

PROJECT REPORT CPR2883

Highways Maintenance Economic Assessment (HMEA) User Guide

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Report details

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1 Introduction

1.1 Background

The Highways Maintenance Economic Assessment (HMEA) tool and HMEA Collator, are used to process and assess the economic impacts of different road network maintenance scenarios over a specified analysis period. This includes the estimation of impacts to aGVA (approximate Gross Value Added¹, an estimate of the total output of an economy), Value Added Tax (VAT), Tax from Income, National Insurance Contributions (NIC) and employment with the impacts to road users directly associated with the use of the road network.

In addition, this tool includes the option to calculate the benefit of the network (i.e. the impact on accidents, travel time and CO₂) shown by the change in behaviour, and therefore the change in cost, if that traffic was using an alternative network (e.g. traffic on the trunk road network moved to the local road network).

A further option allows the increased income from tolls and road charging to be included in the analysis.

The pre-existing Highways Maintenance Assessment Toolkit (HMAT) is used as part of this process and provides the assessment of the indirect impacts on road users and society from the condition of the road network. The HMAAT analysis is separate from HMEA and HMEA accesses the results from the HMAAT analyses.

Figure 1-1 shows the overall structure of the HMEA model and its use to analyses different maintenance scenarios.

An HMEA analysis is for a single road network but that network may comprise up to 6 sub-networks with network condition and impacts on road users analysed separately for each sub-network, prior to the HMEA analysis.

¹ aGVA (approximate Gross Value Added) is the value generated by any unit engaged in the production and the contribution of individual sectors or industries to a country's Gross Domestic Product (GDP). It represents the direct economic benefits of economic activity, whereas welfare involves wider components. Many welfare gains from transport schemes are themselves recorded as increases in GDP, for example the economic benefits of increased employment and productivity, but some are not. It is possible that some impacts on GDP do not reflect increases in welfare. Wider economic benefits that are missing from conventional appraisal methods reflect the main market imperfections, including agglomeration externalities and imperfect competition.

HMEA uses aGVA for one of the measures of the impact of road network condition on the economy. aGVA is measured for the national economy but data is available for regional parts of the country (e.g. for individual or groups of Local Authorities).

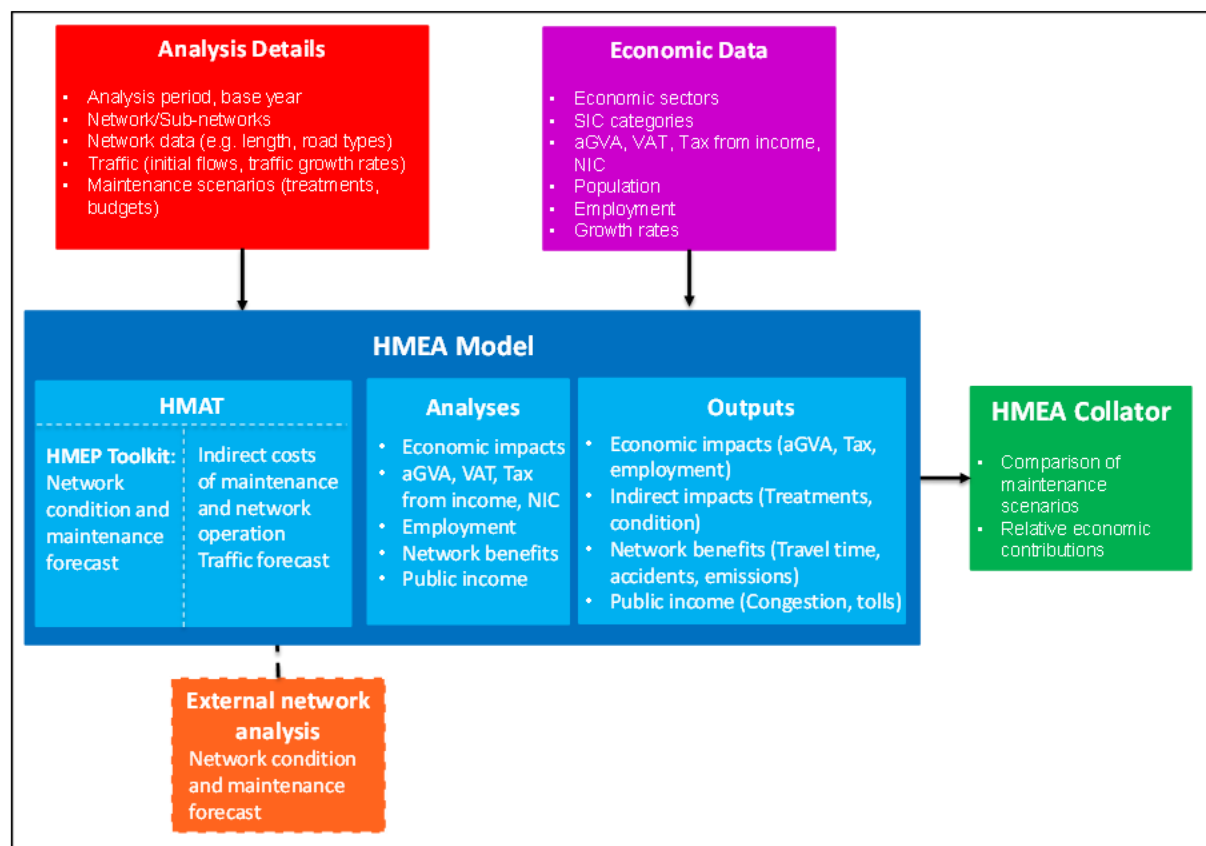


Figure 1-1 Overall structure for the HMEA model

HMAT provides an estimate of the treatment and condition impacts of a specified maintenance scenario for a road network. This includes generating results for vehicle operating costs, travel time and accident impacts along with changes in carbon generated by use and maintenance of the network. Further guidance on how to use HMAT is provided separately. HMAT incorporates the Highways Maintenance Efficiency Programme (HMEP) Carriageway Life-cycle Planning Toolkit to project forward the condition and treatment programme over the analysis period. However, a recent update to HMAT (version 2 onwards) provides the option to enter the results equivalent to those from an HMEP Toolkit analysis directly when calculated from an external analysis. A summary of the input data required for HMAT when bypassing HMEP is given in Appendix A. On the opening screen of the HMAT toolkit the user chooses to use or not use the HMEP carriageway analysis tool in the HMAT analysis. If the HMEP built into HMAT is not used, some of the data that would be provided in HMEP and has been used in the external analyses of network condition and maintenance need is input in HMAT.

1.2 Structure of this document

A description of the HMEA process, followed by a bullet point summary of the process is provided in Section 2.

More detailed descriptions of the HMEA input worksheets (including guidance on sources for the data) are provided in Sections 3, 4, 5 and 6. Additional settings for the HMEA tool are described in Section 7.

Discussion of the supporting information and output worksheets in the HMEA tool are provided in Sections 8, 9 and 10.

The HMEA collator tool and interpretation of the results from HMEA analyses are described in Section 11.

HMEA and HMAAT require data inputs not commonly used in the assessment of maintenance assessment programmes. Appendix B contains example data links for some of that data but data specific to the road network analysed may be available locally (e.g. in a Local Authority).

1.3 Additional supporting information

In addition to this document, supporting information on how to use the HMEA model can be found on the “Introduction” tab of the HMEA workbook and via the help buttons. The version number of the model can be found on all worksheets in the workbook and a version history can be found on the “Introduction” tab of the workbook.

2 The HMEA process

2.1 Loading HMEA files

Running HMEA can require many different files if the network is made of sub-networks and different maintenance scenarios are to be investigated. To help manage the different files and run the analyses, Appendix C describes a suitable folder structure for the initial data files and the results files from the analyses.

2.2 Description of the HMEA process

In order to run the overall HMEA process, it is first necessary to determine the number of sub-networks that will be used in the scenario to be analysed in HMEA, such as sub-networks in a geographic area making up the network analysed in HMEA (e.g. different districts within a Local Authority). The HMEA analysis can then compare the effects of different maintenance scenarios (e.g. do minimum, steady state etc.) on the sub-networks and the overall network. Before undertaking any processing through HMAAT and HMEA, it is recommended that the user confirms the data required and its availability for the sub-networks/scenarios to be analysed.

HMAAT has been modified to enable an external analysis of the future network condition but no changes have been made to the calculation of the impacts of network condition. The HMAAT analyses for the network to be analysed in HMEA must be completed before the HMEA analysis as data as well as results from the HMAAT analysis is used in the HMEA analysis.

If HMEP is to be used to forecast the network condition and future maintenance, this is undertaken as part of the HMAAT analysis (i.e. HMEP forms part of HMAAT). If an alternative

model is used to forecast network condition and future maintenance, the data needed from those analyses and how to load the results into HMAT is described in Appendix A.

Figure 2-1 shows how, on the opening HMAT screen, the use of the HMEP Toolkit is selected or disabled for the HMAT analysis. The button “HMEP condition analysis – disabled” switches between enabling and disabling the HMEP Toolkit in HMAT.

