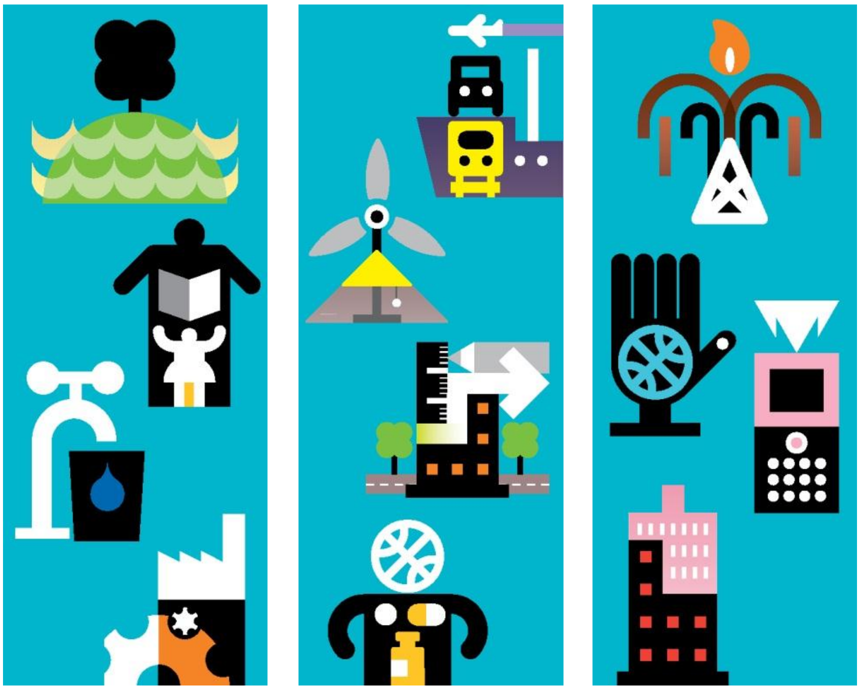

PRIISM Forecasting Report

PRISM Management Group

Mott MacDonald

PRIISM Forecasting Report

September 2014

PRISM Management Group

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Contents

Executive Summary

Background

The West Midlands' Policy Responsive Integrated Strategy Model (PRISM) is a multi-modal disaggregate demand model of the West Midlands Metropolitan Area. The model comprises separate highway and Public Transport (PT) assignment models linked together with a demand model. PRISM was originally developed to represent a 2001 base and was later rebased to 2006. Mott MacDonald was commissioned by the PRISM Management Group (PMG) to undertake a comprehensive update and to produce updated highway and public transport models for a 2011 base year. This report documents the development of the 2021 and 2031 forecast year models, including the variable demand model.

Key Features

The highway models represent an average weekday for three time periods; the AM average hour from 0700 to 0930, the IP average hour from 0930 to 1530 and the average PM hour from 1530 to 1900. Four user-classes are modelled; Car Work, Car Non Work, LGV and HGV. The models use an equilibrium assignment procedure that incorporates detailed junction modelling and blocking back within the Area of Detailed Modelling.

The PT models represent an average weekday for three time periods; the AM average hour from 0700 to 0900, the IP average hour from 1000 to 1200 and the average PM hour from 1600 to 1800. Three user-classes are modelled; “Fare”, “No Fare” and PLANET Long Distance. The assignment methodology makes use of the headway based assignment and parameters provided in the VISUM software.

The demand model consists of the following three main components: the Population Model, the Travel Demand Model and the Final Processing Model. The outcome of these three processes is a set of revised demand matrices for assignment in the HAM and PTAM. These new matrices include responses to cost changes in the assignment model.

Model Development

The 2011 base year highway and public transport models were developed and validated as reported in the Local model Validation Report (LMVR). The response of the PRISM variable demand model to changes in car fuel cost, public transport fares and car journey time is realistic, albeit slightly outside the recommended WebTAG ranges in some cases. The relative elasticities within each test between demand segments is also realistic, suggesting PRISM is a robust model for forecasting the travel demand patterns of the West Midlands population. The calibration process produced a model that closely fits observed link traffic flow and journey time observations.

Forecasting

Demand

Forecasts of demand for 2021 and 2031 were developed based on a variety of inputs, including economic data, planning data and trip cost information. Taking these into account, PRISM forecasts trip making to grow in line with population growth at approximately 5% every 10 years. Mode share is forecast to change only slightly. Results overall are in line with NTEM. At a disaggregate level, there is slightly greater growth in PRISM in car passenger trips, a much larger reduction in bus trips and whilst rail trips are flat in PRISM a large increase is forecast in NTEM.

Highway assignment

Future year highway schemes were coded into PRISM based on consultation with West Midlands Local Authorities. Generalised cost parameters were updated to 2021 and 2031. Overall, growth of approximately 10% in trips is forecast to 2021 and 20% by 2031. The growth for car-work trips and LGVs is more significant than that for car non-work and HGV. Overall, trip lengths are forecast to remain fairly stable.

Public Transport assignment

Overall, small increases in demand are forecast to 2021 and 2031. Overall there is a small reduction in local demand and a significant increase in long distance demand. The fare segment shows greater sensitivity compared with the no-fare segment; both reduce over time whilst long distance trips increase. Overall, small increases in trips are forecast for the AM and PM peak periods and a small decrease for the inter peak period.

1 Introduction

1.1 Overview

The Policy Responsive Integrated Strategy Model (PRISM) is a multi-modal disaggregate demand model of the West Midlands Metropolitan Area. The model comprises both a highway and a public transport assignment model linked with a demand model. The client is the seven Metropolitan districts of the West Midlands, the Highways Agency and Centro.

PRISM was originally developed to represent a 2001 base year and was later rebased to 2006. Mott MacDonald has been commissioned to develop a 2011 base year model.

This Forecasting Report describes the development of the new Reference Case PRISM forecasts, so-called because they form a reference point for other forecasts and for use in providing growth to other local models. The PRISM Reference Case forecasts represent a most-likely future given information currently available on the most-likely socio-demographics, economics and transport policies in the West Midlands.

Other PRISM Refresh reports of relevance are:

- PRIISM Local Model Validation Report (Mott MacDonald, 2014)
- PRISM Refresh Technical Note 1: Zoning (Mott MacDonald, June 2012)
- PRISM Refresh Highway Matrix Build Report (Mott MacDonald, September 2013)
- PRISM Refresh Technical Note 3: Highway Network Build (Mott MacDonald, December 2012)
- Data collection:
  - PRISM Surveys 2011: Household Travel Survey (Mott MacDonald, November 2012)
  - PRISM Surveys 2011: Public Transport (Mott MacDonald, November 2012)
  - PRISM Surveys 2011: Roadside Interviews (Mott MacDonald, November 2012)
  - PRISM Surveys 2011: Urban Centres (Mott MacDonald, November 2012)
- PRISM Demand Model:
  - PRISM 2011 Base: Mode-Destination Model Estimation (RAND Europe, 2014)
  - PRISM 2011 Base: Frequency and Car Ownership Models (RAND Europe, 2014)
  - PRISM 2011 Base: Demand Model Implementation (RAND Europe, 2014)

The forecasts have been developed in accordance with the Department for Transport (DFT) online Transport Analysis Guidance (WebTAG) http://www.dft.gov.uk/webtag and the Highways Agency (HA) Design Manual for Roads and Bridges (DMRB) Volume 12, as well as Mott MacDonald internal Best Practice guidelines.

1.2 Scenario

1.2.1 Scenarios and Interventions

PRISM was originally designed in 2001 and since its development in 2004 it has been used for a wide range of applications. This has included support for the assessment of local development plans, major scheme business cases, local models and as a database of travel and transport information. As a database of travel movements, PRISM has provided input to more local models, including microsimulation.

As in the past, it is intended that future transport and land use planning projects in the West Midlands that require modelling support will use PRISM, either as the database of network detail, planning data or travel demand patterns, or as a fully functional tool. The database may be more useful for smaller scale studies, for which cordoned networks and/or matrices can be generated for the years 2011, 2021 and 2031, whilst the full model specification becomes more relevant when forecasting the impacts of strategic transport schemes or substantial land use changes in the future.

1.2.2 Key Design Considerations

PRISM is the Strategic Transport Model for the West Midlands. The model's geographical area, modal representation, functional responsiveness and segmentation have been designed to reflect the intended uses of the model which are:

- To support development of local and regional transport and land use policies.
- To support Major Scheme Business Cases.
- To provide network inputs and consistent demand forecasts for local studies.
- To be a database of travel demand data in the West Midlands Region.
- To provide the Highways Agency with a robust regional modelling tool for projects and programmes in the West Midlands.

The model's design focuses on the above objectives, also recognising the investment in the original model in 2001, consistency with results and assumption previously made, and constraints imposed by software and reducing funding budgets.

As part of the consultations of the PRISM Management Group (PMG) it was decided that a new unified Public Transport model should be created alongside the PRISM HAM and that the PT model should be made by taking elements from two previous models; the Centro 2005/2008 PT Model and the PRISM 2006 PT Model. Where previously the models were used separately and could feed into each other the 'Unified' model can be used separately by the relevant parties.

This provides many benefits:
The ability for parties to work separately, removing errors that occur from the exchange of data between parties and between both models;
Greater accuracy of skims and route choice throughout the model;
Provision for Centro to use larger networks with a wider coverage;
A more detailed zoning system which means that users are fed more accurately onto the network than previously; and
The ability for more than one party to work together on the model.

2 Variable Demand Model

2.1 Development

2.1.1 Overview

The PRISM Variable Demand Model (VDM) is a system comprised of three main components:
Demand Model
Highway Assignment Model (HAM)
Public Transport Assignment Model (PTAM)

The demand model was developed by RAND Europe using household interview data collected between 2009 and 2012. It interacts with the PRISM assignment models by supplying demand matrices which are assigned and the resulting travel costs fed back to the demand model. More information on the implementation of the PRISM VDM can be found in the PRIISM LMVR.

2.1.2 Future Year Inputs

The PRISM VDM is run in ‘forecast mode’ by updating key inputs for the future year. These key inputs are as follows:
Demand model econometric parameters
Percentage real increase in public transport fares
Number of annual surface-access passengers to Birmingham Airport
Planning data
HAMs and PTAMs
LGV and HGV matrices
External car matrices

The future year HAM and PTAMs are covered in subsequent chapters whilst the other points are covered here.

2.1.3 Demand Model Econometric Parameters

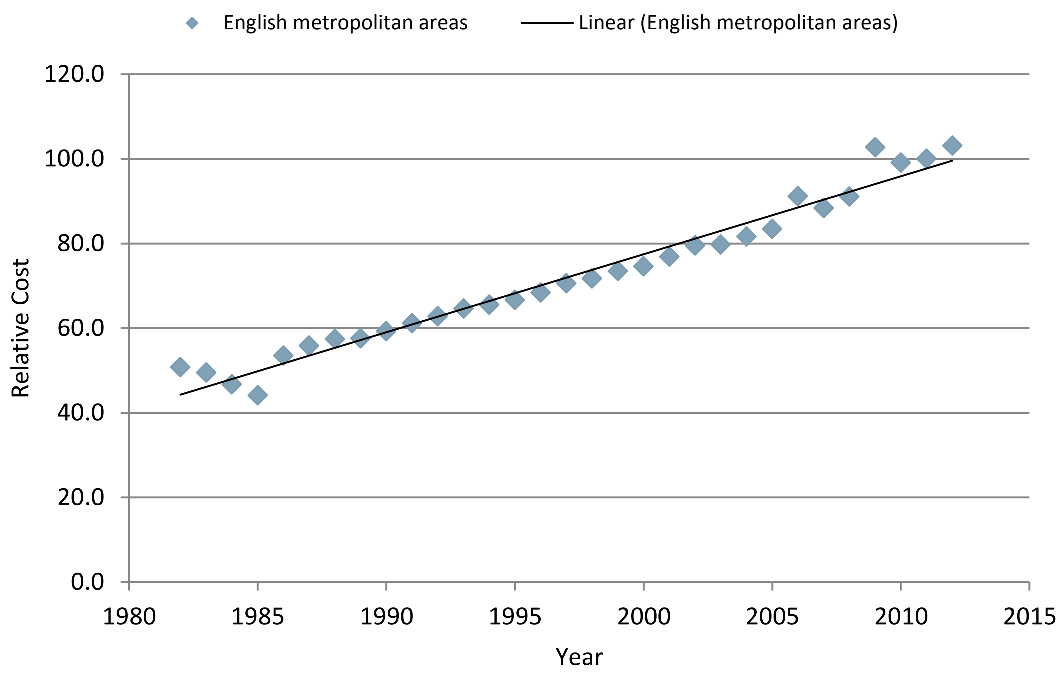
The following demand model parameters have been calculated for the future years 2021 and 2031 based on the methods in WebTAG Unit 3.5.6, October 2012:
Car fuel costs
Value of time (only used in the Other-Other Primary Destination Tour models)

2.1.4 Real Fare Increases

Public transport fares are an input to the PRISM Demand Model in the form of origin-destination matrices extracted from the PTAM. Since the fares extracted are still in 2011 prices, a factor is applied to reflect the real increase in fares between 2011 and the future year.

The factors were derived using DfT data on bus fares between 1982 and 2012. The DfT definition of 'English metropolitan areas' was assumed to be analogous to the WMMA. By using a linear relationship, growth factors of 18.9% (for 2021 vs 2011) and 37.7% (for 2031 vs 2011) were derived.

