	0.11445	0.07956	0.03131	0.01664	0.01664	0.00000	0.09212	0.04606	0.06200	0.00000	0.00000	0.00000	0.06014	0.06200	0.00000	0.00000	0.00000	0.00000	0.09588	0.07956	0.00000	0.00000	0.00000	0.00000	0.25500
P20	0.02100	0.02040	0.06060	0.00000	0.00000	0.00000	0.21560	0.09800	0.00000	0.00000	0.00000	0.00000	0.01940	0.08000	0.04000	0.00000	0.00000	0.00000	0.06120	0.20400	0.00000	0.00000	0.00000	0.00000	0.18360
P21	0.03570	0.05712	0.01111	0.01144	0.00000	0.00000	0.17640	0.06566	0.01100	0.00000	0.00000	0.00000	0.13095	0.07900	0.00000	0.00000	0.00000	0.00000	0.24072	0.04590	0.00000	0.00000	0.00000	0.00000	0.13770
P22	0.03150	0.00000	0.00000	0.00000	0.00000	0.00000	0.44492	0.05978	0.03000	0.00000	0.00000	0.00000	0.11737	0.03000	0.00000	0.00000	0.00000	0.00000	0.09282	0.06222	0.00000	0.00000	0.00000	0.00000	0.12342
P23	0.12810	0.01428	0.00000	0.01456	0.01456	0.00000	0.29106	0.11956	0.02700	0.00000	0.00000	0.00000	0.11834	0.05400	0.00000	0.00000	0.00000	0.00000	0.12444	0.02754	0.00000	0.00000	0.00000	0.00000	0.06936
P24	0.00000	0.05916	0.01919	0.03952	0.01976	0.00000	0.09408	0.05684	0.00000	0.05800	0.00000	0.00000	0.05626	0.07700	0.01900	0.00000	0.00000	0.00000	0.07854	0.17646	0.00000	0.00000	0.00000	0.00000	0.25500
P25	0.00000	0.09690	0.00101	0.00000	0.00000	0.00000	0.03136	0.15582	0.11100	0.03200	0.00000	0.00000	0.01552	0.11100	0.06300	0.00000	0.00000	0.00000	0.03264	0.17748	0.00000	0.00000	0.00000	0.00000	0.17748
P26	0.00000	0.09690	0.00101	0.00000	0.00000	0.00000	0.03136	0.15582	0.11100	0.03200	0.00000	0.00000	0.01552	0.11100	0.06300	0.00000	0.00000	0.00000	0.03264	0.17748	0.00000	0.00000	0.00000	0.00000	0.17748
P27	0.01260	0.08874	0.11312	0.18200	0.03848	0.00000	0.06076	0.10976	0.02500	0.00000	0.00000	0.00000	0.08439	0.08700	0.00000	0.00000	0.00000	0.00000	0.03774	0.06324	0.00000	0.00000	0.00000	0.00000	0.10200
P28	0.06825	0.07344	0.02929	0.01456	0.00416	0.00000	0.15582	0.14896	0.04000	0.00000	0.00000	0.00000	0.09118	0.10100	0.00000	0.00000	0.00000	0.00000	0.05916	0.07752	0.00000	0.00000	0.00000	0.00000	0.13668
P29	0.12495	0.21828	0.00000	0.00000	0.00000	0.00000	0.25676	0.09310	0.02400	0.00000	0.00000	0.00000	0.04656	0.04800	0.02400	0.00000	0.00000	0.00000	0.09690	0.00000	0.00000	0.00000	0.00000	0.00000	0.07242
P30	0.22470	0.00000	0.00000	0.00000	0.00000	0.00000	0.29792	0.00000	0.00000	0.00000	0.00000	0.00000	0.25996	0.00000	0.00000	0.00000	0.00000	0.00000	0.13668	0.00000	0.00000	0.00000	0.00000	0.00000	0.08160
P31	0.22470	0.00000	0.00000	0.00000	0.00000	0.00000	0.29792	0.00000	0.00000	0.00000	0.00000	0.00000	0.25996	0.00000	0.00000	0.00000	0.00000	0.00000	0.13668	0.00000	0.00000	0.00000	0.00000	0.00000	0.08160
P32	0.18795	0.00000	0.00000	0.00000	0.00000	0.00000	0.22540	0.00000	0.00000	0.00000	0.00000	0.00000	0.34823	0.00000	0.00000	0.00000	0.00000	0.00000	0.17442	0.00000	0.00000	0.00000	0.00000	0.00000	0.06222
P33	0.18690	0.00000	0.00000	0.00000	0.00000	0.00000	0.14994	0.00000	0.00000	0.00000	0.00000	0.00000	0.33271	0.00000	0.00000	0.00000	0.00000	0.00000	0.27642	0.00000	0.00000	0.00000	0.00000	0.00000	0.05610