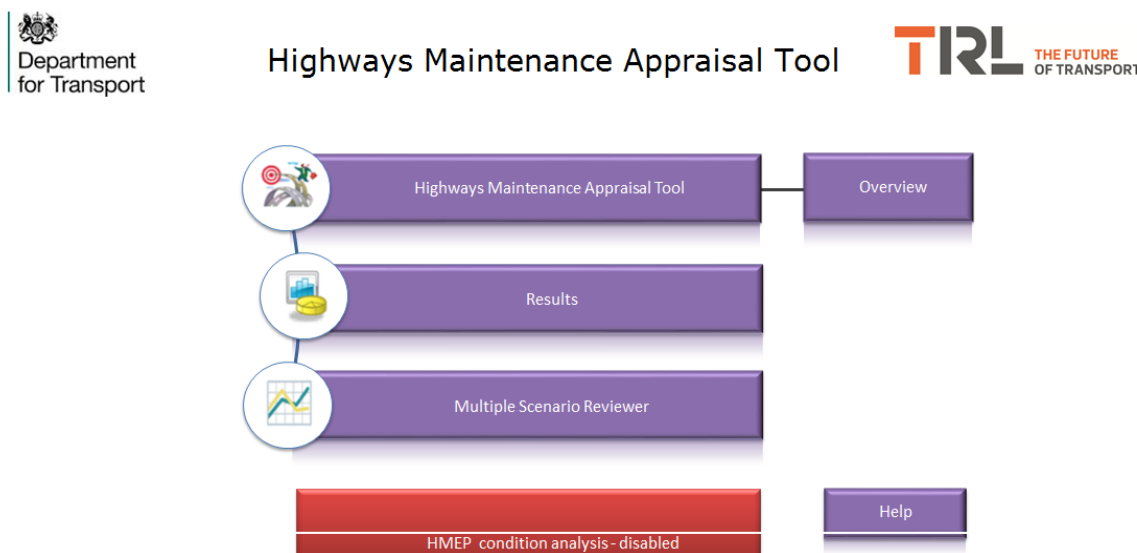


Figure 2-1 Modified HMAT opening screen

For each selected scenario it is necessary to run the HMAT model for each sub-network (e.g. if there are three sub-networks and four scenarios then this will require 12 HMAT analyses and will result in 4 HMEA analyses, one per scenario). The process to generate the results for one scenario (and three sub-networks) is illustrated in Figure 2-2.

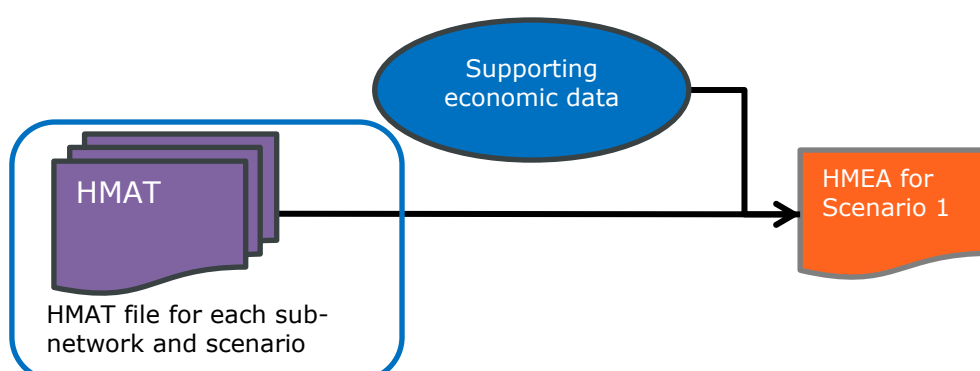


Figure 2-2 HMEA analysis for one scenario

Details for the sub-network to be analysed in HMAAT and then HMEA are specified in HMAAT and automatically read into HMEA as part of the loading of the HMAAT analysis results. The data specified in HMAAT and used in HMEA is:

- Base year of the analysis (shown as Start Year in HMAAT)
- Analysis period
- Road types in the network or sub-network²
- Network length
- Network traffic

Where multiple sub-networks are used in an HMEA analysis, it is important that the HMAAT files are structured the same. The same parameters must be used for:

- Analysis period
- Base year of the analysis
- Number of road types
- Road types (e.g. Motorway, Dual carriageway, Single carriageway with each split by rural/urban etc.)
- Number of condition bands (and structured in order of Good to Poor condition)
- Number and types of maintenance treatments but the details of the treatments, such as cost and rate of working, can be different on each sub-network.

When this process is replicated for additional scenarios, it is anticipated that the supporting economic data input into HMEA is unchanged (i.e. the economic impacts of the different scenarios use the same HMEA base data). Therefore, to run the additional scenarios, copies of the HMEA tool used for scenario 1 can be used with different HMAAT files for the other scenarios. However, it is not a requirement that the same economic data is used for each scenario.

Once the HMEA tool has been run (and saved) for each scenario the analysis results can be summarised and compared using the HMEA Collator as illustrated in Figure 2-3. The Collator can compare the results from up to five HMEA analyses.

² It is recognised that the road types will not necessarily be the same for all sub-networks in the network to be analysed in HMEA. HMEA will use all the road types defined in the HMAAT analyses for the sub-networks.

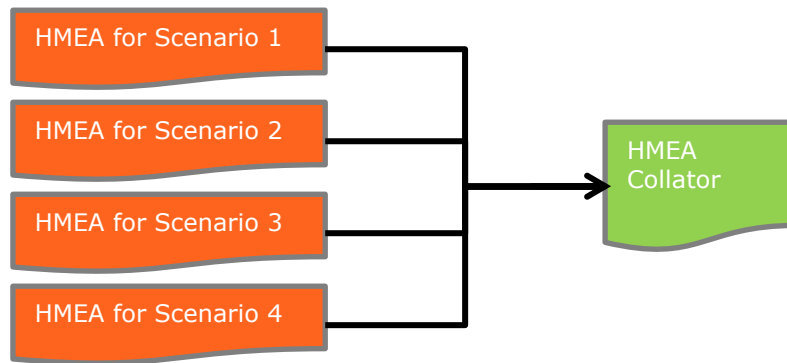


Figure 2-3 Comparing HMEA analyses

2.3 Use of the HMAT Tool

The alterations of HMAT for use with HMEA have not changed the operation of HMAT which is described in the HMAT User Guide (Buckland, 2015) but HMEA allows HMAT to be used in a number of ways:

- HMEP, embedded in HMAT, can be used to forecast the condition and maintenance need for the network that is used in HMAT. Operation of the HMEP Life-cycle Toolkit is described in the HMEP Life-cycle Planning Toolkit Guidance (UKRLG Asset Management Board, 2019).
- HMEP stand-alone analyses can provide results of the forecast of network condition and maintenance need which can be copied into HMAT without the need to re-run the HMEP analyses in HMAT.
- Other external analyses can be used to produce the forecasts of network condition and maintenance need which can be copied into HMAT. The format of the results must match the format required in HMAT.

Further guidance on the use of the results from stand-alone analyses with the HMEP Toolkit or another external model is given in Appendix A.

The forecasts of network condition and maintenance are then used in HMAT to estimate the indirect costs associated with those forecasts.

Some HMEA data is also used in the HMAT analyses (as described in Section 2.1) and some HMAT data is used in the HMEP Life-Cycle Toolkit as described in the HMAT User Guide (Buckland, 2015). The HMAT data used in the HMEP Toolkit is entered in HMAT if the HMEP Toolkit within HMAT is to be used in the analysis or if the network condition and maintenance forecast are from an external analysis. HMAT shows the data required when the option to Enable/Disable the HMEP analysis is selected.

HMAT analyses include a simple analysis of the effect of the amount of maintenance on the levels of employment and aGVA resulting from that maintenance work. If the HMEP Life-Cycle Toolkit is used in an HMAT analysis, the results of the employment analysis are shown in HMAT but are not used in HMEA. If the HMEP Life-Cycle Toolkit is not used in the HMAT analysis (i.e. external forecasts of network condition and maintenance are used in HMAT) then the analyses of employment and aGVA are not used and the results are not shown in

HMAT. The employment and aGVA analyses in HMEA are more comprehensive than the analyses of these aspects in HMAT.

2.4 Step-by-step guide to the HMEA process

To run an HMEA analysis the following steps are required:

1. Determine the number of sub-networks that will be used to run the analysis and collect together the required information.
2. Decide on the scenarios (e.g. do minimum, steady state etc.) to be compared between HMEA analyses.
3. If using external analyses to forecast the future network condition and maintenance need carry out those analyses for each sub-network and maintenance scenario.
4. Prepare the HMAT files (including loading the results of the external network condition and maintenance need analyses, if carried out) with the data required for the HMAT analyses
5. Run the HMAT analyses (one HMAT analysis will need to be run for each sub-network and scenario combination). Store the results for all scenarios for each sub-network in one folder (to enable HMEA to access the files).
6. Assemble the economic data required for the HMEA analysis of the network (i.e. generally this is the sum of the sub-networks analysed in HMAT) and enter it into a copy of the HMEA tool for each scenario.
7. Load the completed HMAT analyses for the scenario into the HMEA file, extract the data from the HMAT files and review the results of the HMEA analyses.
8. Save the HMEA analyses in a location that can be identified for use in the HMEA Collator (i.e. the HMEA analyses to be compared should be in the same folder).
9. Run the HMEA Collator and review the results of the comparison based on the selected base case scenario

Note: It is anticipated that the economic data entered into the HMEA tool will be the same for each scenario. However, if this is not the case then economic data in the corresponding copy(s) of HMEA will need to be amended in step 6.