Figure 2.1: DfT bus fare indices for English metropolitan areas and the linear relationship derived



Source: Mott MacDonald

2.1.5 Birmingham Airport

A separate access model has been developed for Birmingham International Airport. The airport model calculates, for externally given growth figures, where passengers would come from and which mode they would use. The model applies only to passengers and visitors, as the workers at the airport are governed by the standard home-to-work element of the model.

The external forecasts for growth are calculated from DfT UK Aviation Forecasts, January 2013 Constrained Central Forecast, and CAA Passenger Survey Report, 2011. The forecasts are for 12.2 and 17.3 million passengers by 2021 and 2031 respectively. These forecasts are then used to calculate the number of surface access passengers to the airport on an average weekday as shown in Table 2.1: Average weekday surface-access-passengers to Birmingham Airport for the base and future years.

Table 2.1: Average weekday surface-access-passengers to Birmingham Airport for the base and future years

	Business	Leisure	Total
2011	6,098	16,319	22,417
2021	7,817	24,146	31,963
2031	10,444	34,721	45,165

Source: Mott MacDonald

Table 2.1 shows that the number of surface-access-passengers to the airport is forecast to increase by 28% and 48% by 2021 for business and leisure purposes respectively. The growth is forecast to be 71% and 113% by 2031.

2.1.6 Planning Data

Planning data is a key input to the Population Model and a key driver to the travel patterns forecast by the Travel Demand Models. The following data is supplied to the models:

- **Zonal Targets**: The Population Model requires targets for each zone in the FMA, broken down in to various population strata for use in the calculation of the future West Midlands population:
- Gender; age group; worker status; students; household type; and total income
- **Population**: Some of the Travel Demand Models use total population as an *attraction variable*s
- **Employment**: Some of the Travel Demand Models use total employment , retail employment and service employment as *attraction variables*
- **Enrolments**: The education-purpose Travel Demand Models use primary, secondary or tertiary enrolments as *attraction variables*

The planning data variables used by the Travel Demand Models are called *attraction variables*. More information on attraction variables and which ones are relevant to each travel demand purpose can be found in the PRIISM LMVR.

The development of planning data for 2011 is explained in the PRIISM LMVR. The methodology for projecting this data to 2021 and 2031 is discussed in the following subsections. All future year planning data can be found in Appendix xx.

2.1.6.1 Population

The approach to forecasting population data was to first make an initial estimate using relevant available local housing policy and other assumptions. This initial estimate was then adjusted so that the district totals match those given in NTEM 6.2. The final step was to send the data to each Local Authority and make any adjustments based on their detailed local knowledge. Following the use of PRISM to support the Birmingham Develop Plan, the PRISM population data has been refined (but still adjusted to match the NTEM 6.2 district total) based on close consultation with Birmingham City Council.

For four Local Authorities (Birmingham, Sandwell, Dudley, Walsall and Wolverhampton) where a Strategic Housing Land Availability Assessment (SHLAA) was available the following approach was adopted for deriving an initial estimate:

- Use information on housing completions seen between 2011 and 2012
- Use the SHLAA to provide the location of new households
- Multiply each new household by an average occupancy figure of 2.1 and a proportional figure of 0.75 to reflect an assumption that three quarters of these proposed developments will be built
- Apply a factor to all zones in each district so that the district totals match those given in NTEM 6.2

For the other three Local Authorities (Coventry and Solihull) where a SHLAA was not available, monitoring data was used instead. The annual monitoring return provides details on the number of dwellings (units) which were built between the end of March 2011 and April 2012 or are under construction at April 2012 (i.e. since the Census 2011). The following approach was adopted:

- Use information on housing completions seen between 2011 and 2012
- Assume that all properties under construction will be complete by 2021 and therefore take all these units and multiply by an occupancy rate figure of 2.1
- The "dwellings with planning permission" figure provides the number of dwellings (units) that are proposed. It was assumed that 60% of these developments will be built by 2021 again with an occupancy rate of 2.1
- Growth to 2021 and 2031 is based on giving each zone a flag of high, medium or low growth based on existing core strategies and excluding zones which would not expect to see development (e.g. green belt or zones fully built out)
- Apply a factor to all zones in each district so that the district totals match those given in NTEM 6.2

For zones outside of the West Midlands Metropolitan Area the relevant NTEM 6.2 growth has been applied directly to the 2011 population figures.

Table 2.2 presents the base and future year population totals by area. In most WMMA districts the growth in population is forecast to be roughly 3-5% by 2021 and 7-9% by 2031. The exceptions include:

- Coventry: growth is forecast to be above average; 9% and 18% by 2021 and 2031
- Sandwell: growth is forecast to be above average; 11% and 22% by 2021 and 2031

Table 2.2: PRISM Total Population by District for Base and Future Years

Population	2011	2021	2031	2011 to 2021	2011 to 2031
Birmingham	1,003,390	1,040,277	1,072,127	4%	7%
Coventry	307,353	335,520	363,901	9%	18%
Dudley	307,403	320,126	330,009	4%	7%
Sandwell	291,874	324,311	355,826	11%	22%
Solihull	204,745	212,773	221,171	4%	8%
Walsall	256,655	265,441	274,233	3%	7%
Wolverhampton	239,172	250,106	260,262	5%	9%
Rest of FMA	1,623,192	1,702,692	1,778,679	5%	10%

Population	2011	2021	2031	2011 to 2021	2011 to 2031
Rest of WM	1,161,392	1,227,599	1,285,853	6%	11%
Rest of UK	54,284,310	58,066,893	61,450,201	7%	13%

Source: Mott MacDonald

2.1.6.2 Zonal Targets

Zonal targets have been derived through simply uplifting the data so that the total population in each zone matches the population totals calculated above whilst retaining the zonal characteristics, currently based on the 2001 Census.

2.1.6.3 Employment

Future growth in employment for 2021 and 2031 used policy documents available at the time to identify zones where low, medium and high job growth is expected. Ratios are applied accordingly and totals are constrained to NTEM 6.2 totals.

Table 2.3 presents the base and future year employment totals by area. In most WMMA districts the growth in employment is forecast to be roughly 5-9% by 2021 and 11-16% by 2031. The exception is Dudley where employment growth is forecast to be below average; 2% and 5% by 2021 and 2031.

Table 2.3: PRISM Total Employment by District for Base and Future Years

Employment	2011	2021	2031	2011 to 2021	2011 to 2031
Birmingham	447,179	482,008	519,386	8%	16%
Coventry	146,568	153,223	162,786	5%	11%
Dudley	118,937	121,817	124,896	2%	5%
Sandwell	125,738	133,765	145,054	6%	15%
Solihull	107,590	115,768	122,387	8%	14%
Walsall	106,082	115,369	123,574	9%	16%
Wolverhampton	110,005	116,655	123,622	6%	12%
Rest of FMA	843,197	869,997	891,297	3%	6%
Rest of WM	542,091	553,032	564,755	2%	4%
Rest of UK	27,283,308	28,914,656	29,813,166	6%	9%

Source: Mott MacDonald

2.1.6.4 Enrolments

Future growth in enrolments is based directly on the population growth within the individual zones.

2.1.7 Freight Demand Matrices

The PRISM Demand Model does not calculate forecasts for freight and therefore future growth in freight demand must come from an external source. A single factor has been applied to the base year freight matrices to forecast to 2021 and 2031, derived from DfT's Road Traffic Forecasts 2013. The following factors have been used:

- LGV: 23.5% to 2021 and 54.0% to 2031
- HGV: 2.1% to 2021 and 11.9% to 2031

2.1.8 External Car Matrices

The PRISM Demand Model forecasts the travel demand of the West Midlands population and therefore does not produce forecasts of external-to-external movements. A single factor is applied to all such movements by time period based on DfT's Road Traffic Forecasts 2013 (kilometrage forecasts for cars on motorways in the West Midlands). The following factors have been used:

- 15.9% by 2021
- 33.3% by 2031

2.2 Forecast

2.2.1 Travel Patterns

The PRISM VDM has been run using the above assumptions for 2021 and 2031 and the HAM and PTAMs as described in the proceeding chapters. The following analyses describe the key forecast changes in travel patterns of the West Midlands population.

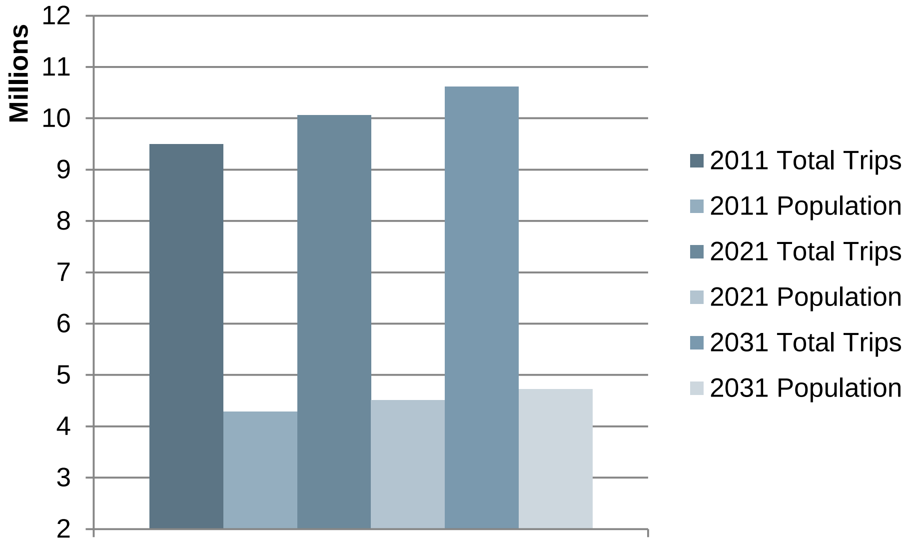
Analysis of the PRISM VD can be made at two levels:

- **Assignment Model**: demand matrices for the assignment models have been pivoted using the synthetic matrices output from the PRISM Demand Model. It is theses matrices that are assigned to the network models and used for further network analyses. This level analysis is presented in the subsequent Highway and Public Transport chapters
- **Demand Model**: the PRISM Demand Model produces forecasts of travel demand in the FMA that are a purely mathematical representation based on the travel behaviour of the 2011 Household Travel Survey and the land use and network data output from a converged Variable Demand Model run. This level of analysis is presented in this chapter.

2.2.1.1 Total trip making

The first stage of the PRISM Demand Model is to estimate segmentation and total trip making of the population within the FMA. Figure 2.2 shows that trip making is forecast to grow in line with population by roughly 0.5 million trips (5%) every 10 years.

Figure 2.2: Total Trip Making and Population as Forecast by the PRISM Demand Model



Source: Mott MacDonald

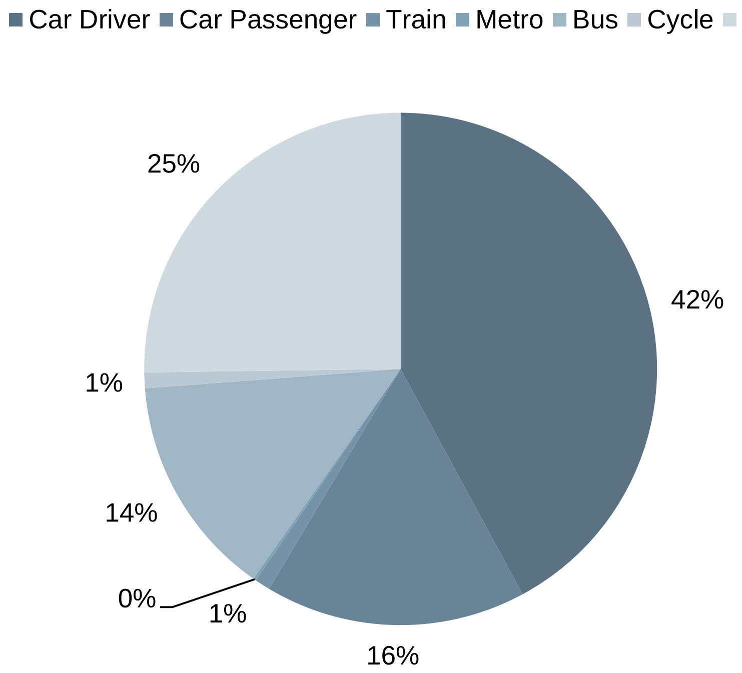
The overall mode and purpose shares are forecast to be fairly stable over time as shown in Table 2.4. The 2011 mode shares are visualised in Figure 2.3 and show that the majority of the population are forecast to drive or be driven by car (58%). Train and metro account for a tiny percentage of the overall mode share with bus accounting for 14%, cycle 1% and walking 25%. Over time the car share increases slightly accompanied by a small reduction in the share of bus.

Table 2.4: PRISM Demand Model Forecast Mode Shares

	Car Driver	Car Passenger	Train	Metro	Bus	Cycle	Walk
2011	42%	16%	1%	0%	14%	1%	25%
2021	44%	17%	1%	0%	12%	1%	24%
2031	45%	17%	1%	0%	11%	1%	24%

Source: Mott MacDonald

Figure 2.3: 2011 Total Trip Making and Population as Forecast by the PRISM Demand Model



Source: Mott MacDonald

The 2011 purpose splits are visualised in Figure 2.4 and show that 28% of travel is forecast to be for commuting purposes, 14% for shopping and 21% is non-home-based. The purpose splits are forecast to be very stable over time with a slight decrease (1%) in the share of shopping trips and a similar increase in escorting others.