Table A3.2: Attraction tour proportions by purpose

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17	T18	T19	T20	T21	T22	T23	T24	T25
P01	0.00840	0.02448	0.12423	0.55224	0.06968	0.00000	0.00784	0.02058	0.00800	0.02900	0.00000	0.00000	0.00776	0.03500	0.01300	0.00000	0.00000	0.00000	0.00816	0.02142	0.00312	0.00500	0.02700	0.03264	0.02754
P02	0.00840	0.02448	0.12423	0.55224	0.06968	0.00000	0.00784	0.02058	0.00800	0.02900	0.00000	0.00000	0.00776	0.03500	0.01300	0.00000	0.00000	0.00000	0.00816	0.02142	0.00312	0.00500	0.02700	0.03264	0.02754
P03	0.02835	0.01428	0.06868	0.55536	0.14248	0.00000	0.00000	0.02646	0.00000	0.00000	0.00000	0.00000	0.02619	0.01400	0.06800	0.00000	0.00000	0.00000	0.00000	0.04182	0.01456	0.00000	0.00000	0.02754	0.00000
P04	0.02835	0.01428	0.06868	0.55536	0.14248	0.00000	0.00000	0.02646	0.00000	0.00000	0.00000	0.00000	0.02619	0.01400	0.06800	0.00000	0.00000	0.00000	0.00000	0.04182	0.01456	0.00000	0.00000	0.02754	0.00000
P05	0.00840	0.05814	0.67872	0.20488	0.03432	0.00000	0.00784	0.00000	0.00000	0.00000	0.00000	0.00000	0.01552	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00816	0.00000	0.00000	0.00000	0.00000	0.00000
P06	0.00000	0.04182	0.59489	0.29952	0.02808	0.00000	0.00000	0.02646	0.00000	0.00000	0.00000	0.00000	0.00000	0.01400	0.00000	0.00000	0.00000	0.00000	0.00000	0.01428	0.00000	0.00000	0.00000	0.00000	0.00000
P07	0.02100	0.03978	0.11918	0.44824	0.08112	0.00000	0.00000	0.05782	0.07800	0.00000	0.00000	0.00000	0.00000	0.00000	0.02000	0.00000	0.00000	0.00000	0.00000	0.09996	0.00000	0.00000	0.00000	0.00000	0.06018
P08	0.00840	0.05814	0.67872	0.20488	0.03432	0.00000	0.00784	0.00000	0.00000	0.00000	0.00000	0.00000	0.01552	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00816	0.00000	0.00000	0.00000	0.00000	0.00000
P09	0.00000	0.00000	0.28078	0.75088	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
P10	0.00000	0.07446	0.22018	0.39728	0.07592	0.00000	0.00000	0.01764	0.01800	0.01800	0.00000	0.00000	0.00000	0.05500	0.05500	0.00000	0.00000	0.00000	0.01836	0.03672	0.00000	0.00000	0.00000	0.00000	0.03672
P11	0.31290	0.05916	0.11211	0.10608	0.01560	0.00000	0.05096	0.03332	0.00600	0.00300	0.00000	0.00000	0.19109	0.04000	0.00300	0.00000	0.00000	0.00000	0.04692	0.00918	0.00000	0.00000	0.00000	0.00000	0.02550
P12	0.31290	0.05916	0.11211	0.10608	0.01560	0.00000	0.05096	0.03332	0.00600	0.00300	0.00000	0.00000	0.19109	0.04000	0.00300	0.00000	0.00000	0.00000	0.04692	0.00918	0.00000	0.00000	0.00000	0.00000	0.02550
P13	0.31290	0.05916	0.11211	0.10608	0.01560	0.00000	0.05096	0.03332	0.00600	0.00300	0.00000	0.00000	0.19109	0.04000	0.00300	0.00000	0.00000	0.00000	0.04692	0.00918	0.00000	0.00000	0.00000	0.00000	0.02550
P14	0.31290	0.05916	0.11211	0.10608	0.01560	0.00000	0.05096	0.03332	0.00600	0.00300	0.00000	0.00000	0.19109	0.04000	0.00300	0.00000	0.00000	0.00000	0.04692	0.00918	0.00000	0.00000	0.00000	0.00000	0.02550
P15	0.31290	0.05916	0.11211	0.10608	0.01560	0.00000	0.05096	0.03332	0.00600	0.00300	0.00000	0.00000	0.19109	0.04000	0.00300	0.00000	0.00000	0.00000	0.04692	0.00918	0.00000	0.00000	0.00000	0.00000	0.02550
P16	0.31290	0.05916	0.11211	0.10608	0.01560	0.00000	0.05096	0.03332	0.00600	0.00300	0.00000	0.00000	0.19109	0.04000	0.00300	0.00000	0.00000	0.00000	0.04692	0.00918	0.00000	0.00000	0.00000	0.00000	0.02550