An HMEA analysis can include up to 6 economic sectors for the road network. If more than 6 sectors are to be used, HMEA analyses, using up to 6 sectors in each analysis, can be used to assess the economic contribution of the road network and the results from the HMEA analyses combined separately from the HMEA Collator. Appendix D describes how to combine the results from two HMEA analyses using a total of more than six economic sectors.

2.5 Summary of the HMEA model

HMEA comprises 9 worksheets in addition to the “Introduction” sheet providing some background information and describing the colour coding on the worksheets and tabs style. The version number of the Tool is also on this worksheet.

The worksheet tabs are colour coded to aid navigation of the model. The following tabs will always be visible in the model:

- White Tab: sheet providing supporting information describing HMEA
- Purple Tabs: sheets requiring user inputs
- Green Tab: sheet for selecting HMAT files for use in the analysis
- Red Tab: contains advanced settings for the analysis

The following tabs will only be visible once HMAT data has been imported and the economic analysis completed:

- Yellow Tabs: contain supporting information extracted from the HMAT files
- Orange Tabs: contain the output from the HMEA analysis

Cells in the worksheets are also colour coded to show where data can be input, which are read only (i.e. calculated values or fixed text) and where errors occur (e.g. missing data or input values do not sum to the correct total).

The cream cells on the worksheets show where data can be input. White cells show the values HMEA has calculated and cannot be changed. When HMAT data has been loaded into HMEA, some cream cells will change to white (e.g. the names of the sub-networks) and cannot be changed. If the number of sub-networks is reduced from a previous analysis, the cells will remain cream if there is any data for the sub-network(s) removed remaining on one of the worksheets. A sub-network that has been removed will be given a dummy name if data still remains in HMEA for that sub-network.

The order of completing the data required in the worksheets is important and should be followed to achieve the full flexibility of the process. The following worksheets are used for the analysis and results:

(i). Economic data

This worksheet is used to input the economic data and undertake preliminary analyses used later in the process. The names of the sub-networks are specified on this worksheet but cannot be changed after loading HMAT data (and associating the HMAT files with the relevant sub-networks) in HMEA.

(ii). Network benefits

Use of this worksheet is optional (i.e. it can be enabled/disabled at the top of the worksheet). If used, this worksheet assesses the benefits of having the network being analysed (referred to as the base network). The basis for this analysis is to show the effects of the traffic carried by the base network using an alternative network (e.g. traffic moved from the Trunk Road Network to the local road network) in terms of the change in behaviour and costs of operating on the two networks.

(iii). Public income

This worksheet is also optional and allows the income from congestion charges and/or tolls to be included in the economic analysis. This worksheet can be disabled (at the top of the worksheet) if this part of the analysis is not required.

(iv). Name and Filepaths

This worksheet is used to specify the location and names of files containing the HMAAT analyses for the scenario to be analysed in HMEA. On this worksheet, the user chooses to enable the model to use the forecast condition of the network to impact the economic and traffic growth rates specified as part of the input data. Enabling the use of network condition to influence the growth rates does not change the forecast condition of the network, or the maintenance required, but reflects a possible increase in the expected growth rate for each year if the network condition is improved, compared to the start of the analysis period (or decreased if the condition in the year is worse than at the start of the analysis period). The size of the impact on the growth rates is specified on the “Advanced Settings” worksheet.

Importing the HMAAT data on this worksheet causes the HMEA analysis to start.

(v). Advanced settings

Changes in the condition of the network may impact the expected growth rate for traffic and economic parameters and hence impact the economic costs (e.g. a worsening network condition can be assumed to reduce the rates of traffic growth and economic growth for the network analysed).

Note in an HMEA scenario, the impacts of changes in condition use the same data for all sub-networks.

(vi). Network size

This worksheet is not for direct data input but summarises the key data from each HMAAT analysis used in the HMEA analysis.

(vii). Condition and maintenance data

This worksheet is not for direct data input but summarises the key data from each HMAAT analysis included in the HMEA analysis.

(viii). Future projections

Data for the HMEA analysis is entered for the base year(s) of the data and normalised to the base year of the analysis. This worksheet shows the change in the economic data for each year through the analysis period using the growth rates specified as part of the “Economic Data”.

(ix). Summary (Life analysis)

The results of the HMAAT and HMEA analyses for the network are summarised on this worksheet. The results for the sub-networks are shown in addition to the aggregated results for the full (base) network.

3 HMEA model inputs: Economic Data

This worksheet is used to enter the economic data to be used in the HMEA analysis. This includes both data for the overall economy (e.g. England, Wales etc) where data is not

available for the sub-networks, and data for the network/sub-network being analysed. Data entered on this worksheet is used to populate the “Economic Impacts” rows on the “Future Projections” and the “Summary (life analysis)” worksheets.

3.1 Value Added Tax and National Insurance

Data for Value Added Tax (VAT) and National Insurance Contributions (NIC) are not generally available at the local level so are specified for the national economy even if only part of the national network (e.g. a Local Authority) is analysed. The datasets may be available for different years so the year for each dataset used in the analysis is also specified to enable the data to be normalised to the common base year (as specified in HMA). Figure 3-1 shows the start of the Economic data worksheet.

HMEA model - Economic Data
Version: v1.04

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VAT and NIC data ?

| | Total (£ Million) | Population (count) | Base year |
|--------------------------|-------------------|--------------------|-----------|
| National Insurance (NIC) | 4,553 | 3,138,631 | 2017 |
| Value Added Tax (VAT) | 5,244 | 3,138,631 | 2017 |

Network name, tax data and growth rates ?

Network Case Study - General

| | Name | Base year data | | Basic Growth rates (% per year) | | | | |
|--------------------------------|----------|----------------|--------------------------------------|---------------------------------|--------------------------|------|------|------------|
| | | Year | | aGVA | Tax receipts from Income | VAT | NIC | Employment |
| | | Population | Tax receipts from Income (£ million) | | | | | |
| Sub-network 1 | Region 1 | 698,369 | 1131 | 1.4% | 1.4% | 1.4% | 1.4% | 0.9% |
| Sub-network 2 | Region 2 | 907,434 | 1334 | 1.4% | 1.4% | 1.4% | 1.4% | 0.9% |
| Sub-network 3 | Region 3 | 1,532,828 | 2450 | 1.4% | 1.4% | 1.4% | 1.4% | 0.9% |
| Sub-network 4 | | | | | | | | |
| Sub-network 5 | | | | | | | | |
| Sub-network 6 | | | | | | | | |
| Sub-network 7 | | | | | | | | |
| Sub-network 8 | | | | | | | | |
| Sub-network 9 | | | | | | | | |
| Sub-network 10 | | | | | | | | |
| Total for Case Study - General | | 3,138,631 | 4,915 | | | | | |

Figure 3-1. National data

3.2 Network name, tax data and growth rates

The name of the network to be analysed is entered on this worksheet (see Figure 3-1) to enable identification of the data with other data and the results of the analyses. A number of analyses may be carried out for this network and the names of those analyses are specified on the “Name and Filepaths” worksheet.

When the HMA data and results are loaded into HMEA the names of the sub-networks are locked so that they cannot be changed on this worksheet. In addition, the data entry cells for the unused sub-networks (ones which have not been named or do not have data) will be locked. Therefore, to edit the sub-network names or add more data it will be necessary to clear the existing HMA data using the options on the “Name and Filepaths” worksheet (see Section 6) and re-enter the same files or a new set of HMA files. If data has not been loaded into HMEA, the sub-network names can be edited (i.e. they are coloured yellow).

The main table in this part of the worksheet is used to enter population, tax receipts data and annual growth rates for the economic data for each of the sub-networks. The same growth rate, for each parameter, is used for all years in the analysis period. The year for the

population and tax receipts data is input to enable the data to be normalised to the common base year (as specified in HMAAT).

Data for population is available from national statistics (e.g. Office of National Statistics) or local data. Note it may be necessary to break down the national data for application to a sub-network.

3.3 Discount rates

The discount rates to be applied to the analysis forecasts enable the comparison of costs occurring at different times in the future. Although the values can be set in HMEA (see Figure 3-2), the expected settings, in accordance with the WebTAG guidance (Department for Transport, 2019) are 3.5% per year for the first 30 years of the analysis period and 3.0% for the remaining years in the analysis period. These values may be changed.

| Discount rates ? | | | |
|------------------|------|-------------------------------|--------------------------|
| | % | Rate applies to | |
| Discount rate 1 | 3.5% | The first | 30 years of the analysis |
| Discount rate 2 | 3.0% | The remainder of the analysis | |

| Industry sectors ? | | | | | | |
|--------------------|-------------------------------|-------------|---|--------------------------|-----------------------|-----------|
| Name | Industry sectors for analysis | | | | | |
| | Sector 1 | Sector 2 | Sector 3 | Sector 4 | Sector 5 | Sector 6 |
| | Manufacturing | Real Estate | Human health and social work activities | Wholesale & retail trade | Public administration | Education |

Figure 3-2 Discount rates and industry sectors

3.4 Industry sectors

The economy for the analysed road network is described by the economic sectors most relevant to the network (see Figure 3-2). These can be left blank, however, adding in names for the sectors is recommended as it will both make it clearer for the use of HMEA, and interpretation of the results particularly if the data is reviewed in the future. For these cells it is possible to select an item from the dropdown list, or manually type in the name of the selected sector.