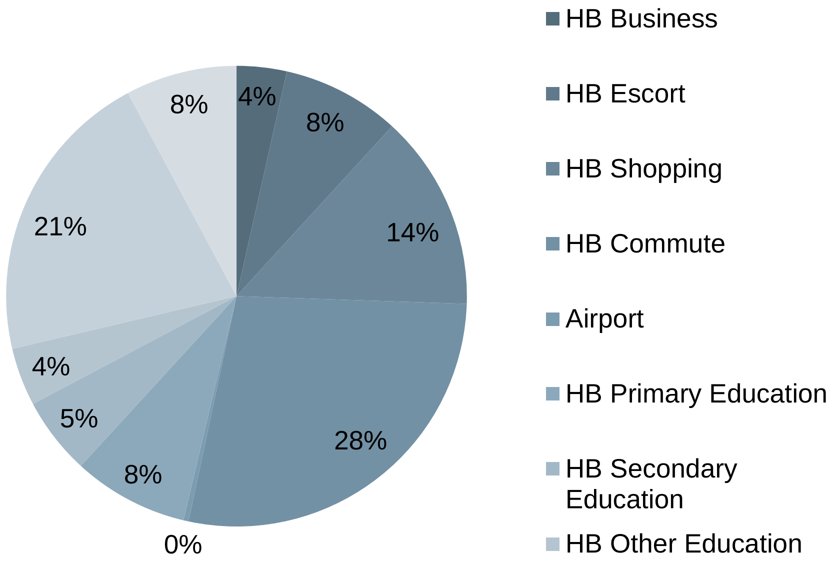
Table 2.5: PRISM Demand Model Forecast Purpose Splits

	2011	2021	2031
HB Business	4%	4%	4%
HB Escort	8%	9%	9%
HB Shopping	14%	13%	13%
HB Commute	28%	28%	27%
Airport (Business)	0%	0%	0%
Airport (Leisure)	0%	0%	1%
HB Primary Education	8%	8%	8%
HB Secondary Education	5%	5%	5%
HB Other Education	4%	4%	4%
NHB Other-Other	0%	0%	0%
NHB Other-Other Detour	4%	4%	4%

	2011	2021	2031
NHB Work-Other	1%	1%	1%
NHB Work-Other Detour	2%	2%	2%
NHB Work-Work	0%	0%	0%
NHB Work-Work Detour	0%	0%	0%
HB Other	21%	21%	21%

Source: Mott MacDonald

Figure 2.4: 2011 Total Trip Making and Population as Forecast by the PRISM Demand Model

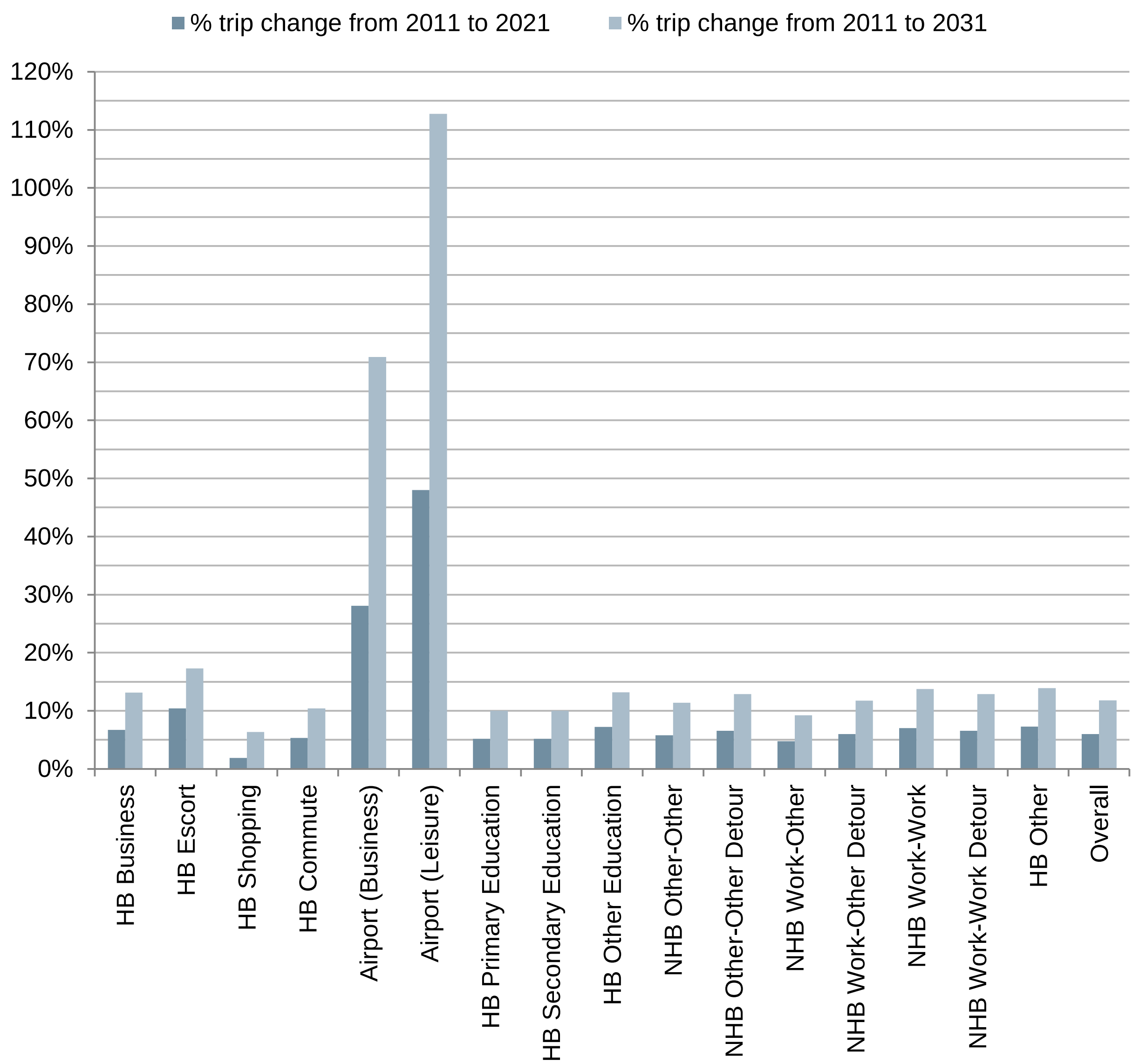


Source: Mott MacDonald

Growth forecast by purpose is shown in Figure 2.5 where as expected, growth is around 5% to 2021 and 10% to 2031 in the majority of cases. Variations of note include:

- Home-based escort travel is forecast to grow faster at 10% by 2021 and 17% by 2031
- Home-based shopping is forecast to grow slower at 2% by 2021 and 7% by 2031
- Growth in airport demand is driven by the external forecasts as discussed in 2.1.5.

Figure 2.5: Growth in demand by purpose as forecast by the PRISM Demand Model



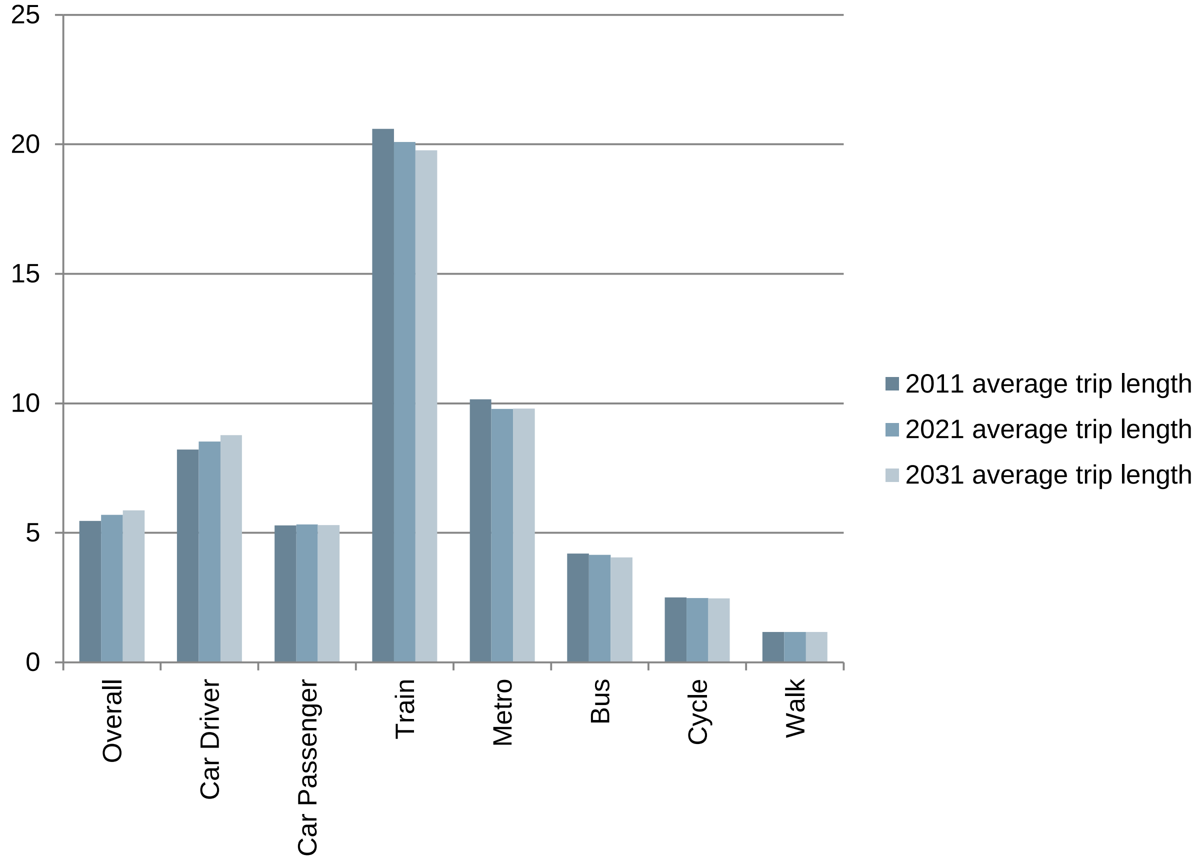
Source: Mott MacDonald

2.2.1.2 Average Trip Lengths

The PRISM Travel Demand model uses journey distances provided by the HAM and PTAMs which allows us to calculate total kilometrage and therefore average trips lengths. Figure 2.6 shows the average trip length over the whole population within the FMA by mode.

Trip lengths are forecast to be fairly stable, on average, over time, with train journeys being the longest – roughly double the length of metro and four times as long as car driver trips. Over all modes, the average trip length is forecast to increase slightly from 5.5 km in 2011 to 5.7km in 2021 and 5.9km in 2031. A similar pattern is forecast for car driver trips whereas train, metro and bus journeys are actually forecast to shorten in length over time.

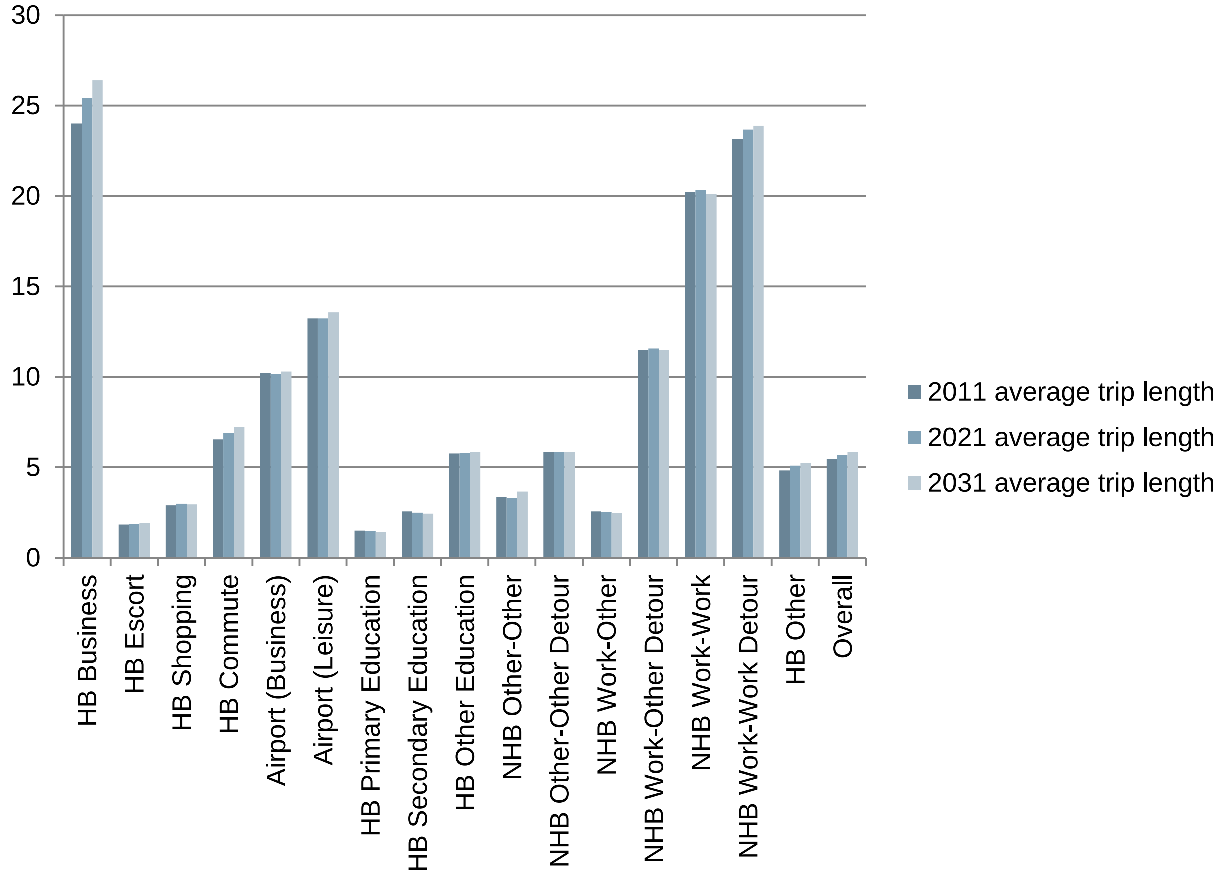
Figure 2.6: Average Trip Lengths by Mode as Forecast by the PRISM Demand Model



Source: Mott MacDonald

Figure 2.7 shows average trip lengths by journey purpose. Business journeys are the longest on average and forecast to increase over time. Trips to the airport are on average half as long as business trips with commute trips on average around 7km and also forecast to increase over time.