P17	0.06090	0.03570	0.04444	0.04576	0.01248	0.00000	0.10290	0.03724	0.01200	0.00600	0.00000	0.00000	0.06499	0.09000	0.00600	0.00000	0.00000	0.00000	0.16014	0.10710	0.00000	0.00000	0.00000	0.00000	0.22644
P18	0.04725	0.05712	0.01111	0.04056	0.01768	0.00000	0.10976	0.14896	0.02200	0.00600	0.00000	0.00000	0.06499	0.09000	0.00600	0.00000	0.00000	0.00000	0.10302	0.09792	0.00000	0.00000	0.00000	0.00000	0.18360
P19	0.10185	0.08262	0.03232	0.01664	0.01664	0.00000	0.07938	0.04704	0.06500	0.00000	0.00000	0.00000	0.04656	0.06500	0.01600	0.00000	0.00000	0.00000	0.09894	0.08262	0.00000	0.00000	0.00000	0.00000	0.26316
P20	0.01890	0.01836	0.07070	0.00000	0.00000	0.00000	0.18914	0.12054	0.01800	0.00000	0.00000	0.00000	0.01746	0.08800	0.05300	0.00000	0.00000	0.00000	0.05406	0.17850	0.00000	0.00000	0.00000	0.00000	0.17850
P21	0.03675	0.03570	0.01212	0.01248	0.00000	0.00000	0.17052	0.05684	0.01200	0.00000	0.00000	0.00000	0.12416	0.11600	0.00000	0.00000	0.00000	0.00000	0.26112	0.03570	0.00000	0.00000	0.00000	0.00000	0.13056
P22	0.03045	0.02958	0.00000	0.00000	0.00000	0.00000	0.41944	0.05586	0.00000	0.00000	0.00000	0.00000	0.11058	0.02900	0.00000	0.00000	0.00000	0.00000	0.08772	0.11628	0.00000	0.00000	0.00000	0.00000	0.11628
P23	0.13125	0.01428	0.00000	0.01456	0.01456	0.00000	0.28616	0.09506	0.04200	0.00000	0.00000	0.00000	0.12125	0.05600	0.00000	0.00000	0.00000	0.00000	0.12750	0.02856	0.00000	0.00000	0.00000	0.00000	0.07038
P24	0.00000	0.03978	0.02020	0.04056	0.02080	0.00000	0.11564	0.07644	0.00000	0.07800	0.00000	0.00000	0.05723	0.09800	0.00000	0.00000	0.00000	0.00000	0.06018	0.16014	0.00000	0.00000	0.00000	0.00000	0.23970
P25	0.00000	0.10302	0.08787	0.00000	0.00000	0.00000	0.04214	0.17052	0.10100	0.02900	0.00000	0.00000	0.01358	0.08700	0.08700	0.00000	0.00000	0.00000	0.01428	0.13260	0.00000	0.00000	0.00000	0.00000	0.13362
P26	0.00000	0.10302	0.08787	0.00000	0.00000	0.00000	0.04214	0.17052	0.10100	0.02900	0.00000	0.00000	0.01358	0.08700	0.08700	0.00000	0.00000	0.00000	0.01428	0.13260	0.00000	0.00000	0.00000	0.00000	0.13362
P27	0.01155	0.10302	0.12524	0.15184	0.03536	0.00000	0.05488	0.16562	0.03400	0.01100	0.00000	0.00000	0.04365	0.09000	0.00000	0.00000	0.00000	0.00000	0.05712	0.05712	0.00000	0.00000	0.00000	0.00000	0.06936
P28	0.07245	0.07038	0.02323	0.01144	0.00832	0.00000	0.17640	0.14308	0.04600	0.00000	0.00000	0.00000	0.08148	0.10300	0.00400	0.00000	0.00000	0.00000	0.05814	0.07446	0.00000	0.00000	0.00000	0.00000	0.12852
P29	0.11970	0.20910	0.00000	0.00000	0.00000	0.00000	0.24500	0.08918	0.02300	0.02300	0.00000	0.00000	0.04365	0.04500	0.02300	0.00000	0.00000	0.00000	0.09282	0.00000	0.00000	0.00000	0.00000	0.00000	0.09282
P30	0.22470	0.00000	0.00000	0.00000	0.00000	0.00000	0.29792	0.00000	0.00000	0.00000	0.00000	0.00000	0.25996	0.00000	0.00000	0.00000	0.00000	0.00000	0.13668	0.00000	0.00000	0.00000	0.00000	0.00000	0.08160
P31	0.22470	0.00000	0.00000	0.00000	0.00000	0.00000	0.29792	0.00000	0.00000	0.00000	0.00000	0.00000	0.25996	0.00000	0.00000	0.00000	0.00000	0.00000	0.13668	0.00000	0.00000	0.00000	0.00000	0.00000	0.08160
P32	0.18795	0.00000	0.00000	0.00000	0.00000	0.00000	0.22540	0.00000	0.00000	0.00000	0.00000	0.00000	0.34823	0.00000	0.00000	0.00000	0.00000	0.00000	0.17442	0.00000	0.00000	0.00000	0.00000	0.00000	0.06222
P33	0.18690	0.00000	0.00000	0.00000	0.00000	0.00000	0.14994	0.00000	0.00000	0.00000	0.00000	0.00000	0.33271	0.00000	0.00000	0.00000	0.00000	0.00000	0.27642	0.00000	0.00000	0.00000	0.00000	0.00000	0.05610