Typical economic sectors are given below but users can enter other names. Note, the sectors will need to be linked to the economic data used to describe the economy for the network analysed.

Typical economic sectors (i.e. those where national data is most likely to be available):

- Accommodation and food services
- Administrative and support services
- Agriculture, forestry and fishing
- Arts entertainment and recreation
- Construction
- Education

- Electricity, gas, steam and air conditioning
- Financial & Insurance activities
- Human health and social work activities
- Information and communication
- Manufacturing
- Mining and quarrying
- Other service activities
- Professional, scientific and technical activities
- Public administration
- Real Estate
- Tourism
- Transportation and storage
- Water supply, sewerage and waste management
- Wholesale & retail trade

3.5 SIC categories

Economic sectors are linked to the SIC (Standard Industrial Classification) of the economy. These are a standard classification of the economy with economic data available at different levels of detail (e.g. using high-level categories or breakdowns of those categories). HMEA uses the high-level categories as this is where data is more generally available. The high-level SIC categories from the UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007) (Office of National Statistics, 2009) used for the economic data are:

| SIC | Description |
|------------|--|
| A | Agriculture, forestry and fishing |
| B | Mining and quarrying |
| C | Manufacturing |
| E | Electricity, gas, steam and air conditioning supply |
| E | Water supply; sewerage, waste management and remediation activities |
| F | Construction |
| G | Wholesale and retail trade; repair of motor vehicles and motorcycles |
| I | Accommodation and food service activities |
| H | Transport and storage |
| J | Information and communication |
| K | Financial and insurance activities |

| | |
|---|---|
| L | Real estate activities |
| M | Professional, scientific and technical activities |
| N | Administrative and support service activities |
| O | Public administration and defence; compulsory social security |
| P | Education |
| Q | Human health and social work activities |
| R | Arts, entertainment and recreation |
| S | Other service activities |
| T | Activities of households as employers; undifferentiated goods-and services-producing activities of households for own use |
| U | Activities of extra-territorial organisations and bodies |

Note. An economic sector may require contributions from more than one SIC category (e.g. economic sector activity may come from different percentages of one or more SIC categories).

Not all of the economic activity (and therefore the aGVA and employment) described by the SIC categories results from the analysed road network. The HMEA data therefore requires the share (i.e. less than 100%) of the economic activity contributed by the analysed road network to be entered.

3.6 aGVA data split by SIC codes

The allocations of aGVA to the specified SIC categories are the same for all sub-networks analysed. Note the allocation of aGVA to the SIC categories need not be the same for aGVA and employment. The user enters the percentage of the aGVA for the SIC category that is contributed by the analysed road network to each economic sector (see Figure 3-3).

aGVA data is available from national statistics (e.g. Office of National Statistics) or local data may be available. The aGVA values for each SIC category used in the analysis and the total for all sectors are entered for each sub-network (see Figure 3-4).

When HMA data is loaded into the HMEA tool the data entry cells for the unused sub-networks (ones which have not been named or do not have data added) will be locked. Therefore, to add additional data it will first be necessary to clear the existing HMA data and re-enter the same or a new set of HMA files.

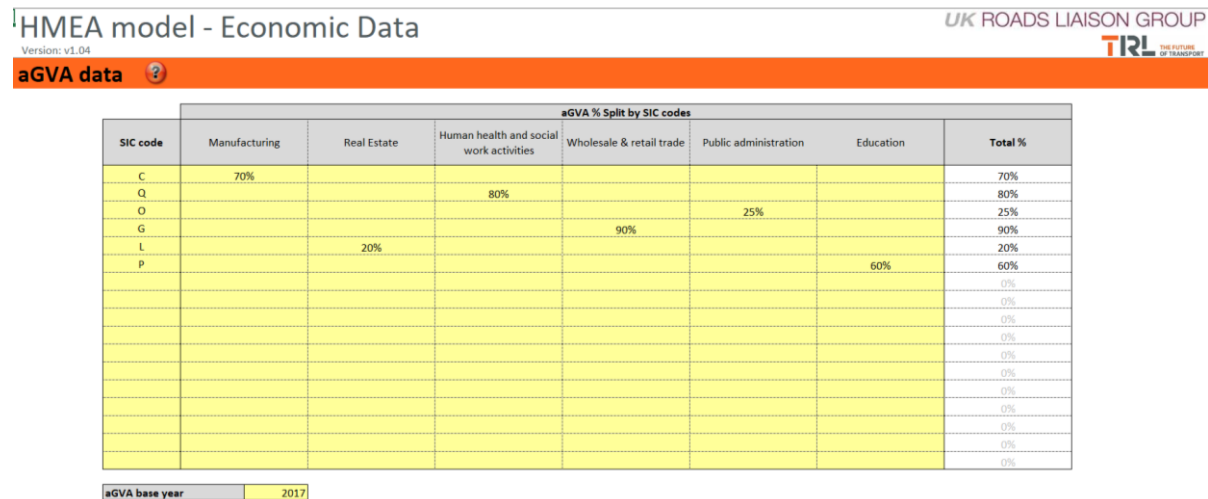


Figure 3-3 Allocation of SIC category aGVA to each economic sector

| | aGVA data (£ million) | | | | | | | | Total for Case Study - General |
|-------------------------------|-----------------------|--------|--------|---|---|---|---|---|--------------------------------|
| SIC code | NW | M&S/W | SEW | - | - | - | - | - | |
| C | 3,205 | 2,456 | 5,068 | | | | | | 10,729 |
| Q | 1,442 | 1,812 | 4,252 | | | | | | 7,506 |
| O | 1,488 | 1,819 | 3,108 | | | | | | 6,415 |
| G | 1,367 | 1,683 | 3,043 | | | | | | 6,093 |
| L | 984 | 1,428 | 2,233 | | | | | | 4,645 |
| P | 927 | 1,240 | 2,134 | | | | | | 4,301 |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| . | | | | | | | | | |
| Total aGVA for all sectors | 14,044 | 16,833 | 31,311 | | | | | | 62,188 |

Figure 3-4 aGVA values for each SIC category and sub-network

3.7 Employment data split by SIC codes

The allocations of employment to the specified SIC categories are the same for all sub-networks analysed. As noted above for aGVA, the allocation of the number employed to the SIC categories need not be the same for employment and aGVA. The user enters the percentage of the employment for the SIC category contributed by the analysed road network to each economic sector (see Figure 3-5).

Employment data is available from national statistics (e.g. Office of National Statistics) or local data may be available. The numbers employed in each SIC category for the specified sectors are entered (see Figure 3-6).

Employment data

[illegible]

Figure 3-5 Allocation of SIC category employment to each economic sector

When HMAT data is loaded into the HMEA tool the data entry cells for the unused sub-networks (ones which have not been named or do not have data added) will be locked. Therefore, to add additional data it will first be necessary to clear the existing HMAT data and re-enter the new set of HMAT files.

| SIC code | Employment data (Count) | | | | | | | | Total for Case Study - General |
|----------------------------------|-------------------------|---------|-----------|--|--|--|--|--|--------------------------------|
| | NW | MdSWW | SEW | | | | | | |
| C | 43,200 | 33,100 | 68,300 | | | | | | 144,600 |
| Q | 3,900 | 4,900 | 11,500 | | | | | | 20,300 |
| O | 49,300 | 60,300 | 103,000 | | | | | | 212,600 |
| G | 39,800 | 49,000 | 88,600 | | | | | | 177,400 |
| L | 19,300 | 28,000 | 43,800 | | | | | | 91,100 |
| P | 24,900 | 33,300 | 57,300 | | | | | | 115,500 |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| Total Employment for all sectors | 518,300 | 621,200 | 1,155,500 | | | | | | 2,295,000 |

Figure 3-6 Employment values for each SIC category and sub-network

3.8 Adjusted data for economic sectors

HMEA uses the values input for the economic sectors and SIC categories to allocate aGVA, employment, NIC, VAT, tax from income and population to the economic sectors for the network analysed and each of the sub-networks. Figure 3-7 shows the table completed by HMEA for aGVA. Similar tables are created for employment, per capita aGVA, tax receipts

from income, VAT and NIC. This data is then used to populate the “Economic Impacts” rows on the Future Projections and the Summary (life analysis) worksheets.

| Adjusted data for named sectors  | | | | | | | |
|---|-----------------------|-------------|---|--------------------------|-----------------------|-----------|-------------------------|
| aGVA base year | 2017 | | | | | | |
| | aGVA data (£ million) | | | | | | |
| | Manufacturing | Real Estate | Human health and social work activities | Wholesale & retail trade | Public administration | Education | Total for Named sectors |
| Total for Case Study - General | 7,510 | 929 | 6,004 | 5,482 | 1,604 | 2,581 | 24,110 |
| NW | 1,728 | 214 | 1,382 | 1,262 | 369 | 594 | 5,549 |
| MaSWW | 2,038 | 252 | 1,630 | 1,488 | 435 | 701 | 6,544 |
| SEW | 3,744 | 463 | 2,993 | 2,732 | 799 | 1,286 | 12,017 |

Figure 3-7 aGVA data adjusted for each sector and sub-network

4 HMEA model inputs: Network benefits


This part of the HMEA analysis is potentially more relevant to Strategic Road Networks (SRNs) where the benefits of the SRN are shown by estimating the effects of the traffic using the SRN, operating on an alternative network (e.g. local road network if the SRN was not present). This is not to represent the increased congestion on the alternative network, it is to represent the different operating conditions on the alternative network, compared to the analysis network. For local road networks, the analysis may show the benefits of the higher road hierarchy.