Figure 2.7: Average Trip Lengths by Purpose as Forecast by the PRISM Demand Model



Source: Mott MacDonald

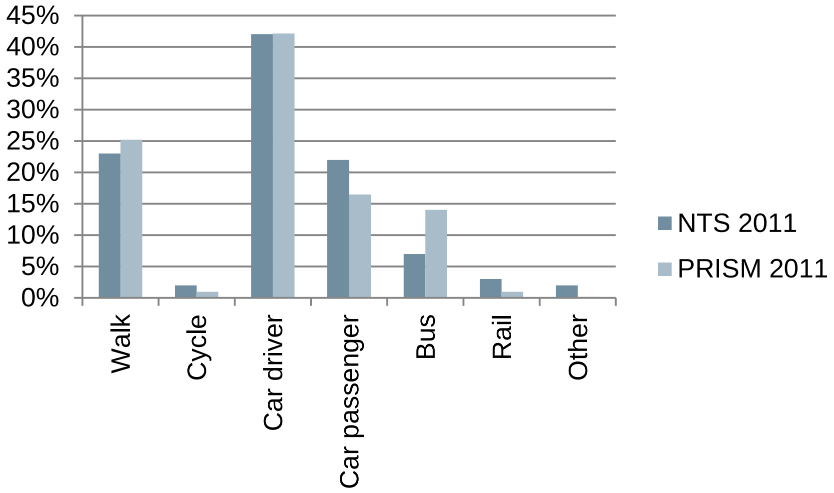
2.2.2 Benchmarking

Overall trip making and trip lengths forecast by the PRISM VDM have been presented in the previous section. The model is now benchmarked against the National Travel Survey (NTS) and National Trip End Model (NTEM). NTS allows us to see how well the demand model replicates national survey data whilst NTEM allows us to compare the model forecasts in 2021 and 2031 against the national model.

2.2.2.1 PRISM 2011 versus NTS 2012

The comparison in Figure 2.8 shows that the PRISM Demand Model forecasts mode shares at an overall level very close to those observed in the 2011 National Travel Survey. The previous sections have shown that mode shares are stable between 2011 and the future years suggesting PRISM is robust in this sense.

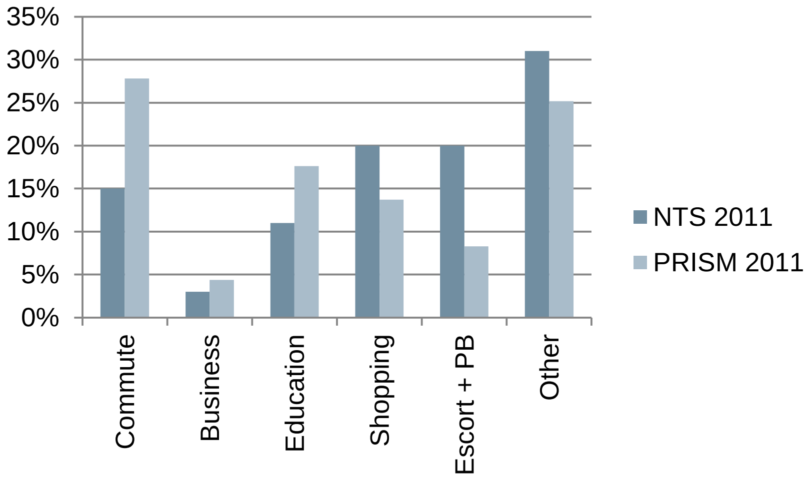
Figure 2.8: Mode Share Comparison between the 2011 PRISM Demand Model and 2011 NTS



Source: Mott MacDonald

A comparison of journey purpose splits is shown in Figure 2.9. Compared to the 2011 NTS, PRISM forecasts a larger percentage of journeys to be commutes than the national average which is likely to be due to the nature of the FMA which contains a densely urban area with a high proportion of workers. Other differences can be explained due to the urban nature of the FMA and PRISM not having separate forecasts for 'personal business (PB)' and escort-education.

Figure 2.9: Mode Share Comparison between the 2011 PRISM Demand Model and 2011 NTS



Source: Mott MacDonald

2.2.2.2 PRISM 2021 and 2031 versus NTEM 6.2

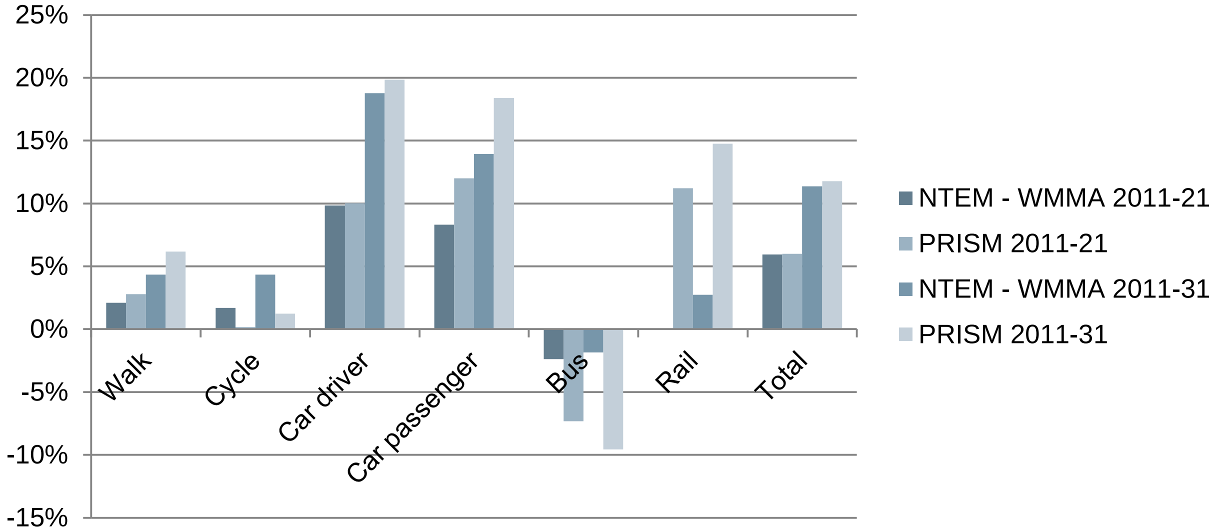
NTEM 6.2 is used to benchmark the PRISM Demand Model forecasts to 2021 and 2031, having compared the 2011 'forecast' against real survey data. NTEM is itself only a forecast and the base year is older than that of PRISM. We would expect that overall trends are similar between the models but that local variation would be apparent in the PRISM forecast.

Figure 2.10 gives the change in trips by mode forecast by NTEM and the PRISM Demand Model. The NTEM data has been extracted for the West Midlands Metropolitan Area which corresponds to the PRISM Area of Detailed Modelling and sits within the FMA.

This comparison shows that the overall growth in trips is almost identical, at 6% to 2021 and 11% to 2031. Other trends are similar such as growth in walk and car trips and a reduction in bus trips. There are some differences:

- PRISM forecast growth in car passenger trips is around 4% greater
- PRISM forecasts a much stronger reduction in bus trips at around 7-10% rather than 2%
- PRISM forecasts growth in rail trips of around 10-15% whereas NTEM forecasts very little growth at all

Figure 2.10: Total trips in the West Midlands



Source: Mott MacDonald

In conclusion, the PRISM Demand Model compares very well to national survey data and models suggesting the forecasts are robust at an aggregate level.

2.2.3 Convergence

The measure of convergence for a VDM is the demand-supply gap as defined in WebTAG Unit 3.10.14:

Figure 2.11: The Demand-Supply Gap Calculation

$$\frac{\sum_{ijctm} C(X_{ijctm})\left|D(C(X_{ijctm})) - X_{ijctm}\right|}{\sum_{ijctm} C(X_{ijctm})X_{ijctm}} * 100$$

Where;

X_{ijctm} is the current flow vector or matrix from the model

$C(X_{ijctm})$ is the generalised cost vector or matrix obtained by assigning that matrix

$D(C(X_{ijctm}))$ is the flow vector or matrix output by the demand model, using the costs $C(X_{ijctm})$ as input

$ijctm$ represents origin i, destination j, demand segment/user class c, time period t and mode m

Source: WebTAG Unit 3.10.14, April 2011

WebTAG states that tests indicate gap values of less than 0.1% can be achieved in many cases, although in more problematic systems this may be nearer to 0.2%. The gap values achieved in the PRISM VDM forecasts for 2021 and 2031 were **0.12%** and **0.17%** respectively. This is as a very good result given that PRISM is one of the largest models in the world to have included detailed junction modelling.

3 Highway

3.1 Development

3.1.1 Overview

The PRISM Highway Assignment Models (HAMs) are a key input to the PRISM VDM. They provide an initial estimate of forecast year highway travel costs through an assignment of the base year matrices which are then iteratively refined using forecast year demand matrices output from the PRISM Demand Model.

To provide accurate estimates of future year travel costs it is essential to identify expected changes to the highway network between the base and future years. The other necessary change to the HAMs is to update the generalised cost formulation to reflect real changes in value of time and vehicle operating costs.

3.1.2 Future Year Schemes

The future year PRISM HAMs were built to include committed developments and other network commitments in the West Midlands area in addition to the base year 2011 network. As recommended in WebTAG Unit 3.15.5 (April 2011), only planned proposals are included and speculative proposals are not. This is to ensure that the Reference scenario will "represent the outcome that appears most likely given published plans".

The schemes included in the PRISM Reference Case are shown in Table 3.1 below.

Table 3.1: Network Commitments in the West Midlands Area Assumed in the PRISM Reference Forecasts

Scheme	Area
Aston Hall Road/Lichfield Road	Birmingham
Chester Road	Birmingham
Churchbridge Cannock Island	Birmingham
Hard Shoulder Running M5 Junction 4a-6	Birmingham
Hard Shoulder Running M6 Junction 10a-13	Birmingham
Hard Shoulder Running M6 Junction 2-4	Birmingham
Hard Shoulder Running M6 Junction 5 to 8	Birmingham
Highgate Road/Stratford Road Junction	Birmingham
Selly Oak Phase 1B	Birmingham
Metro (extension to New Street)	Birmingham
Birmingham City Centre Interchange – various road network changes	Birmingham
Albert Street Closure - closed between Curzon Street and Masshouse Lane	Birmingham
Paradise Circus	Birmingham
Metro to Centenary Square LTB	Birmingham
Ashted Circus - Pinch Point Scheme	Birmingham
Curzon Circle - Pinch Point Scheme	Birmingham

Scheme	Area
Holloway Circus - Pinch Point Scheme	Birmingham
Bordesley Circus - Pinch Point Scheme	Birmingham
Haden Circus - Pinch Point Scheme	Birmingham
Jennens Road/Cardigan Street New Signalised junction	Birmingham
A444 Whitley Interchange / Leaf Lane	Coventry
A45/A46 Tollbar End	Coventry
A46/A428 junction signalisation	Coventry
A4600 Congestion Reduction Scheme	Coventry
City Centre Public Realm Schemes Phase 1	Coventry
City Centre Public Realm Schemes Phase 2	Coventry
Friargate Bridge (Ring Road J6)	Coventry
Gateway Mitigation Schemes (including BRT)	Coventry
High Street, Pensnett	Dudley
A5 / A5148 - pinch point scheme	HA
M42 J6 - pinch point scheme	HA
M5 J2 - pinch point scheme	HA
M5 J4 - pinch point scheme	HA
M6 J6 Salford Circus - pinch point scheme	HA
Signal Junction - C0513 Horseley Heath/Horseley Road	Sandwell
A41 Expressway	Sandwell
A45 Bridge Maintenance scheme	Solihull
Chester Road / Dunster Road	Solihull
Signal Junction - Solihull Bypass / Hampton Lane / Marsh Lane / Yew Tree Lane	Solihull
A34 Stratford Road / Haslucks Green junction	Solihull
A45 Diversion	Solihull
Darlaston Strategic Development Area (DSDA) - Bentley Mill Way	Walsall
DSDA - Bentley Road South	Walsall
DSDA - Bescott Road/Wallows Road Junction	Walsall
DSDA - Brown Lion Junction	Walsall
Speed Limits – 30mph – Wolverhampton Road/Sutton Road	Walsall
Sutton Road/The Crescent	Walsall
City Centre Public Realm	Wolverhampton
Patshull Avenue / Wobaston Road	Wolverhampton
Vine Island (A449 / Wobaston Road) roundabout	Wolverhampton
i54 Transport Strategy	Wolverhampton

Source: Mott MacDonald

3.1.3 Generalised Cost Formulation

Generalised cost refers to both the monetary (i.e. fuel cost, vehicle operating cost) and non-monetary (i.e. travelling time) costs of a journey. Generalised cost parameters are input as a series of values individual to each user-class. Monetary values are input to VISUM as pence per metre and non-monetary are input as pence per second. These costs interact to affect route choice. If time is highly valued and distance is not valued at all, the quickest journey will be chosen, no matter how long the distance. Similarly, if distance is highly valued and time not at all, the shortest distance will be chosen.