Table A3.3: Finalised distribution and mode split parameters

Purp	Alpha					Beta	Lambda			ASC values					Intrazonals				
	Car	PT	PnR	Walk	Cyc	All mds	Dest	Md Ch	Act Ch	Car	PT	PnR	Walk	Cyc	Car	PT	PnR	Walk	Cyc
1	1.153	0.336	1.000	1.734	1.741	N/A	-0.110	-0.500	-0.153	-6.233	32.795	50.000	18.249	29.285	-6.010	8.755	10	30.000	21.720
2	2.386	0.794	1.000	3.448	3.296	N/A	-0.043	-0.260	-0.057	-9.400	37.531	50.000	16.528	50.000	0.590	27.450	10	30.000	30.000
3	1.000	0.310	1.000	0.553	0.828	N/A	-0.146	-0.500	-0.253	50.000	29.698	50.000	16.184	34.045	0.000	-5.160	10	-19.00	-19.50
4	1.000	0.550	1.000	2.054	2.076	N/A	-0.043	-0.260	-0.057	50.000	50.000	50.000	-15.78	50.000	0.000	21.850	10	4.545	10.990
5	1.465	0.215	1.000	1.585	2.225	N/A	-0.154	-0.500	-0.169	28.000	36.750	49.760	1.430	20.400	-1.640	16.140	10	30.000	30.000
6	1.426	0.265	1.000	1.831	2.120	N/A	-0.129	-0.500	-0.142	51.160	57.390	49.460	8.780	44.930	2.315	16.610	10	30.000	30.000
7	1.329	0.388	1.000	2.483	2.487	N/A	-0.120	-0.500	-0.132	63.070	47.690	49.230	4.130	40.520	11.490	17.760	10	30.000	30.000
8	1.900	0.500	1.000	2.261	3.499	N/A	-0.062	-0.310	-0.068	60.700	55.910	50.000	-26.62	26.070	0.000	-15.70	10	9.635	4.950
9	1.900	0.600	1.000	1.855	2.605	N/A	-0.062	-0.310	-0.068	60.700	34.800	50.000	-4.050	39.250	0.000	30.000	10	30.000	30.000
10	1.900	0.340	1.000	1.708	1.609	N/A	-0.062	-0.310	-0.068	60.700	38.760	50.000	-8.140	34.770	0.000	28.170	10	30.000	30.000
11	1.600	0.339	1.000	0.767	1.106	N/A	-0.160	-0.500	-0.176	1.078	27.617	50.000	14.583	31.274	9.250	-1.280	10	4.990	8.560
12	2.138	0.525	1.000	0.734	1.507	N/A	-0.160	-0.500	-0.176	-1.135	15.811	50.000	20.434	26.953	-0.200	-11.70	10	-5.130	1.995
13	2.747	0.598	1.000	1.022	1.877	N/A	-0.160	-0.500	-0.176	-15.62	34.572	50.000	24.219	41.796	-9.070	-30.00	10	-18.50	-15.00
14	1.000	0.640	1.000	1.899	2.456	N/A	-0.062	-0.310	-0.068	50.000	50.000	50.000	-29.37	50.000	-11.90	-16.10	10	9.585	18.170
15	1.000	0.610	1.000	1.731	2.197	N/A	-0.062	-0.310	-0.068	50.000	50.000	50.000	-22.21	50.000	-11.90	-18.60	10	7.005	17.640
16	1.000	0.340	1.000	1.405	2.173	N/A	-0.062	-0.310	-0.068	50.000	50.000	50.000	-14.86	50.000	-11.90	-30.00	10	-13.60	1.285