On this worksheet the user enters details of the alternative road network. The data for the analysed road network does not change. The analysis shows the impact on the total value of accidents, travel time costs and CO₂ emissions if the base network was not present (and the traffic moved to the alternative network). The results from this analysis populate the “Network Benefits” rows on the “Future Projections” and the “Summary (life analysis)” worksheets.

This part of the analysis can be included/excluded by the user (see the button “Disable calculation” on the “Network benefits” worksheet (see Figure 4-1). If the analysis is disabled, then the data entry tables and the results rows will not be visible.

HMEA model - Network benefits
Version: v1.04
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Disable calculation

Accident costs 

Base year
2019

Growth rate (%)
1.8%

Cost of fatal accidents
£ 1,745,879

Cost of serious accidents
£ 199,614

Figure 4-1 Enabling the Network Benefits analysis

4.1 Accident costs

Figure 4-1 shows the details required for value of fatal and serious traffic accidents. The same values are used for the base and alternative networks. The year of the values for the accidents is specified to enable all the data to be normalised to a common base year. This data may be available from the DfT WebTAG (Department for Transport, 2019), Office of National Statistics (ONS) or may be available locally.

The annual growth rate for the values of accidents is also specified.

4.2 Alternative network – traffic and accidents

Details are required for the traffic on the alternative network assuming the base network is available. This data may be available from the Office of National Statistics (ONS) or may be available locally.

The road types are taken from the road types used in HMAT and cannot be changed on this worksheet. Note that not all the road types may be needed to specify the traffic on the alternative network. The rows for the road types not needed should be left blank (see Figure 4-2). The traffic data can be specified in one of two ways (as used in HMAT). These are the 'model' format or DfT format. The same format is used for each road type.

The numbers of fatal and serious accidents in the base year are specified for the alternative network. Note, the year of the traffic and numbers of accidents data for the alternative network is the same for both sets of data (see Figure 4-2).

Annual traffic growth rates on the alternative network for the analysis period are input for each vehicle type. The same growth rates are used for all road types (see Figure 4-2).

The base data entered represents the traffic in the Base Year and changes in each year (i.e. change in levels of traffic on the base network) are calculated for each year of the analysis period. Where the option to enable the change in network condition to affect economic and traffic growth has been selected, changes are made each year to the traffic growth rates for the base network given in the input data, according to the process described in Section 6.4. The annual traffic growth rates on the alternative network are not changed.

Alternative network: road traffic and accidents

| | | | | | | | |
|-------------------|--|------|--|---------------------------|--|-----|--|
| Traffic base year | | 2018 | | Traffic Data entry format | | DfT | |
|-------------------|--|------|--|---------------------------|--|-----|--|

| Road Type | Unit | Analysis | | | | | |
|-----------------|--------------------|----------------|------------|------------|----------------|-------------------|--------------------|
| | | Cars and taxis | Motorbikes | Light vans | Goods vehicles | Buses and coaches | All motor vehicles |
| A roads - Urban | Million vehicle km | 2,160 | 100 | 340 | 500 | 20 | 3,120 |
| A roads - Rural | Million vehicle km | 4,730 | 400 | 850 | 180 | 40 | 6,200 |
| B roads - Urban | Million vehicle km | 730 | 200 | 180 | 10 | 10 | 1,130 |
| B roads - Rural | Million vehicle km | 1,790 | 400 | 430 | 30 | 20 | 2,670 |
| C roads - Urban | Million vehicle km | | | | | | - |
| C roads - Rural | Million vehicle km | | | | | | - |
| U roads - Urban | Million vehicle km | | | | | | - |
| U roads - Rural | Million vehicle km | | | | | | - |

| | |
|--------------------------|-----|
| No. of fatal accidents | 65 |
| No. of serious accidents | 714 |

| | Cars and taxis | Motorbikes | Light vans | Goods vehicles | Buses and coaches |
|-------------------------|----------------|------------|------------|----------------|-------------------|
| Annual Growth rates (%) | 1.2% | 1.2% | 1.9% | 0.1% | 0.3% |

Figure 4-2 Alternative network traffic and accidents

4.3 Redistribution of road traffic

Details are required for numbers and types of traffic on the road types the traffic on the base network would use on the alternative network, if the base network is not available.

This is shown by the percentage of the traffic on each road type in the base network that moves to each road type on the alternative network (see Figure 4-3).

Note that if it is assumed there would be less traffic if the base network is not present (i.e. some of the journeys currently taken, would not be taken) then the percentage of the traffic moving to the roads on the alternative network need not add to 100% for each road type on the base network.

4.4 Vehicle speeds for the alternative network

Figure 4-3 also shows the data required for the estimated free-flow traffic speeds on the alternative network if the base network is available. It is likely that this data will be found locally as national data is unlikely to be suitable for a specific network. The speeds are given for each vehicle type on each road type.

It is recognised that this is a very general representation of traffic on the base network and the alternative network but the aim is to provide an estimate of the effect of the overall traffic levels from the two networks if the base network is not available and is not intended as a detailed analysis of changes in traffic patterns.

Redistribution of road traffic ?

| Base Network | Unit | Alternative network | | | | | | | | Total |
|-----------------|------|---------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-------|
| | | A roads - Urban | A roads - Rural | B roads - Urban | B roads - Rural | C roads - Urban | C roads - Rural | U roads - Urban | U roads - Rural | |
| Motorway Urban | % | 70% | | 30% | | | | | | 100% |
| Motorway Rural | % | | 70% | | 30% | | | | | 100% |
| A roads - Urban | % | 30% | | 40% | | 30% | | | | 100% |
| A roads - Rural | % | | 30% | | 50% | | 20% | | | 100% |
| B roads - Urban | % | | | | | | | | | 0% |
| B roads - Rural | % | | | | | | | | | 0% |
| C roads - Urban | % | | | | | | | | | 0% |
| C roads - Rural | % | | | | | | | | | 0% |
| U roads - Urban | % | | | | | | | | | 0% |
| U roads - Rural | % | | | | | | | | | 0% |

Vehicle speeds for alternative network ?

| Alternative network | Unit | Vehicle speeds for alternative network (km/h) | | | | |
|---------------------|------|---|-----|------|------|-----|
| | | Cars | LGV | OGV1 | OGV2 | PSV |
| A roads - Urban | km/h | 48 | 48 | 40 | 40 | 40 |
| A roads - Rural | km/h | 80 | 48 | 48 | 48 | 48 |
| B roads - Urban | km/h | 48 | 48 | 48 | 48 | 32 |
| B roads - Rural | km/h | 64 | 64 | 48 | 48 | 48 |
| C roads - Urban | km/h | 48 | 48 | 32 | 32 | 32 |
| C roads - Rural | km/h | 48 | 48 | 48 | 48 | 32 |
| U roads - Urban | km/h | 48 | 48 | 32 | 32 | 32 |
| U roads - Rural | km/h | 48 | 48 | 48 | 48 | 32 |

Figure 4-3 Redistribution of base network traffic to the alternative network

4.5 Ratio of CO₂ emissions between the alternative and base networks

The rate of emissions of CO₂ varies with road type and level of traffic. The ratio of emissions on the alternative network to the rate on the base network is based on the ratio of the emission per vehicle kilometres driven on the two networks. If the ratio for the base network is half the ratio for the alternative network, then a factor of 2 is applied in HMEA (see Figure

4-4). This ratio may be derived from the total emissions per vehicle km on the two networks or a direct estimate of the emission per vehicle (by vehicle type) on different road types.

Ratio of CO₂ emissions between alternative network and base network ?

| | |
|---|-----|
| Ratio of emissions between alternative network and base network - Urban | 1.3 |
| Ratio of emissions between alternative network and base network - Rural | 1.3 |

Figure 4-4 CO₂ emissions on the alternative and base networks

Details of the emissions from traffic using different road types are available from the Office of National Statistics (ONS) or may be available locally.

5 HMEA model inputs: Public Income

This worksheet is used to enter details of the congestion charges and tolls for the network and enables an estimate of that income to be included in the economic contribution made by the base road network. The data allows for a Public Income to be calculated for only part of the network included in other parts of the HMEA analysis.

This calculation can be enabled or disabled using the button at the top of the worksheet (see Figure 5-1). If the analysis is disabled, then the data entry tables and the results rows will not be visible.

The format of the traffic data is the same for the Congestion Charge and Tolls analyses. The format options are as for the Network Benefits analysis (i.e. the same as available in HMAT).

The base data entered represents the income available from the road users in the Base Year and changes in each year (i.e. change in levels of traffic and change in charge per vehicle) are calculated for each year of the analysis period. Where the option to enable the change in network condition to affect economic and traffic growth has been selected, changes are made each year to the base traffic growth rates given in the input data, according to the process described in Section 6.4.