Generalised cost values were calculated based on the latest vehicle operating costs, values of time and user class splits as outlined within WebTAG Unit 3.5.6 (October 2012). The resulting parameter values can be found in Table 3.2 below.

Table 3.2: Value of time (per second) and vehicle operating costs (per metre) for the 2021 and 2031 PRISM HAMs

		Pence per Second			Pence per Metre		
		AM	IP	PM	AM	IP	PM
2021	Car Work	1.0687	1.0466	1.0296	0.0167	0.0170	0.0170
2021	Car Non-Work	0.2515	0.2912	0.2553	0.0079	0.0080	0.0080
2021	LGV	0.4299	0.4299	0.4299	0.0182	0.0184	0.0184
2021	HGV	0.7166	0.7166	0.7166	0.0792	0.0807	0.0806
2031	Car Work	1.2743	1.2500	1.2280	0.0154	0.0156	0.0156
2031	Car Non-Work	0.2869	0.3292	0.2919	0.0064	0.0065	0.0065
2031	LGV	0.5158	0.5158	0.5158	0.0173	0.0175	0.0175
2031	HGV	0.8596	0.8596	0.8596	0.0824	0.0840	0.0838

Source: Mott MacDonald

3.2 Forecast

3.2.1 Convergence

The highway assignment models use a procedure that includes an equilibrium assignment with blocking back and Intersection Capacity Analysis (ICA). Measures of convergence monitored during assignment are provided in Table 3.3.

Table 3.3: Highway assignment convergence criteria

	Description	Acceptability guideline
1	The final delays of the equilibrium assignment and those obtained from running ICA are close, i.e. ICA produces delays that are consistent with the assignment result	More than 90% of turns have a relative difference in delay less than 5%
2	The turn volumes from the last equilibrium assignment are close to the smoothed volumes	More than 95% of turns have a GEH less than 1
3	The turn volumes from the last equilibrium assignment are close to those from the previous assignment	More than 95% of turns have a GEH less than 2
4	The difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as the percentage of the minimum costs	Less than 0.1% or at least stable with convergence fully documented and all other criteria met

The convergence criteria are summarised below for four consecutive iterations:

1. The final delays of the equilibrium assignment and those obtained from running ICA are close, i.e. ICA produces delays that are consistent with the assignment result.
2. The turn volumes from the last equilibrium assignment are close to the smoothed volumes.
3. The turn volumes from the last equilibrium assignment are close to those from the previous assignment.

Table 3.3: 2021 Assignment Convergence Criteria.

		Criteria					
		1		2		3	
Time period	Number of iterations	Target	Achieved	Target	Achieved	Target	Achieved
AM	14	90%	98%	95%	100%	95%	99%
IP	14	90%	99%	95%	100%	95%	100%
PM	14	90%	97%	95%	100%	95%	99%
AM	15	90%	98%	95%	100%	95%	100%
IP	15	90%	99%	95%	100%	95%	100%

PM	15	90%	98%	95%	100%	95%	99%
AM	16	90%	99%	95%	100%	95%	100%
IP	16	90%	99%	95%	100%	95%	100%
PM	16	90%	98%	95%	100%	95%	99%
AM	17	90%	99%	95%	100%	95%	100%
IP	17	90%	99%	95%	100%	95%	100%
PM	17	90%	98%	95%	100%	95%	100%

Error! Reference source not found.3.4 summarises %GAP (Criterion 4) for the last four iterations of the assignment and three time periods.

Table 3.4: 2021 %GAP

Time Period	Number of Iterations	Target	Achieved (Car Work)	Achieved (Car Non-Work)	Achieved (HGV)	Achieved (LGV)
AM	14	<0.1%	0.00%	0.01%	0.00%	0.00%
IP	14	<0.1%	0.00%	0.01%	0.00%	0.00%
PM	14	<0.1%	0.00%	0.01%	0.00%	0.00%
AM	15	<0.1%	0.00%	0.01%	0.00%	0.00%
IP	15	<0.1%	0.00%	0.01%	0.00%	0.00%
PM	15	<0.1%	0.00%	0.01%	0.00%	0.00%
AM	16	<0.1%	0.00%	0.01%	0.00%	0.00%
IP	16	<0.1%	0.00%	0.01%	0.00%	0.00%
PM	16	<0.1%	0.00%	0.01%	0.00%	0.00%
AM	17	<0.1%	0.00%	0.01%	0.00%	0.00%
IP	17	<0.1%	0.00%	0.01%	0.00%	0.00%
PM	17	<0.1%	0.00%	0.01%	0.00%	0.00%
0	0	<0.1%	0.00%	0.00%	0.00%	0.00%

Table 3.5: 2031 Assignment Convergence Criteria.

		Criteria					
		1		2		3	
Time period	Number of iterations	Target	Achieved	Target	Achieved	Target	Achieved
AM	14	90%	96%	95%	99%	95%	99%
IP	14	90%	99%	95%	100%	95%	99%
PM	14	90%	95%	95%	99%	95%	99%
AM	15	90%	97%	95%	99%	95%	99%
IP	15	90%	99%	95%	100%	95%	100%
PM	15	90%	96%	95%	99%	95%	98%
AM	16	90%	97%	95%	100%	95%	99%
IP	16	90%	99%	95%	100%	95%	100%
PM	16	90%	96%	95%	99%	95%	99%
AM	17	90%	97%	95%	99%	95%	98%
IP	17	90%	99%	95%	100%	95%	99%
PM	17	90%	97%	95%	100%	95%	99%

Error! Reference source not found.3.6 summarises %GAP (Criterion 4) for the last four iterations of the assignment and three time periods.

Table 3.6: 2031 %GAP

Time Period	Number of Iterations	Target	Achieved (Car Work)	Achieved (Car Non-Work)	Achieved (HGV)	Achieved (LGV)
AM	14	<0.1%	0.01%	0.03%	0.00%	0.01%
IP	14	<0.1%	0.01%	0.02%	0.00%	0.00%
PM	14	<0.1%	0.01%	0.04%	0.00%	0.01%
AM	15	<0.1%	0.01%	0.03%	0.00%	0.01%
IP	15	<0.1%	0.00%	0.02%	0.00%	0.00%
PM	15	<0.1%	0.01%	0.03%	0.00%	0.01%
AM	16	<0.1%	0.01%	0.03%	0.00%	0.01%
IP	16	<0.1%	0.01%	0.02%	0.00%	0.00%
PM	16	<0.1%	0.01%	0.03%	0.00%	0.01%
AM	17	<0.1%	0.00%	0.02%	0.00%	0.00%
IP	17	<0.1%	0.00%	0.01%	0.00%	0.00%
PM	17	<0.1%	0.01%	0.02%	0.00%	0.00%
0	0	<0.1%	0.00%	0.00%	0.00%	0.00%

3.2.2 Vital Statistics

The PRISM VDM forecast demand matrices used by the HAMs are as follows:

- **Car demand with at least one end in the FMA**: a process called pivoting has been applied which means they are the 2011 base matrices adjusted based on the change forecast by the PRISM Demand Model between 2011 and 2021/31.
- **Car demand with both ends outside the FMA**: fixed growth factors of 15.9% by 2021 and 33.3% by 2031 have been applied as described in 2.1.8.
- **LGV and HGV demand**: fixed growths factors of 23.5% and 2.1% for LGV and HGV respectively to 2021 and 54% and 11.9% to 2031 have been applied as described in 2.1.7.

As shown in Table 3.7, the overall 12 hour growth from 2011 to 2021 and 2031 is forecast to be 10% and 22% respectively. This will be due to a combination of a growth in trip making of the West Midlands population (roughly 5% and 10% to 2021 and 2031) and the growth in external and LGV/HGV trips as described above.

Table 3.7: 12 hour HAM demand for base and future years

12hr	Total	%change from 2011
2011	5,570,661	
2021	6,142,501	10%
2031	6,796,208	22%

Source: Mott MacDonald

Table 3. presents the 12 hour demand totals for each of the four HAM demand segments. The growth in LGV and HGV is as expected whilst car non-work trips are forecast to grow at a slower rate to car work trips; consistent with the PRISM Demand Model forecast where business travel is forecast to grow faster than shopping and commute which make up the majority of non-work demand.

Table 3.8: 12 hour HAM demand for base and future years by demand segment

12hr	Car non-work	Car work	LGV	HGV
2011	4,167,996	455,588	607,969	339,109
2021	4,528,181	517,249	750,841	346,230
2031	4,916,011	564,365	936,370	379,462
11to21	9%	14%	24%	2%
11to31	18%	24%	54%	12%

Source: Mott MacDonald

Table 3. presents the average hour demand totals by time period and year. The forecast growth is similar for the two peak periods whilst the inter-peak demand is forecast to grow at a slightly slower rate. This may be a result of the slightly slower growth in shopping demand seen in the PRISM Demand Model and also the difference in demand segment composition by time period.

Table 3.9: Average hour HAM demand for base and future year by time period

Av Hr	AM	IP	PM
2011	479,257	429,368	513,232
2021	534,424	470,009	567,540
2031	592,067	520,954	625,805
11to21	12%	9%	11%
11to31	24%	21%	22%

Source: Mott MacDonald

Table 3. to d

Table 3.2 show the forecast growth in demand by purpose and time period. For LGV and HGV the growth is straightforward given the nature of the forecast. For the car demand segments the following points are worthy of note:

- Growth in non-work demand is forecast to be consistent across time periods at 8-9% by 2021 and 17-19% by 2031
- Growth in car work demand is forecast to be stronger in the AM than the other two periods suggesting that car journey time is forecast to increase faster in the IP and PM than the AM (Table 3.2 in 3.1.3 show that delays in the AM period do appear to increase at a lower rate than the PM)

Table 3.10: AM average hour HAM demand for base and future year by demand segment

Av Hr	Car non-work	Car work	LGV	HGV
2011	365,617	27,942	59,425	26,273
2021	399,997	34,213	73,389	26,825
2031	433,658	37,456	91,553	29,400
11to21	9%	22%	23%	2%
11to31	19%	34%	54%	12%

Source: Mott MacDonald

Table 3.11: IP average hour HAM demand for base and future year by demand segment

Av Hr	Car non-work	Car work	LGV	HGV
2011	305,580	41,715	47,481	34,591
2021	329,659	46,392	58,639	35,318
2031	358,614	50,511	73,121	38,708
11to21	8%	11%	24%	2%

Av Hr	Car non-work	Car work	LGV	HGV
11to31	17%	21%	54%	12%

Source: Mott MacDonald

Table 3.12: PM average hour HAM demand for base and future year by demand segment

Av Hr	Car non-work	Car work	LGV	HGV
2011	405,849	38,698	49,863	18,822
2021	442,924	43,817	61,581	19,217
2031	480,051	47,903	76,789	21,062
11to21	9%	13%	24%	2%
11to31	18%	24%	54%	12%

Source: Mott MacDonald

The final matrix level analysis is made by looking at the forecast growth in origin and destination trips by districts as shown in Table 3.13: 12-hour trips originating in each district for the base and future years13 and d

Table 3.4. The overall level of growth is again as expected with some variation across districts. Points worthy of note include:

- Growth within the FMA is forecast to be less than outside due to the differences in the approach to calculating growth
- Trips to and from Coventry and Sandwell are forecast to grow at a slightly faster rate than elsewhere in the WMMA, consistent with the above average population growth discussed in 2.1.6.1.
- 12-hour demand is forecast to grow faster than population which could be due to the following:
- a slight increase in the PRISM Demand Model car mode share as shown in Table 2.4
- larger growth factors used for LGV, HGV and external car demand

Table 3.13: 12-hour trips originating in each district for the base and future years

District	2011	2021	2031	11to21	11to31
Birmingham	301,756	331,981	363,205	10%	20%
Coventry	114,783	129,201	144,356	13%	26%
Dudley	108,624	117,105	126,488	8%	16%

District	2011	2021	2031	11to21	11to31
Sandwell	97,756	111,014	126,123	14%	29%
Solihull	76,409	84,144	93,098	10%	22%
Walsall	86,976	95,192	103,940	9%	20%
Wolverhampton	78,245	85,203	93,124	9%	19%
Intermediate	439,399	479,330	525,548	9%	20%
External	78,393	92,195	108,936	18%	39%
Ext_WM_Region	39,515	46,608	54,008	18%	37%

Source: Mott MacDonald

Table 3.14: 12-hour trips destined to each district for the base and future years

District	2011	2021	2031	11to21	11to31
Birmingham	301,332	331,737	363,335	10%	21%
Coventry	117,648	132,063	147,483	12%	25%
Dudley	107,717	116,539	126,019	8%	17%
Sandwell	98,702	111,993	126,987	13%	29%
Solihull	76,534	84,574	93,496	11%	22%
Walsall	85,558	93,986	102,904	10%	20%
Wolverhampton	79,593	86,839	95,107	9%	19%
Intermediate	432,253	471,482	517,009	9%	20%
External	81,024	95,288	112,347	18%	39%
Ext_WM_Region	41,496	47,471	54,138	14%	30%

Source: Mott MacDonald

3.2.3 Assignments

The analyses presented here come from the final assignments output from the converged future year VDMs.

3.2.3.1 Traffic Flows

It is now known that the PRISM HAM forecast growth in traffic is roughly 10% by 2021 and 20% by 2031 with slightly higher growth in Sandwell and Coventry and for trips outside the WMMA. Table 3.5 and Table 3.6 present the growth in total kilometrage which has been calculated by summing the vehicle kilometrage over all links in the model.