17	1.261	0.325	1.000	0.619	1.207	N/A	-0.157	-0.500	-0.173	-0.442	19.067	50.000	15.281	28.509	9.400	15.600	10	3.255	7.540
18	1.115	0.307	1.000	0.802	1.267	N/A	-0.157	-0.500	-0.173	3.157	19.858	50.000	12.190	29.474	6.840	16.770	10	6.145	9.405
19	1.900	0.800	1.000	1.598	2.542	N/A	-0.062	-0.310	-0.068	50.000	26.495	50.000	-6.811	50.000	0.000	30.000	10	23.090	29.560
20	1.900	0.900	1.000	1.673	2.788	N/A	-0.062	-0.310	-0.068	50.000	26.422	50.000	-1.921	50.000	0.000	30.000	10	3.825	18.600
21	1.466	0.925	1.000	0.764	1.457	N/A	-0.160	-0.500	-0.176	2.658	8.704	50.000	16.541	29.114	1.355	30.000	10	0.465	5.015
22	1.940	0.455	1.000	0.858	1.358	N/A	-0.159	-0.500	-0.175	1.477	17.282	50.000	10.699	28.928	1.790	21.860	10	0.025	4.330
23	1.900	0.440	1.000	2.313	3.123	N/A	-0.062	-0.310	-0.068	50.000	50.000	50.000	-43.05	48.131	0.000	4.665	10	-30.00	-26.20
24	0.671	0.156	1.000	0.637	0.956	N/A	-0.159	-0.500	-0.175	0.407	27.675	50.000	14.460	26.344	-3.340	18.730	10	-0.390	6.840
25	0.735	0.145	1.000	0.716	4.080	N/A	-0.158	-0.500	-0.174	2.167	26.203	50.000	12.628	22.691	-1.490	18.450	10	0.870	30.000
26	1.900	0.500	1.000	1.689	2.320	N/A	-0.062	-0.310	-0.068	50.000	21.993	50.000	-10.78	44.271	0.000	30.000	10	2.725	21.180
27	1.276	0.315	1.000	1.025	1.447	N/A	-0.100	-0.500	-0.168	0.967	26.590	49.820	-2.360	17.810	-9.780	4.500	10	2.665	-2.900
28	0.909	0.171	1.000	0.618	0.836	N/A	-0.158	-0.500	-0.174	6.154	36.691	50.000	8.108	24.712	-1.760	0.800	10	1.850	6.040
29	1.900	0.400	1.000	1.829	2.144	N/A	-0.062	-0.310	-0.068	50.000	50.000	50.000	-38.89	21.764	0.000	-10.30	10	-1.590	7.660
30	0.957	0.198	1.000	0.760	1.137	N/A	-0.106	-0.500	-0.161	5.163	31.670	49.880	11.730	27.640	8.485	10.780	10	8.310	7.615
31	1.900	0.400	1.000	2.031	2.635	N/A	-0.045	-0.310	-0.068	62.450	34.350	50.000	-13.35	43.500	0.000	23.700	10	22.070	14.230
32	1.177	0.279	1.000	0.692	1.345	N/A	-0.103	-0.500	-0.201	4.173	26.560	49.880	14.050	21.930	8.685	3.315	10	8.120	9.605
33	1.900	0.500	1.000	1.791	2.249	N/A	-0.062	-0.500	-0.167	52.100	31.080	50.000	-0.840	31.160	0.000	25.380	10	23.400	15.820