5.1 Congestion charge

For each vehicle type, the number of vehicles (expressed as a daily count) and the annual rate of increase in the number of vehicles are input (see Figure 5-1) for each sub-network. The number of days per week is input to allow the use of the charge for only part of the week.

The same base year is used for the vehicle counts and the charge per vehicle, and is entered with the expected annual increase in the charge per vehicle during the analysis period.

The charge per vehicle, the days or part days when the income is generated is most likely to be data that is only available locally.

HMEA model - Public Income
 Version: v1.04

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Disable calculation

Congestion charge

Base year

Days per week congestion charge applies

| | | Unit | Region 1 | Region 2 | Region 3 | | | | | | | |
|-------------------|-----------------------|--------|----------|----------|----------|--|--|--|--|--|--|--|
| Cars and taxis | Count | No/Day | 12,000 | 12,000 | 12,000 | | | | | | | |
| | Count Growth rate (%) | % | 1.0% | 1.0% | 1.0% | | | | | | | |
| Motorbikes | Count | No/Day | 4,500 | 4,500 | 4,500 | | | | | | | |
| | Count Growth rate (%) | % | 1.0% | 1.0% | 1.0% | | | | | | | |
| Light vans | Count | No/Day | 2,000 | 2,000 | 2,000 | | | | | | | |
| | Count Growth rate (%) | % | 1.0% | 1.0% | 1.0% | | | | | | | |
| Goods vehicles | Count | No/Day | 750 | 750 | 750 | | | | | | | |
| | Count Growth rate (%) | % | 1.0% | 1.0% | 1.0% | | | | | | | |
| Buses and coaches | Count | No/Day | 1,000 | 1,000 | 1,000 | | | | | | | |
| | Count Growth rate (%) | % | 1.0% | 1.0% | 1.0% | | | | | | | |

| | Unit | Cars and taxis | Motorbikes | Light vans | Goods vehicles | Buses and coaches |
|--------------------|------|----------------|------------|------------|----------------|-------------------|
| Charge per vehicle | £ | 11.50 | 11.50 | 11.50 | 11.50 | 11.50 |
| Growth rate | % | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% |

Figure 5-1 Public income - Congestion charge

5.2 Tolls

Details entered are the charge per vehicle and the days or part days when the income is generated. It is most likely this data is only available locally. Note there is no impact included of traffic avoiding tolls and taking a longer journey.

Data entered shows the numbers of vehicles (by vehicle type) that are subject to the toll each day for each sub-network. Unlike the Congestion Charge, the tolls are assumed to apply every day.

The base year shows the year of the vehicle count and the annual growth rates show how the counts will increase through the analysis period.

As with the Congestion Charge, the Toll Charge per vehicle and the annual increase in the charge are input for each vehicle type on each sub-network.

| Tolls ? | | | | | | | | | | | |
|-------------------|------------------------|--------|----------|----------|----------|--|--|--|--|--|--|
| Base year | | 2017 | | | | | | | | | |
| | | Unit | Region 1 | Region 2 | Region 3 | | | | | | |
| Cars and taxis | Count | No/Day | 28,793 | 28,793 | 28,793 | | | | | | |
| | Count Growth rate (%) | % | 1.7% | 1.7% | 1.7% | | | | | | |
| | Charge per vehicle | £ | £1.50 | £1.50 | £1.50 | | | | | | |
| | Charge Growth rate (%) | % | 1.5% | 1.5% | 1.5% | | | | | | |
| Motorbikes | Count | No/Day | 355 | 355 | 355 | | | | | | |
| | Count Growth rate (%) | % | 1.7% | 1.7% | 1.7% | | | | | | |
| | Charge per vehicle | £ | £1.50 | £1.50 | £1.50 | | | | | | |
| | Charge Growth rate (%) | % | 1.5% | 1.5% | 1.5% | | | | | | |
| Light vans | Count | No/Day | 1,777 | 1,777 | 1,777 | | | | | | |
| | Count Growth rate (%) | % | 2.7% | 2.7% | 2.7% | | | | | | |
| | Charge per vehicle | £ | £4.00 | £4.00 | £4.00 | | | | | | |
| | Charge Growth rate (%) | % | 1.5% | 1.5% | 1.5% | | | | | | |
| Goods vehicles | Count | No/Day | 1,244 | 1,244 | 1,244 | | | | | | |
| | Count Growth rate (%) | % | 1.1% | 1.1% | 1.1% | | | | | | |
| | Charge per vehicle | £ | £12.00 | £12.00 | £12.00 | | | | | | |
| | Charge Growth rate (%) | % | 1.5% | 1.5% | 1.5% | | | | | | |
| Buses and coaches | Count | No/Day | 355 | 355 | 355 | | | | | | |
| | Count Growth rate (%) | % | 1.0% | 1.0% | 1.0% | | | | | | |
| | Charge per vehicle | £ | £4.00 | £4.00 | £4.00 | | | | | | |
| | Charge Growth rate (%) | % | 1.5% | 1.5% | 1.5% | | | | | | |

Figure 5-2 Public income – Tolls

6 HMEA model inputs: Name and Filepaths


6.1 Analysis name

This worksheet is used to enter a name for the analysis (typically this will be some variation of the scenario name) and to select and load HMAT analysis results to be used in the HMEA analysis (see Figure 6-1).

HMEA model - Treatment & condition impact

Version: v1.04

UK ROADS LIAISON GROUP



Analysis name

Current Budget

Highways Maintenance Appraisal Tool (HMAT) files

Select folder for HMAT files

| | File path | Sub-Network |
|----|---|-------------|
| 1 | C:\Data\projects\HMEA\HMAT 30 yrs v2\Current Budget\HMAT - Current Budget - R1.xlsm | ... |
| 2 | C:\Data\projects\HMEA\HMAT 30 yrs v2\Current Budget\HMAT - Current Budget - R2.xlsm | ... |
| 3 | C:\Data\projects\HMEA\HMAT 30 yrs v2\Current Budget\HMAT - Current Budget - R3.xlsm | ... |
| 4 | | ... |
| 5 | | ... |
| 6 | | ... |
| 7 | | ... |
| 8 | | ... |
| 9 | | ... |
| 10 | | ... |

Use condition to modify traffic and therefore costs

Extract HMAT data and process

Clear processed data and file paths

Figure 6-1 Names and Filepaths for HMAT files

6.2 Selecting HMAT files

Before importing HMAT data into HMEA it is first necessary to show the locations of the HMAT files.

The button above the main table on this worksheet can be used to select a folder containing the HMAT files (see Figure 6-1). Using this button will use the names of all the Excel files in the selected folder and add them to the table. If the number of files in the folder exceeds the size of the table (i.e. ten) then the process will be aborted.

The buttons within the table containing “...” can be used to select each file individually.

If a file has been incorrectly selected, then this can be corrected by using the matching “...” button to either select a new file or to clear out the entry by selecting “Cancel” in the select file prompt that opens.

Note: Lines can be left blank in this list (e.g. paths can be entered for rows 1, 2 and 5 in the table) and only the files listed will be loaded.

Any changes to the file paths will result in the output data being cleared from the model (a warning prompt will be presented before data is removed).

6.3 Assigning the data to a sub-network

Once the file paths for the HMAT files have been entered it is necessary to identify which sub-network each file corresponds to. This is done using the sub-network column of the main table (to the right of the “...” buttons). For each file in the list the corresponding sub-network should be selected from the dropdown list.

When HMAT data is loaded into the HMEA tool, the data entry cells for assigning the sub-network will be locked. Therefore to change which sub-network applies to each file, the HMAT data must first be removed using the “Clear processed data and file paths” button or click on one of the buttons to select an HMAT file (see Figure 6-1).

6.4 Using condition to modify traffic

HMAT analyses provide information on the condition of each sub-network for each year of the analysis period.

The dropdown box below the main table allows for this calculation to be switched on or off. The recommended setting for this is “Use condition to modify traffic and therefore costs”.

An HMAT analysis uses the annual traffic flows to calculate the costs of impacts of road condition on road users but traffic is not used in the change in condition of the network. In practice, if condition deteriorates from the condition at the start of the analysis period, the annual traffic growth rate may reduce or if the condition is improved, the base traffic growth rate for the year may increase. However, the traffic growth figures in HMAT take no account the effect the change in condition has on the level of traffic.

HMEA enables the effect of network condition on the traffic growth rate to be considered in the results from the HMAT analysis. Note that this does not change the forecast network

condition from HMA, it changes only the numbers of vehicles affected by that condition (e.g. in the calculation of the effect on vehicle operating costs, delays at roadworks etc).

The growth rates of the economic parameters in HMEA are also changed by the effect of network condition (i.e. the economy grows faster if the network is in better condition than at the start of the analysis period and slower if the condition is worse than at the start of the analysis period).

If this option is not selected, the forecast traffic remains at the level calculated in HMA. Using condition to modify the traffic growth (see Figure 6-1) affects:

- HMA - Road condition and roadworks impacts
- HMEA - Network benefits and public income

Growth rates for the economic impacts

For the effect on the HMA results, the condition of each road type is used but for the economic impacts in HMEA, a weighted average of the condition of all road types is used for each sub-network.