Table 3.15: Growth in vehicle kilometrage from 2011 to 2021 by demand segment

2011-21	Car work	Car non work	LGV	HGV	Total
AM	4%	19%	24%	2%	15%
IP	-2%	24%	24%	2%	14%
PM	1%	22%	24%	2%	16%

Source: Mott MacDonald

Table 3.16: Growth in vehicle kilometrage from 2011 to 2031 by demand segment

2011-31	Car work	Car non work	LGV	HGV	Total
AM	17%	35%	55%	13%	33%
IP	10%	42%	55%	13%	31%
PM	15%	39%	55%	12%	33%

Source: Mott MacDonald

Overall kilometrage is forecast to grow slightly faster than demand, suggesting users are willing to travel further which may be a result of increases in VOT. The growth varies by demand segment:

- LGV and HGV kilometrage is forecast to grow at the same rate as demand
- Car work kilometrage is forecast to grow at a slower rate than demand
- Car non-work kilometrage is forecast to grow at a faster rate than demand

The local area flow plots shown in Appendix xx show that traffic growth is fairly well distributed across the network.

3.2.3.2 Delays

The logical conclusion for having a growth in traffic over time would be for the delays in the HAM to increase accordingly. Table 3.7 and Table 3.18 below present the overall matrix-level change in travel time calculated using the TUBA-standard rule-of-half. In this case, the calculation for each origin-destination pair is to take the change in journey time and multiply this by the average demand between the base and future year.

Table 3.17: Total increase in vehicle hours travelled between 2011 and 2021

2021 increases in vehicle hours	Car work	Car non work	LGV	HGV	*Share of average hour demand*	*Average share of impact*
AM	409	2,747	494	133	*32%*	*35%*
IP	471	1,377	370	124	*31%*	*22%*
PM	638	3,366	490	109	*37%*	*43%*
Share of average hour demand	*8%*	*78%*	*9%*	*6%*		
Average share of impact	*14%*	*70%*	*13%*	*3%*		

Source: Mott MacDonald

Table 3.18: Total increase in vehicle hours travelled between 2011 and 2031

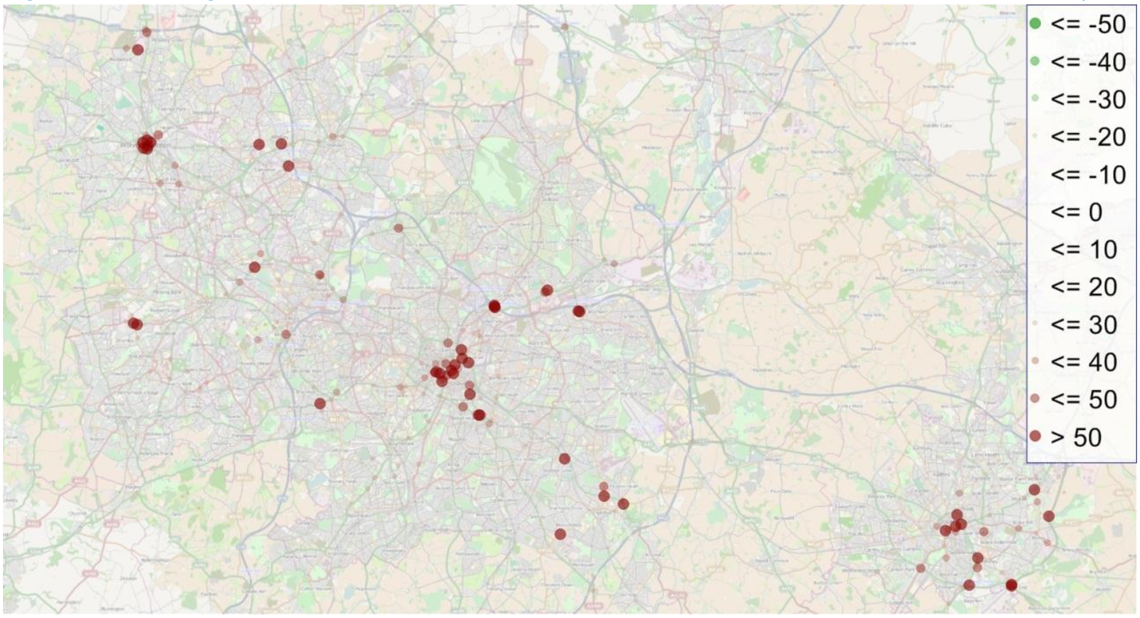
2031 increases in vehicle hours	Car work	Car non work	LGV	HGV	*Share of average hour demand*	*Average share of impact*
AM	948	6,700	1,511	496	*33%*	*35%*
IP	1,182	3,583	903	348	*31%*	*22%*
PM	1,565	8,522	1,359	362	*36%*	*43%*
Share of average hour demand	*7%*	*76%*	*11%*	*6%*		
Average share of impact	*13%*	*68%*	*14%*	*4%*		

Source: Mott MacDonald

As would be expected, journey times increase on average over time and the tables show that the impact is consistent with the level of demand across time periods and demand segments. We may expect for the impact on journey times to be roughly double in 2031 compared to 2021 and this is indeed shown in the tables above. The evidence suggests that the model is very stable across time periods and demand segments in terms of an overall increase in journey times over time.

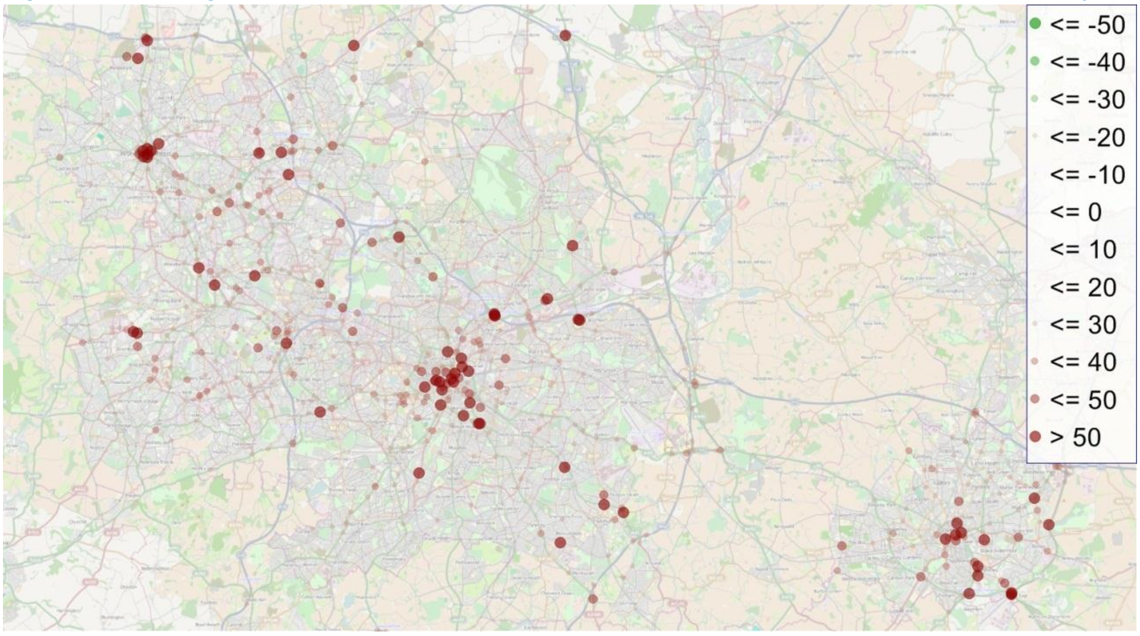
Figure 3.1 to Figure 3.6 below show, for each node the change in the maximum ratio-of-flow-to-capacity (RFC) over all turns through that node, between the base and future years. The plots have been extracted with the blocking back model turned off which means that turns are allowed to go over capacity and links have their volume-delay-functions (VDFs) calibrated to approximate the queuing wait time that would occur if the blocking back model were to be turned on.

Figure 3.1: Change in the maximum RFC of turns for each node between 2011 and 2021 in the AM period



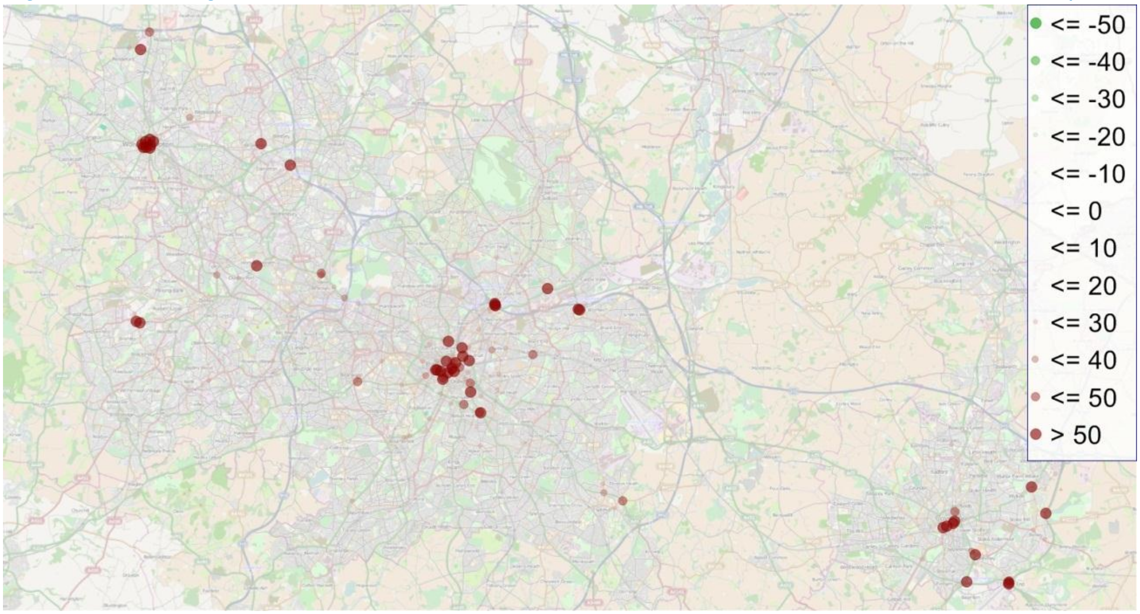
Source: Mott MacDonald

Figure 3.2: Change in the maximum RFC of turns for each node between 2011 and 2031 in the AM period



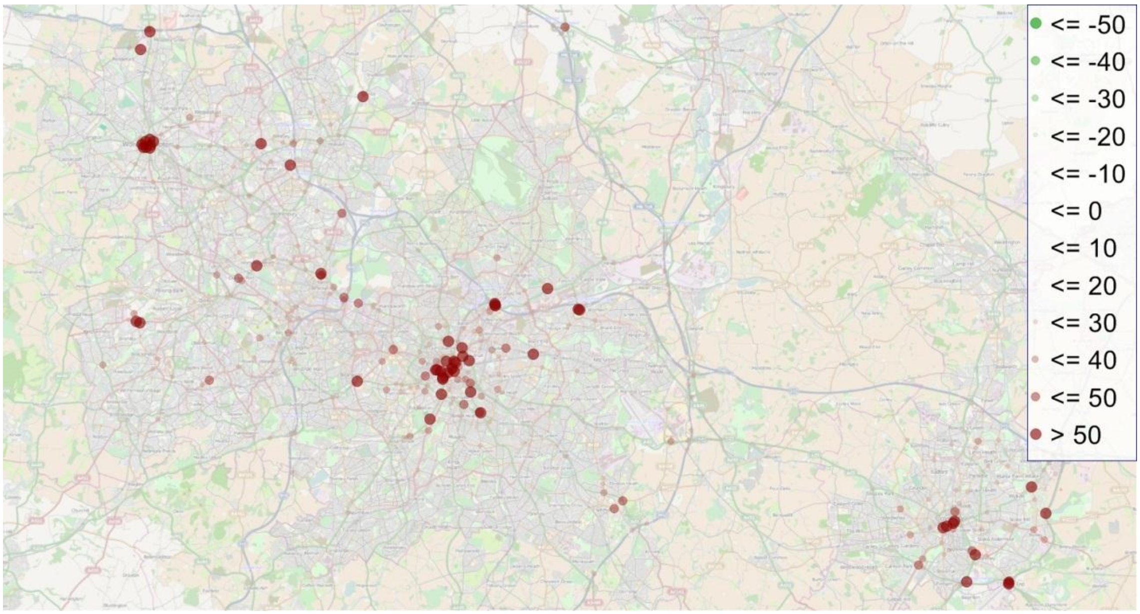
Source: Mott MacDonald

Figure 3.3: Change in the maximum RFC of turns for each node between 2011 and 2021 in the IP period