Table A3.4: Finalised period to hour factors

Time Period	Car	PT	Walk	Cycle
AM	0.479	0.470	0.540	0.520
IP1	0.333	0.333	0.333	0.333
IP2	0.380	0.333	0.333	0.333
PM	0.426	0.400	0.400	0.420
OP	0.083	0.083	0.083	0.083

Table A3.5: Finalised parking distribution calibration parameters

Title	Value
Car occupancy	1.18
Minimum search time	0.9 minutes
Maximum search time	15 minutes
Search time scaling parameter	1.46
Value of Time	11.57
Lambda	-0.3
Weight on walk time	2

Table A3.6: Finalised special zone calibration parameters

	Airport EMP	Airport OTH	Dublin Port EMP	Dublin Port OTH	Dun La're EMP	Dun La're OTH
Charge (parking or taxi fare)	20	15	0	0	0	0
Lambda	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Alpha car	1.28	1.26	1.28	1.26	1.28	1.26
Beta car	0	0	0	0	0	0
ASC car	0	0	47	50	42	46
Alpha PT	0.32	0.33	0.32	0.33	0.32	0.33
Beta PT	0	0	0	0	0	0
ASC PT	49	63	49	50	50	49
Prop car = taxi	0.42	0.42	0	0	0	0
Prop car = Kiss & Fly/Sail	0.51	0.51	0	0	0	0

Annex 4 Park and Ride Calibration

A4.1 Introduction

This chapter sets out the methodology of the park and ride calibration process in the ERM. This methodology was adopted for the ERM and differs slightly from the methodology used in the SERM, SWRM, MWRM and WRM, due to the ERM having a full complement of observed data. To undertake park and ride calibration, several elements are required:

- Identify park and ride sites;
- Collate site characteristics such as capacity and charges;
- Identify observed data for calibration; and
- Define Park and Ride site catchments;
- Create site files; and,
- Calibrate.

A4.2 Model Development

A4.2.1 Sites

52 park and ride sites were identified in the ERM as outlined Table A4.7.

The Irish Rail website was consulted to gather pertinent information about each site such as capacity and any associated parking charges.

A4.2.2 Observed Usage

Observed occupancy was collected as part of the data collection program. Site occupancy levels were recorded at each site over the course of three days on the 20th, 21st and 22nd of October 2015 at any time between 09:00 and 12:00 (noon).