Analyses may result in large changes in the percentage of the network in poor condition. To avoid the change in traffic growth or in the economic parameters being too large, these effects can be limited by specifying the maximum permitted change (see Figure 6-2) on the “Advanced settings” worksheet. Between the maximum improvement and deterioration in condition, the effect of network condition on the growth rates is a linear change.

In Figure 6-2 the values used to reflect the impact of change in condition are shown as white cells. These are yellow before HMA data is loaded (and can be changed) but the values cannot be changed once the HMA data has been loaded.

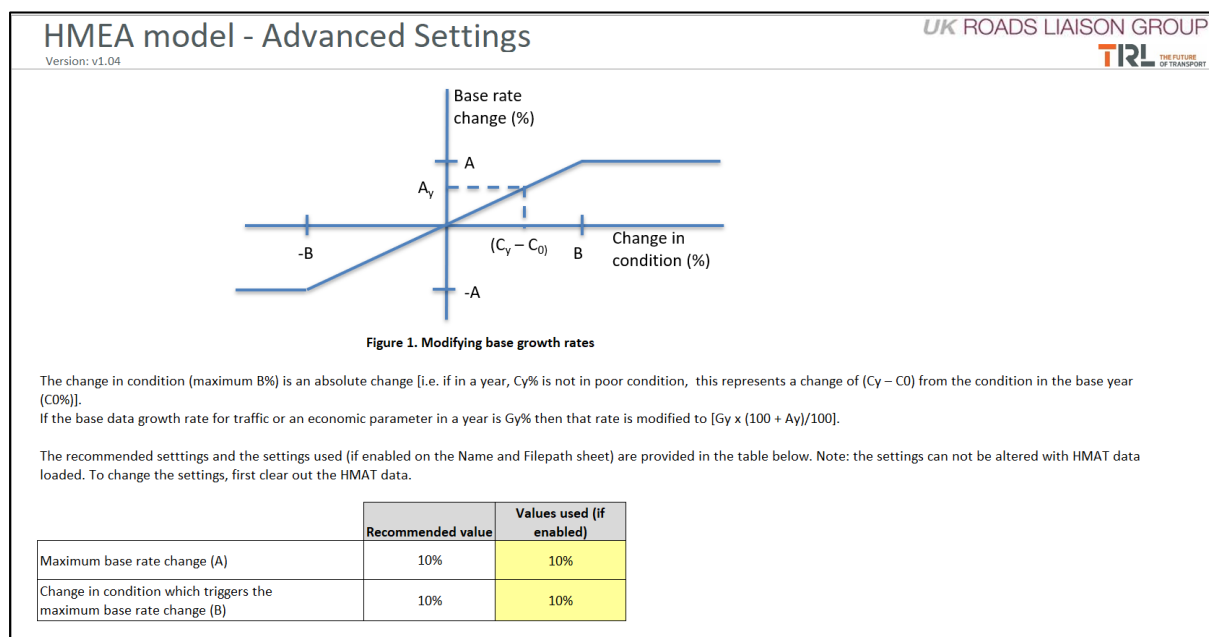


Figure 6-2 Effect of network condition on changes in traffic growth and economic parameters

Enabling this option modifies the estimates of future traffic levels and the resulting costs on the “Future Projections” and the “Summary (life analysis)” worksheets in HMEA.

When HMA data is loaded this option will be locked in the HMEA file. Using the “Clear processed data and file paths” button or clicking on one of the selecting HMA files buttons on the “Name and Filepaths” worksheet resets the option.

6.5 Extracting data

After data has been input on the preceding worksheets and selecting the HMA files to include in HMEA, attaching the sub-network names and selecting the “Effect of condition” option on the Name and Filepaths” worksheet, the HMEA analysis can be run by selecting the “Extract HMA data and process” button (see Figure 6-1).

This will lock the data settings selected and data entry cells which cannot be modified after HMA data has been imported. The HMEA calculations will be completed and the results worksheets become visible.

The analysis run time will depend on the speed of the computer used for the analysis (and the sizes of the HMA files) but this may take some minutes. While the analysis is running, avoid interacting with Excel (either in the HMEA workbook or opening a different workbook).

6.6 Clearing processed data and file paths

To clear the HMA data (e.g. to create a new copy of the HMEA file with a different set of HMA files for another scenario) then the “Clear processed data and file paths” button can be used (see Figure 6-1).

To clear the HMA data but to keep the file paths (e.g. to change a setting or to modify a cell which becomes locked) then click on one of the HMA file buttons in the main table.

7 HMEA model settings: Advanced settings

This worksheet describes the algorithm for modifying the base traffic and economic growth rates when network condition changes (see Figure 6-2). It is on this worksheet where the maximum changes to the traffic growth rates, and therefore the associated costs, caused by changes in network condition can be set.

HMA can include between 3 and 10 condition bands to represent the condition of the network. For modifying the annual growth rates, the definition of poor condition is a function of the number of condition bands:

- 3 condition bands, poor condition is the percentage in the bottom condition band
- 4 condition bands, poor condition is the percentage in the bottom condition band

- 5 condition bands, poor condition is the percentage in the bottom two condition bands
- 6 condition bands, poor condition is the percentage in the bottom two condition bands
- 7 condition bands, poor condition is the percentage in the bottom two condition bands
- 8 condition bands, poor condition is the percentage in the bottom three condition bands
- 9 condition bands, poor condition is the percentage in the bottom three condition bands
- 10 condition bands, poor condition is the percentage in the bottom three condition bands

Before loading the HMA data into HMEA the maximum changes permitted in the analysis can be set (the cells are coloured yellow before the HMA data is loaded). Once the HMA data has been loaded, the maximum change values cannot be changed unless the HMA data is cleared.

8 HMEA model supporting information

8.1 Network size

This worksheet presents the sub-network information taken from the HMA worksheets. This worksheet is not used in the calculations in HMEA and is presented for information only.

8.2 Condition and maintenance data

This worksheet presents the settings used in the HMA analyses. Only the analysis period is used in the calculations in HMEA and the other data is presented for information only.

Note: if the HMA files selected for loading into HMEA have different settings then the load process will be aborted (and the user notified).

9 HMEA model outputs: Future Projections

This worksheet shows the future projections (over the analysis period) from the HMEA analysis and the data extracted from the HMA analyses. The first set of tables at the top of the worksheet show the undiscounted and discounted costs for the whole network (see Figure 9-1 and Figure 9-2).

If more than one sub-network has been analysed, then summaries for each sub-network will be provide below the summary for the whole network.

| HMEA model - Projections | | | | Analysis year | | | | | | | | | |
|---|---|--------------------------------|--------------------------|---------------|-------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Version: v1.04 | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Analysis name: Current Budget | | | | | | | | | | | | | |
| Undiscounted costs for Case Study - General | | | Analysis period total | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | |
| | Parameter | Unit | | 17,000 | 17,000 | 17,000 | 17,000 | 17,000 | 17,000 | 17,000 | 17,000 | 17,000 | |
| | Expenditure by Treatment | £ k | 510,000 | 31.2% | 36.4% | 40.9% | 44.7% | 47.9% | 50.6% | 52.9% | 54.9% | 56.5% | |
| | Percentage in poor condition | % | | | | | | | | | | | |
| | Treatment and Condition Impacts | Vehicle operating costs | £ k | 321,047,158 | 5,454,300 | 5,626,535 | 5,805,375 | 6,022,748 | 6,272,815 | 6,595,036 | 6,970,052 | 7,362,761 | 7,735,221 |
| | | Travel time | £ k | 82,903,415 | 1,879,292 | 1,934,150 | 1,978,666 | 2,022,841 | 2,069,655 | 2,119,042 | 2,170,929 | 2,225,244 | 2,282,149 |
| | | Carbon (vehicle fuel) | £ k | 10,810,994 | 183,779 | 185,610 | 189,201 | 190,861 | 192,818 | 194,895 | 197,783 | 201,169 | 207,024 |
| | | Roadworks Accidents | £ k | 10,863 | 336 | 341 | 340 | 343 | 346 | 344 | 346 | 349 | 352 |
| | | Carbon (vehicles in roadworks) | £ k | 543 | 12 | 13 | 13 | 13 | 13 | 15 | 15 | 15 | 16 |
| | | Roadworks time delays | £ k | 194,531 | 6,352 | 6,454 | 5,616 | 5,671 | 5,725 | 5,891 | 5,954 | 6,006 | 6,058 |
| | | Accidents | £ k | 12,599,736 | 419,991 | 419,991 | 419,991 | 419,991 | 419,991 | 419,991 | 419,991 | 419,991 | 419,991 |
| | | Carbon (Embodied in materials) | £ k | 14,019 | 256 | 259 | 267 | 270 | 274 | 278 | 281 | 285 | 293 |
| | | Total HMAT costs | £ k | 427,581,258 | 7,944,318 | 8,173,353 | 8,399,468 | 8,662,738 | 8,961,638 | 9,335,492 | 9,765,353 | 10,215,822 | 10,651,104 |
| | | Network Benefits | Change in accident costs | £ k | - 3,976,508 | - 133,734 | - 132,779 | - 133,087 | - 133,383 | - 133,659 | - 133,912 | - 134,132 | - 134,387 |
| | Change in travel time costs | | £ k | 32,370,234 | 744,220 | 761,278 | 775,229 | 789,499 | 805,279 | 822,502 | 841,066 | 861,159 | 882,577 |
| | Change in cost of CO ₂ emissions | | £ k | 7,819,936 | 132,958 | 134,283 | 136,890 | 138,089 | 139,500 | 140,993 | 143,071 | 145,508 | 149,733 |
| | Total Network Benefits costs | | £ k | 36,213,663 | 743,443 | 762,783 | 779,032 | 794,205 | 811,119 | 829,584 | 850,005 | 872,281 | 897,702 |
| | Public Income | Congestion charge | £ k | 3,032,844 | 199,147 | 195,303 | 185,725 | 176,048 | 166,456 | 157,092 | 148,054 | 139,408 | 131,201 |
| | | Tolls | £ k | 1,261,641 | 80,821 | 79,416 | 75,687 | 71,904 | 68,141 | 64,456 | 60,890 | 57,470 | 54,216 |
| | | Total Public Income | £ k | 4,294,485 | 279,968 | 274,719 | 261,412 | 247,953 | 234,598 | 221,548 | 208,943 | 196,878 | 185,417 |
| | Economic Impacts | aGVA | £ k | 913,588,459 | 25,137,019 | 25,474,424 | 25,806,960 | 26,141,823 | 26,479,538 | 26,820,526 | 27,165,120 | 27,513,593 | 27,866,190 |
| | | Per Capita aGVA | £ | | 53,225 | 53,478 | 53,725 | 53,972 | 54,220 | 54,467 | 54,715 | 54,964 | 55,214 |
| | | Tax Receipts from income | £ k | 67,528,384 | 1,858,150 | 1,883,080 | 1,907,646 | 1,932,386 | 1,957,338 | 1,982,534 | 2,007,997 | 2,033,747 | 2,059,802 |
| | | VAT | £ k | 29,631,425 | 815,356 | 826,295 | 837,074 | 847,930 | 858,879 | 869,935 | 881,108 | 892,407 | 903,840 |
| | | NIC | £ k | 25,726,902 | 707,917 | 717,414 | 726,773 | 736,199 | 745,705 | 755,304 | 765,005 | 774,815 | 784,742 |
| | | Total tax receipts | £ k | 122,886,710 | 3,381,422 | 3,426,790 | 3,471,494 | 3,516,515 | 3,561,923 | 3,607,773 | 3,654,110 | 3,700,969 | 3,748,384 |
| | | Employment | No. | | 472,283 | 476,356 | 480,351 | 484,356 | 488,376 | 492,418 | 496,483 | 500,576 | 504,699 |
| Total Economic Impacts | | £ k | 1,036,475,169 | 28,518,441 | 28,901,214 | 29,278,453 | 29,658,338 | 30,041,460 | 30,428,299 | 30,819,230 | 31,214,562 | 31,614,574 | |