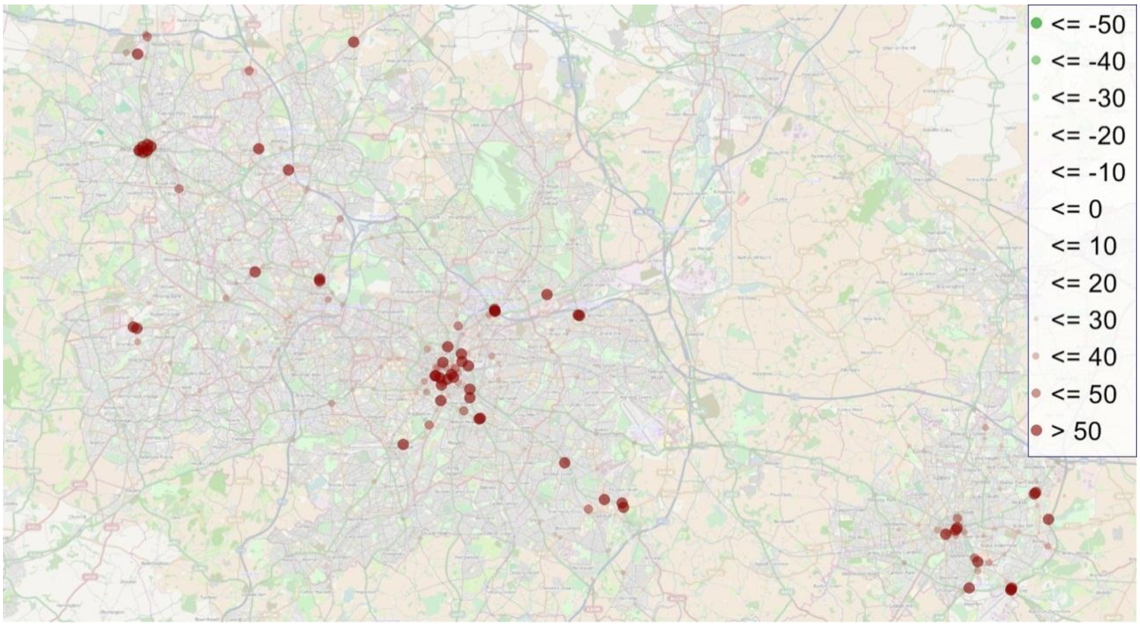
Source: Mott MacDonald

Figure 3.4: Change in the maximum RFC of turns for each node between 2011 and 2031 in the IP period



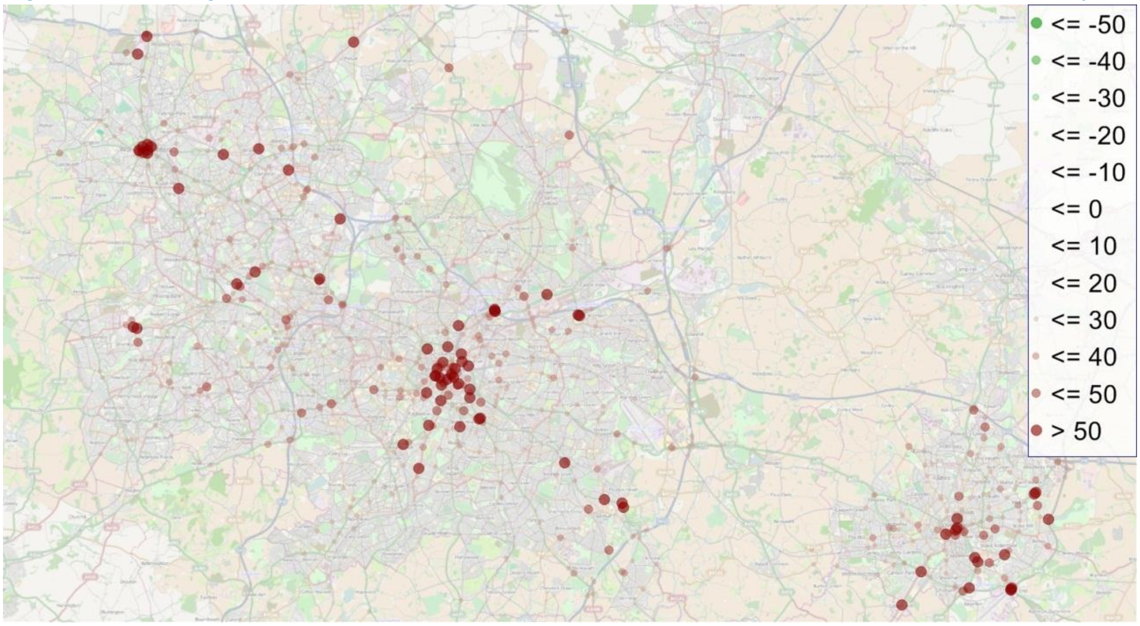
Source: Mott MacDonald

Figure 3.5: Change in the maximum RFC of turns for each node between 2011 and 2021 in the PM period



Source: Mott MacDonald

Figure 3.6: Change in the maximum RFC of turns for each node between 2011 and 2031 in the PM period



Source: Mott MacDonald

The plots show once again a high level of consistency across time periods and an expected increase in the maximum RFCs over time. The greatest increases appear concentrated in centres such as Birmingham, Coventry and Wolverhampton. The PM period appears to be the greatest affected time period, closely followed by the AM and then the IP period. This is consistent with the preceding observations.

4 Public Transport

4.1 Development

4.1.1 Overview

The PRISM base and future year Public Transport Assignment Models (PTAMs) were developed as a collaboration between Centro and Mott MacDonald. Development of the base year models is documented in the PRISM Local Model Validation Report. This chapter provides documentation of the future year network development along with the results of the 2021 and 2031 assignments using the demand forecast by the PRISM VDMs.

4.1.2 Future Year Network Development

4.1.2.1 2013 Public Transport Network

Through consultation with Centro it was determined that there were many significant changes to the bus network between the PRISM base year of 2011 and the present year of 2013. This is predominantly related to bus network reviews conducted in Birmingham, the Black Country and Coventry during this period. Analysis was undertaken to examine the differences in stops and services between the NPTDR (National Public Transport Data Repository) information used to develop the base year models (October 2011) and information related to March 2013.

This analysis showed that there was indeed a significant amount of change in the PT stops and services between 2011 and 2013 and the decision was taken to use the 2013 NTPDR information directly as the basis for developing the future year networks rather than starting with an adjustment to the 2011 models. These changes focused on the core area of the model (the Metropolitan area) where most changes had been made. The first step in developing future year PT networks was therefore to develop networks for 2013 as follows:

- Source stop and timetable information from NTPDR in ATCO-CIF format
- Liaise with PTV (developers of the VISUM software) to process the ATCO-CIF data in to a VISUM-useable format
- Filter the information to represent services for an average weekday only
- Perform an aggregation process to combine similar services and combine stops in to ‘clusters’
- Snap any new stops (new in the 2013 NTPDR compared to 2011) to the 2011 PTAM network
- Load the VISUM-useable, filtered and aggregated NTPDR data on to the network
- Check and calibrate the above step to achieve a satisfactory result

4.1.2.2 Future Year Schemes (post-2013)

As for the PRISM HAMs, the future year PTAMs have been built to include committed developments and other network commitments in the West Midlands area in addition to the above 2013 network. As recommended in WebTAG Unit 3.15.5 (April 2011), only planned proposals are included and speculative proposals are not. This is to ensure that the Reference scenario will “represent the outcome that appears most likely given published plans”.

Table 4.1: The schemes included in the PRISM Reference Case

Scheme	Area
Midland Metro extension to Stephenson Street	Birmingham
Birmingham City Centre Interchange	Birmingham
Coventry, Sandwell and Birmingham City Centre bus network reviews	Various
Coventry to Nuneaton (NUCKLE Phase 1)	Coventry
Birmingham New Street Gateway	Birmingham
One Station (New Street - Moor Street - Curzon Street link)	Birmingham
Electric Spine (Network Rail electrification)	Various
Walsall to Rugeley rail corridor electrification	Walsall
Electrification Cross City South to Redditch and Bromsgrove	Birmingham and Worcestershire
New station at Bromsgrove	Worcestershire
New station at Stratford Parkway	Warwickshire
Wolverhampton City centre public realm – bus network changes	Wolverhampton
Park and ride expansions at rail stations	Various
New rail station at Kenilworth	Warwickshire
Snow Hill Station Livery Street access	Birmingham

4.1.3 Generalised Cost Formulation

As explained in section 3.2.9 of the LMVR the base year assignment parameters have been calibrated using the prior matrix and comparing assigned flows to passenger counts. The parameters used in the base year models are presented in Table 4.2 below.

Table 4.2: 2011 base year assignment parameters

Attribute	AM / PM	IP
VOT	£2.32	£1.60
Access Time	1.75	2.5
Egress Time	1.75	2.5
Walk Time	1.75	2.5
Origin Wait Time	2	2
Transfer Wait Time	2	3
Transfer Penalty	10mins	8mins
Walk Speed	4.8kph	4.8kph
IVT Metro	0.95	0.95
IVT Rail	0.9	0.9
Fare Split	AM 27%, PM 15%	18%
Coordination	Off	Groups
Boarding Penalty Factor	1	1

There is no evidence to support adjusting any of these, other than the value of time (and therefore fare calculation). Fares are incorporated in to generalised cost through local values of time, by time period, developed by Centro. The values of time are applied to convert the fares from pence into minutes. Table 4.3 shows the values used by time period and year (assuming the value of time increases in line with real growth forecast for household GDP).

The values of time grow by XX% to 2021 and XX% to 2031, resulting in VOT's and fare in minutes as presented in Table 4.3.

Table 4.3: Values of time and minutes fare in 2021 and 2031

Year	VOT		
	AM	IP	PM
2011	2.31	1.58	2.31
2021	2.62	1.8	2.62
2031	3.03	2.07	3.03

4.2 Forecast

The PRISM PTAM zoning system is more detailed than the HAM and Demand Model zoning system, although they have been developed so that, in most cases, the PTAM zones nest within the HAM and Demand Model zones. See the PRISM LMVR for more information on how the PTAM has been integrated with the Demand Model to deal with the difference in zoning.

4.2.1 Vital Statistics

The PRISM VDM forecast demand matrices used by the HAMs are as follows:

- **Public transport demand with at least one end in the FMA**: a process called pivoting has been applied which means they are the 2011 base matrices adjusted based on the change forecast by the PRISM Demand Model between 2011 and 2021/31.
- **Public transport demand with both ends outside the FMA**: fixed growth factors of 22% by 2021 and 41% by 2031 have been applied, in line with the West Midlands RUS[1]

As shown in Table 4.4, the overall growth from 2011 to 2021 and 2031 is forecast to be 0.5% and 1.4% respectively. This is broken down by local trips (controlled by PRISM VDM in fare and no fare segments) and long distance. The table shows that the overall small net changes to the demand matrices comprise a decline in local trips (the majority of the demand) and a large increase in long distance.

[1] Network Rail (May 2011) West Midlands and Chilterns Route Utilisation Strategy

Table 4.4: PTAM demand for base and future years

	Local	Long Distance	Total	% Local change from 2011	%Long distance change from 2011
2011	360,371	56,439	416,810		
2021	350,192	68,849	419,041	-3%	22%
2031	343,158	79,574	422,732	-5%	41%

This is consistent with the outputs of the VDM model, comparing the local changes above against Figure 2.3 which shows a decrease in bus, an increase in rail resulting in an overall decline in trip making between 2011 and 2021/31. This is also consistent with ongoing trends observed over the last 40 years in the West Midlands, as presented in Figure 4.2 below. The small growth in overall demand can be explained by the increase in long distance rail travel, which is a flat rate applied to a demand segment separate to the VDM outputs.

Figure 4.2: Annual West Midlands Public Transport Demand Trends

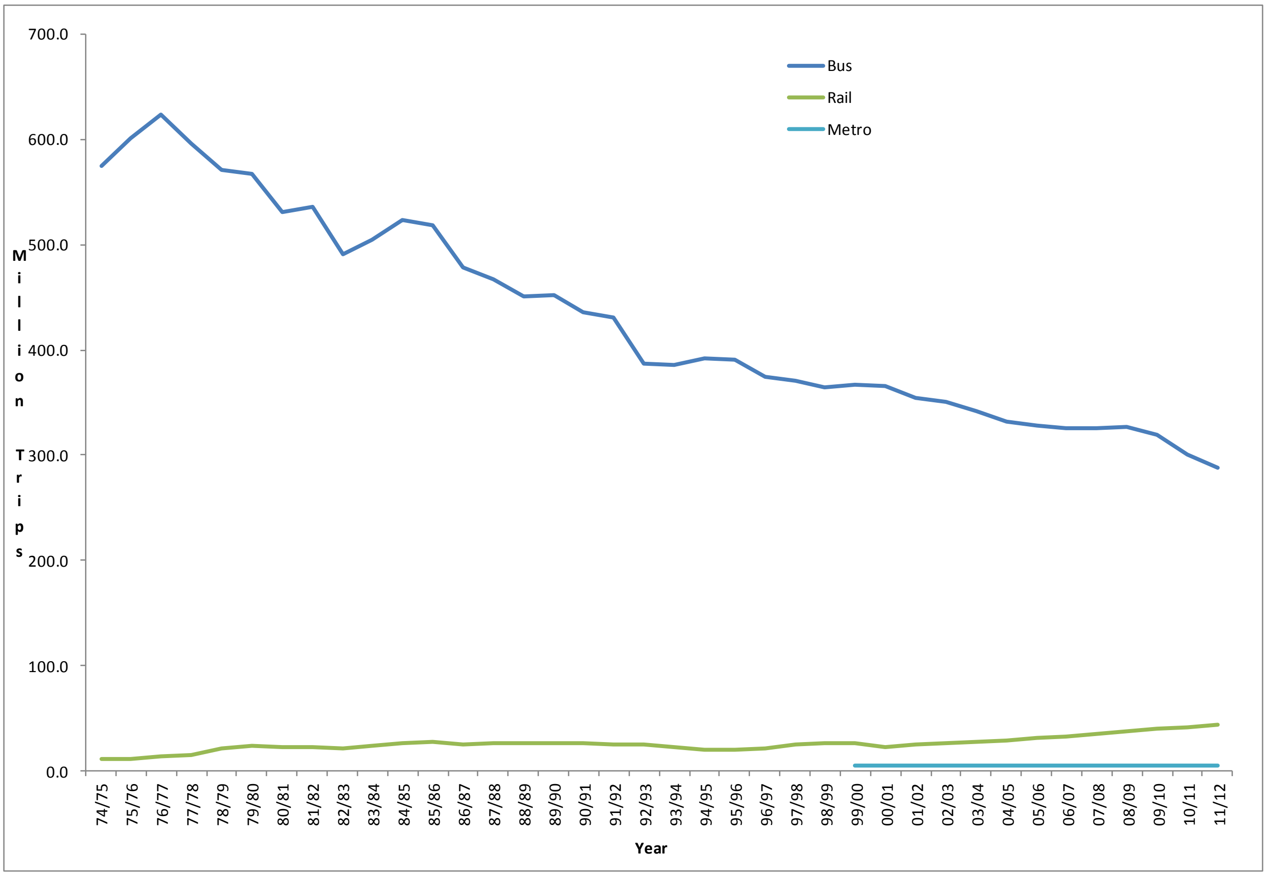


Table 4.5 presents the assigned time period matrices, which represent the three separate two hour periods modelled by demand segment.