From the data collection it was determined that there is a supply of 10,891 parking spaces across the 52 sites, with an estimated demand for 6,596 spaces (61%).

A4.2.3 Site Catchments

Defining site origin catchments involved identifying all zones which could use each specific site as part of their journey. This process was undertaken manually within ArcGIS. Firstly, both rail stations and the railway line within the ERM were plotted. Zone centroids were then added to the map. Using a logical approach, by looking at site locations, road corridors and main destination zones, zones which would likely use a park and ride site were recorded and added to the origin catchment column within the site file. This approach assists in constraining the likely number of people who would use a park and ride site and eliminate illogical movements being made.

Destination zone catchments were set to cover all zones to allow for Park and Ride movements as part of an overall journey.

A4.3 Site file generation

The site file lists each site and pertinent characteristics for use in calculating demand, including:

- Capacity;
- Charges;
- Attraction Factors;
- Site origin catchments; and
- Site destination catchments.

These attraction factors represent additional costs of using Park and Ride at a particular site and can be either increased or decreased on a site by site basis. These values are set independently for each site for each of the modelled time periods. Adjusting these factors helps manage demand at each site during the calibration process. Initially these factors were set to a default value of 1.1 before further refinement during calibration.

A4.3.1 Park and Ride Calibration

Two main elements influence the park and ride calibration process:

- Expected demand (target persons); and
- Mode share.

A4.3.2 Expected Demand

Expected demand at each site was calculated using the observed data to determine the target number of persons using each site in each time period. This calculation was undertaken pivoting off the observed data, by proportionally splitting the remaining capacity between the unobserved time periods to create target demand.

A4.3.3 Mode Share

As previous versions of the model were established with Park and Ride switched off, the first step was to re-run the model with Park and Ride switched on, so as to create some demand.

The model generates standard Park and Ride output files which are read automatically into a macro-enabled spreadsheet. These files are:

- PNR_OUTPUT_Site_Usage_By_Tour.csv – which provides demand in persons per site per time period;
- *_PnR_TP_Out.mat – which contains car and PT based trips per purpose type by time period using park and ride; and
- *_MDC_Params – which includes other costs of using each mode.

Once these have been read into the spreadsheet it calculates the mode share and the modelled demand for each of the individual sites.

Park and Ride ASC values were then adjusted and the model re-run until a plausible level of overall Park and Ride usage was obtained.

A4.3.4 Site Calibration

Once a suitable overall level of usage had been obtained the site choice stage could be calibrated. However, at the stage at which the ERM Park and Ride was added to the model it was understood to have been calibrated at the site level and so site level calibration was not undertaken. The final level of calibration for PnR sites in the ERM is shown in Table A4.8 on Page 120. This indicates that the model is clearly not well calibrated at the individual site level and this will need to be addressed in the long term. However, unless studies wished to look at the usage of individual sites outputs from the model should still be robust.

Table A4.7: ERM Park and Ride sites

Site	Capacity	Charge (€)	Observed Capacity
Adamstown	200	0	17
Athy	90	4	50
Balally	421	5	421
Blackrock	70	6	62
Booterstown	130	4	96
Cheeverston	312	2	49
Clondalkin Fonthill	150	0	9
Clongriffin	400	0	189
Clontarf	117	4	136
Coolmine	170	4	140
Connolly	460	9	217
Dalkey Station	70	4	58
Donabate	210	4	117
Drogheda	300	4	292
Dunboyne	300	0	123
Enfield	120	4	45
Gormanston	137	4	24
Hansfield	60	0	60
Heuston	480	9	235
Hazelhatch	400	4	85
Howth	10	0	17
Kilcoole	15	0	29
Kildare	260	4	133
Killiney	103	0	40
Laytown	23	4	15
Leixlip	40	4	11
Leixlip Louisa Bridge	270	4	166
M3 Parkway	1,200	0	206
Monasterewin	43	4	10
Mullingar	60	4	89
Newbridge	253	4	241
Portmarnock	278	4	279
Red Cow	727	4	552
Sallins	260	4	113
Salthill and Monkstown	100	3.6	96
Sandyford	47	4	44
Shankill	100	3	92
Silver Tankard	20	0	0
Skerries	200	4	133
Stillorgan	341	4	298
Sutton	120	4	103
Garlow Cross	0	0	34
Ross Cross	0	0	8
Carrickmines	352	2	295
Navan	100	4	0
Kilmoon	100	0	0
Bray	100	4	112
Malahide	130	4	79
Rusk and Lusk	260	4	309
Greystones	503	0	380
Maynooth	180	4	189
Balbriggan	99	4	98