Table 4.5 PTAM Total Assignment Period Demand Matrices

	Fare	No Fare	Long Distance	Total
2011	99,110	261,261	56,439	416,810
2021	93,976	256,216	68,849	419,041
2031	88,181	254,977	79,574	422,732
11to21	-5.2%	-1.9%	22.0%	0.5%
11to31	-11.0%	-2.4%	41.0%	1.4%

Table 4.6 shows that the overall change in matrices for the assignment period matrices is consistent with the VDM model, with 0.5% and 1.4% growth from 2011 to 21 and 31 respectively. The largest decrease in demand is observed in the fare demand segment, which is where the largest cost increase occurs as cash fares are increasing at a faster rate than season tickets. The no fare segment is expected to see a lower

rate of decline given that a significant proportion of this segment is senior citizen concessionary travel, which is free to use and with an ageing population likely to be a more stable market for travel.

Table 4.6 PTAM demand for base and future year by time period

Period	AM	IP	PM
2011	124,515	125,054	167,241
2021	128,134	121,932	168,975
2031	128,832	123,090	170,810
11to21	2.9%	-2.5%	1.0%
11to31	3.5%	-1.6%	2.1%

The growth in the AM and PM, compared to a decline in the IP period can be explained by:

- Majority of rail trips taking place in these periods for commuting, therefore the long distance growth particularly influencing this
- ......

Table 4.7 AM PTAM demand for base and future year by demand segment

Period	Fare	No Fare	Long Distance	Total
2011	27,524	83,384	13,107	124,015
2021	27,236	84,910	15,988	128,134
2031	25,668	84,685	18,479	128,832
11to21	-1.0%	1.8%	22.0%	3.3%
11to31	-6.7%	1.6%	41.0%	3.9%

Table 4.8 IP PTAM demand for base and future year by demand segment

Period	Fare	No Fare	Long Distance	Total
2011	21,053	94,687	9,314	125,054
2021	19,571	91,001	11,360	121,932
2031	18,594	91,366	13,130	123,090
11to21	-7.0%	-3.9%	22.0%	-2.5%
11to31	-11.7%	-3.5%	41.0%	-1.6%

Table 4.9 PM PTAM demand for base and future year by demand segment

Period	Fare	No Fare	Long Distance	Total
2011	50,533	82,690	34,018	167,241
2021	47,169	80,305	41,501	168,975
2031	43,919	78,926	47,965	170,810
11to21	-6.7%	-2.9%	22.0%	1.0%
11to31	-13.1%	-4.6%	41.0%	2.1%

Across the three PTAM time periods the following is noted:

- A consistent pattern in falling passenger demand from 2011 to 2021, and further decline in 2031 for trips with a trip end in the FMA (i.e. fare and no fare demand segments)
- Fare demand segment sees the most significant reduction in demand compared to no fare for all years and periods
- Overall the peak periods show growth with the IP a decline

The final matrix level analysis is made by looking at the forecast growth in origin and destination trips by districts as shown in Table 4.10 and Table 4.11. The overall level of growth is again as expected with some variation across districts. Points worthy of note include:

- Decline in passenger trips within the FMA is forecast to be less than outside due to the differences in the approach to calculating growth
- Trips to and from Coventry and Sandwell are forecast to grow whereas elsewhere in the WMMA there is a decline in passenger trips, which is consistent with the above average population growth discussed in section 2.1.6.1
- There is consistency across the districts between levels of growth / decline between 2021 and 2031, where growth / decline is continuing from 2021 in the correct direction

Table 4.10: PTAM trips originating in each district for the base and future years

District	2011	2021	2031	11to21	11to31
Birmingham	166,542	157,932	154,887	-5%	-7%
Coventry	29,729	30,961	31,542	4%	6%
Dudley	21,107	20,878	20,171	-1%	-4%
Sandwell	36,263	37,546	38,643	4%	7%
Solihull	26,374	26,202	25,979	-1%	-1%
Walsall	30,748	28,651	27,623	-7%	-10%
Wolverhampton	27,782	26,408	25,808	-5%	-7%
Intermediate	38,011	41,765	42,264	10%	11%
External	39,761	48,380	55,820	22%	40%

Table 4.11: PTAM trips destined to each district for the base and future years

District	2011	2021	2031	11to21	11to31
Birmingham	172,106	165,745	163,499	-4%	-5%
Coventry	31,060	31,913	32,432	3%	4%
Dudley	21,139	20,494	19,696	-3%	-7%
Sandwell	33,848	35,435	36,423	5%	8%
Solihull	23,176	22,871	22,711	-1%	-2%
Walsall	31,095	28,691	27,600	-8%	-11%
Wolverhampton	28,604	26,865	26,125	-6%	-9%
Intermediate	35,366	38,405	38,829	9%	10%
External	39,923	48,304	55,421	21%	39%

4.2.2 Assignments

The following sections present analysis of demand post assignment of the forecast demand matrices to the future year PTAM networks.

4.2.2.1 Mode Shares

The PTAM assigns trips to the network, with all PT modes available – bus, rail and Midland Metro.

Table 4.12 present the changes in demand from 2011 to both forecast years by PT sub mode. The key points to note are:

- Other than AM 2021 bus demand is in decline from 2011 to 2021, with further decrease to 2031, following the trend as shown in Figure 4.2 (trend chart)
- The over 100% increase in Midland Metro demand is predominantly due to the network change from base to forecast year. From 2021 onwards the Metro network is extended from its current

Birmingham terminus at Snow Hill Station, through the city centre to serve Birmingham New Street station. This direct link grows Midland Metro demand from 5M passengers per annum to in excess of 10M

- Growth in rail demand is consistent with forecasts of long term rail growth showing significant growth across all periods and forecast years

Table 4.12: Percentage change in PT Mode Share

	11 to 21			11 to 31		
	AM	IP	PM	AM	IP	PM
Bus	1%	-5%	-1%	-1%	-5%	-4%
Metro	83%	112%	102%	84%	111%	89%
Train	13%	22%	2%	21%	29%	18%

4.2.2.2 Passenger Kilometres

As shown in Table 4.13 there is a strong relationship between passenger trips and passenger kilometres, with increase in Metro and rail, and decrease in bus.

Table 4.13: Percentage change in passenger kilometres

	11 to 21			11 to 31		
	AM	IP	PM	AM	IP	PM
Bus	2%	-5%	12%	-4%	-5%	2%
Metro	46%	65%	92%	44%	67%	71%
Rail	19%	27%	19%	36%	44%	36%

4.2.2.3 Journey Times

This is a measure of average in vehicle time for each mode, time period and forecast year. As with trips and trip KM's there is a consistent pattern by mode and period. Midland Metro journey times have decreased on average due to the increase in short trips being made in the new city centre extension. Rail journey times have increase due to the increase in long distance trips in future years.

Table 4.14: Percentage change in average journey times

	11 to 21			11 to 31		
	AM	IP	PM	AM	IP	PM
Bus	0%	-3%	9%	-4%	-2%	2%
Metro	-18%	-19%	-4%	-20%	-18%	-9%
Rail	9%	1%	17%	15%	8%	15%

4.2.2.4 Trip Lengths

Similar to journey time's trip lengths have shortened on Midland Metro, due to the increase in city centre short trips related to the city centre extension. Long distance rail trip growth has led to an overall increase in rail trip lengths.

Table 4.15: Percentage change in average trip lengths by mode

	11 to 21			11 to 31		
	AM	IP	PM	AM	IP	PM
Bus	0%	-3%	9%	-4%	-2%	2%
Metro	-18%	-19%	-4%	-20%	-18%	-9%
Rail	9%	1%	17%	15%	8%	15%

4.2.3 Passenger Flows

4.2.4 Journey Times

Table 4.16 presents a comparison of modelled journey times between specific points on the network, consistent with those chosen for validation of the base year network (see LMVR section 3.6.3).

Table 4.16: Comparison of modelled journey times between specific points of network.

JOURNEY DESCRIPTION				MODELLED RESULTS									TRAVELINE WEST MIDLANDS					
Origin Zone	Destination Zone	Origin	Destination	Origin Wait time	Access time	Egress time	Walk time	Transfer wait time	In vehicle time	Journey ride time	Number transfers	**TOTAL Time**	BUS	RAIL	METRO	WALK	TWT	**TOTAL Time**
12956	21742	New Street Station	Coventry Station	9	1	8	0	0	19	37	0	28	0	20	0	6	0	**26**
12956	301	New Street Station	London Euston	21	1	12	0	0	72	106	0	85	0	73	0	10	0	**83**
71731	8557	Wolverhampton Station	Stratford Station	8	3	8	8	5	66	98	1	90	0	73	0	21	0	**94**
12956	12986	New Street Station	Edgbaston Reservoir	2	6	8	0	0	6	23	0	20	16	0	0	8	0	**24**
31612	13432	Russell's Hall Hospital	Kingstanding	4	3	5	0	7	65	85	2	81	52	0	0	23	16	**91**
8620	8566	Redditch Centre	Leamington Centre	14	12	11	8	7	59	112	1	100	124	0	0	5	5	**134**
8372	13711	Tamworth Centre	Sutton Coldfield	11	6	4	3	2	39	70	2	61	25	0	0	24	0	**49**
32122	71725	Dudley Centre	Wolverhampton Station	3	5	2	3	5	27	44	1	41	24	0	0	9	0	**33**
60925	13731	Walsall Centre	Solihull Centre	3	3	3	0	5	34	49	1	46	35	0	0	6	0	**41**
51332	41931	Solihull Centre	Smethwick	18	7	1	0	1	30	57	1	40	0	29	0	11	0	**40**
11031	31012	Kings Norton	Halesowen	3	5	4	7	1	48	69	1	66	39	0	0	15	8	**62**
8538	8346	East Coventry	North of Wolverhampton	13	8	12	9	9	89	149	2	136	39	48	0	15	38	**140**
8620	30812	Redditch Centre	Halesowen	12	12	6	0	34	61	98	1	86	56	0	0	41	0	**97**
901	12956	Cardiff Central Station	New Street Station	10	12	1	0	0	146	169	0	**159**	0	120	0	26	0	**146**
502	12956	Crewe Rail Station	New Street Station	14	12	1	0	0	55	81	0	**67**	0	58	0	24	0	**82**
12956	8372	New Street Station	Tamworth Centre	13	3	15	0	0	17	46	0	**33**	0	16	0	8	0	**24**
21742	8379	Coventry Station	Stafford Station	8	9	12	0	0	63	92	0	**84**	0	62	0	6	0	**68**
12953	50653	Birmingham City Centre	Birmingham Airport	3	5	5	0	0	10	23	0	**20**	0	9	0	18	0	**27**
21215	8566	Coventry City Centre	Leamington Centre	10	5	4	0	0	29	52	0	**42**	0	12	0	30	0	**42**
31231	12953	Brierley Hill Centre	Birmingham City Centre	2	4	3	2	2	60	73	2	**71**	67	0	0	17	0	**84**
60925	12953	Walsall Centre	Birmingham City Centre	3	3	5	0	0	20	31	0	**28**	0	21	0	12	0	**33**

As with the base year model there is a good overall fit between the modelled journey time and those journey times extracted from the Network West Midlands journey planner.

5 Summary

5.1 Forecast

5.1.1 Headline Changes in Demand

Forecasts of demand for 2021 and 2031 were developed based on a variety of inputs, including economic data, planning data and trip cost information. Taking these into account, PRISM forecasts trip making to grow in line with population growth at approximately 5% every 10 years. Mode share is forecast to change only slightly. Results overall are in line with NTEM. At a disaggregate level, there is slightly greater growth in PRISM in car passenger trips, a much larger reduction in bus trips and whilst rail trips are flat in PRISM a large increase is forecast in NTEM.

5.1.2 Headline Changes in Highway

Future year highway schemes were coded into PRISM based on consultation with West Midlands Local Authorities. Generalised cost parameters were updated to 2021 and 2031. Overall, growth of approximately 10% in trips is forecast to 2021 and 20% by 2031. The growth for car-work trips and LGVs is more significant than that for car non-work and HGV. Overall, trip lengths are forecast to remain fairly stable.

5.1.3 Headline Changes in Public Transport

Overall, small increases in demand are forecast to 2021 and 2031. Overall there is a small reduction in local demand and a significant increase in long distance demand. The fare segment shows greater sensitivity compared with the no-fare segment; both reduce over time whilst long distance trips increase. Overall, small increases in trips are forecast for the AM and PM peak periods and a small decrease for the inter peak period.

5.2 Assumptions

The following are the key assumptions that may influence results:

- Zonal targets still based on 2001 uplifted to 2011/21/31 and no allowance for ageing population
- A potential improvement to the model would be to use 2011 Census data
- Real increase in fares are not represented in the PTAM
- Crowding is not represented in the PTAM