Table A4.8: ERM Site calibration

Site	AM GEH	IP1 GEH	IP2 GEH	PM GEH	OP GEH
Adamstown	4.1	5.8	5.9	5.0	1.2
Athy	8.9	11.6	11.8	10.5	0.3
Balally	1.4	11.2	11.6	6.9	11.6
Blackrock	5.6	9.0	9.2	7.5	3.1
Booterstown	7.8	12.1	12.3	10.2	3.5
Cheeverston	0.5	3.7	3.8	2.2	3.7
Clondalkin Fonthill	1.1	2.5	2.5	1.9	1.4
Clongriffin	17.0	22.2	22.4	19.7	2.2
Clontarf	14.4	18.6	18.7	16.4	2.4
Coolmine	13.8	18.5	18.8	16.5	1.9
Connolly	17.7	23.4	23.7	20.8	2.3
Dalkey Station	8.3	11.4	11.6	10.1	1.4
Donabate	13.1	17.3	17.6	15.5	1.5
Drogheda	18.8	25.3	25.8	22.2	3.2
Dunboyne	12.5	16.9	17.2	15.0	1.8
Enfield	7.8	10.5	10.7	9.3	0.8
Gormanston	5.9	7.9	8.0	7.0	0.6
Hansfield	8.9	11.9	12.1	10.6	1.5
Heuston	15.4	21.7	22.0	19.0	4.0
Hazelhatch	10.7	14.4	14.6	12.8	1.4
Howth	5.2	6.8	6.9	6.1	0.2
Kilcoole	4.7	7.1	7.2	6.0	1.2
Kildare	14.3	18.8	19.1	16.9	0.6
Killiney	6.3	9.0	9.1	7.8	1.6
Laytown	4.8	6.3	6.4	5.6	0.4
Leixlip	2.9	4.4	4.5	3.8	0.7
Leixlip Louisa Bridge	13.9	19.2	19.6	17.0	2.3
M3 Parkway	17.2	22.9	23.3	20.5	1.2
Monasterewin	3.9	5.2	5.3	4.6	0.1
Mullingar	11.9	15.6	15.8	14.0	0.2
Newbridge	18.9	25.0	25.5	22.4	1.3
Portmarnock	20.4	26.8	27.2	23.9	2.2
Red Cow	10.3	20.5	20.9	16.3	10.8
Sallins	13.0	17.2	17.5	15.4	0.8
Salthill and Monkstown	8.8	12.9	13.1	11.0	3.0
Sandyford	2.6	0.6	0.7	0.9	4.8
Shankill	9.8	13.8	14.0	12.0	2.4
Silver Tankard	0.9	1.0	1.0	1.0	0.6
Skerries	14.2	18.7	19.0	16.7	1.3
Stillorgan	2.0	6.3	6.8	2.6	11.3
Sutton	12.7	16.7	16.9	14.9	0.8
Garlow Cross	0.5	0.6	0.6	0.6	0.4
Ross Cross	0.5	0.5	0.5	0.5	0.2
Carrickmines	8.2	16.5	16.9	12.9	7.6
Navan	1.7	1.9	2.0	1.9	1.1
Kilmoon	0.5	0.6	0.6	0.6	0.3
Bray	11.3	15.5	15.8	13.6	2.6
Malahide	10.5	14.0	14.2	12.4	1.4
Rusk and Lusk	21.0	28.0	28.4	24.9	2.4
Greystones	16.1	25.2	25.3	20.8	5.1
Maynooth	13.2	19.0	19.4	16.5	3.1
Balbriggan	12.1	15.9	16.2	14.2	1.3

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