Figure 9-1 Projected costs from the HMEA analysis - undiscounted costs

To present results from the forecast future projections, or other parts of the analysis, in a separate graphics package, the values can be copied from the HMEA results tables.

| | | | | | | | | | | | | | |
|---|---|--|------|-----------------------|--|------------|------------|------------|------------|------------|------------|------------|------------|
| Discounted costs for Case Study - General | Parameter | | Unit | Analysis period total | | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
| | Expenditure by Treatment | | £ k | 276,458 | | 16,590 | 16,029 | 15,487 | 9,263 | 8,949 | 8,647 | 8,354 | 8,072 |
| | Percentage in poor condition | | % | | | 36.8% | 37.8% | 40.0% | 40.8% | 42.6% | 42.0% | 39.9% | 37.1% |
| | Vehicle operating costs | | £ k | 121,034 | | 5,949 | 6,100 | 6,312 | 6,406 | 6,492 | 6,586 | 6,648 | 6,689 |
| | Travel time | | £ k | 38,397 | | 1,966 | 1,953 | 1,945 | 1,920 | 1,899 | 1,890 | 1,877 | 1,858 |
| | Carbon (vehicle fuel) | | £ k | 3,542 | | 164 | 161 | 158 | 163 | 170 | 174 | 178 | 181 |
| | Roadworks Accidents | | £ k | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Carbon (vehicles in roadworks) | | £ k | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Roadworks time delays | | £ k | 7 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Accidents | | £ k | 6,178,002 | | 318,946 | 308,161 | 297,740 | 287,671 | 277,943 | 268,544 | 259,463 | 250,689 |
| | Carbon (Embodied in materials) | | £ k | 3,922 | | 217 | 212 | 208 | 135 | 142 | 147 | 153 | 158 |
| | Total HMAT costs | | £ k | 6,344,904 | | 327,244 | 316,587 | 306,363 | 296,296 | 286,646 | 277,342 | 268,320 | 259,575 |
| | Change in accident costs | | £ k | - 6,331,891 | | - 326,889 | - 315,832 | - 305,149 | - 294,828 | - 284,857 | - 275,223 | - 265,915 | - 256,921 |
| | Change in travel time costs | | £ k | - 11,305 | | - 573 | - 572 | - 572 | - 567 | - 561 | - 556 | - 550 | - 545 |
| | Change in cost of CO ₂ emissions | | £ k | 1,062 | | 49 | 48 | 47 | 49 | 51 | 52 | 53 | 54 |
| | Total Network Benefits costs | | £ k | - 6,342,134 | | - 327,413 | - 316,356 | - 305,673 | - 295,346 | - 285,367 | - 275,726 | - 266,411 | - 257,412 |
| | Congestion charge | | £ k | 2,095,582 | | 107,101 | 96,049 | 86,138 | 77,250 | 69,278 | 62,130 | 55,719 | 49,969 |
| | Tolls | | £ k | 862,798 | | 44,240 | 39,776 | 35,763 | 32,155 | 28,913 | 25,998 | 23,377 | 21,021 |
| | Total Public Income | | £ k | 2,958,380 | | 151,341 | 135,825 | 121,901 | 109,405 | 98,191 | 88,127 | 79,096 | 70,990 |
| | aGVA | | £ k | 898,042,795 | | 44,930,071 | 44,934,412 | 44,938,754 | 44,943,096 | 44,947,438 | 44,951,781 | 44,956,124 | 44,960,468 |
| | Per Capita aGVA | | £ | | | 47,049 | 46,221 | 45,409 | 44,610 | 43,825 | 43,055 | 42,298 | 41,554 |
| | Tax Receipts from income | | £ k | 13,590,593 | | 672,444 | 677,186 | 681,963 | 686,773 | 691,617 | 696,495 | 701,407 | 706,354 |
| | VAT | | £ k | 42,199,430 | | 1,997,303 | 2,054,809 | 2,113,972 | 2,174,838 | 2,237,457 | 2,301,878 | 2,368,154 | 2,436,339 |
| | NIC | | £ k | 28,345,226 | | 1,396,075 | 1,409,564 | 1,423,183 | 1,436,934 | 1,450,817 | 1,464,835 | 1,478,988 | 1,493,277 |
| | Total tax receipts | | £ k | 84,135,249 | | 4,065,822 | 4,141,560 | 4,219,118 | 4,298,544 | 4,379,890 | 4,463,207 | 4,548,549 | 4,635,971 |
| | Employment | | No. | | | 954,965 | 972,154 | 989,653 | 1,007,467 | 1,025,601 | 1,044,062 | 1,062,855 | 1,081,987 |
| | Total Economic Impacts | | £ k | 982,178,045 | | 48,995,893 | 49,075,972 | 49,157,872 | 49,241,640 | 49,327,328 | 49,414,988 | 49,504,673 | 49,596,438 |

Figure 9-2 Projected costs from the HMEA analysis - discounted costs

10 HMEA model outputs: Summary (life analysis)

This worksheet shows a summary of the analysis period total for the results of the HMEA analysis and the data extracted from the HMA model(s). This worksheet is the basis for the data shown in the HMEA Collator (see Section 11).

The results of the HMEA analysis are shown as undiscounted costs (see Figure 10-1) and discounted costs (see Figure 10-2). The Summary includes the details of the analysis period and each component of the calculated cost. If a component has not been included (e.g. Network Benefits or Public Income) then these rows are omitted.

To present results from the forecast future projections, or other parts of the analysis, in a separate graphics package, the values can be copied from the HMEA results tables.

HMEA model - Summary
Version: v1.04

| | | | |
|-----------------------------|--|-------------------------------|--|
| Analysis start year: 2020 | | Analysis name: Current Budget | |
| Analysis period (years): 30 | | | |

| Undiscounted costs | | | Region 1 | Region 2 | Region 3 |
|---|------|--------------------------------|-------------|-------------|-------------|
| | Unit | Total for Case Study - General | | | |
| Expenditure by Treatment | £ k | 510,000 | 176,057 | 128,642 | 205,302 |
| Vehicle Operating Costs | £ k | 321,047,158 | 85,713,397 | 100,915,659 | 134,418,102 |
| Travel Time | £ k | 82,903,415 | 23,008,825 | 26,372,125 | 33,522,464 |
| Carbon (vehicle fuel) | £ k | 10,810,994 | 2,743,902 | 3,332,791 | 4,734,301 |
| Roadworks Accidents | £ k | 10,863 | 5,796 | 3,104 | 1,964 |
| Carbon (vehicles in roadworks) | £ k | 543 | 135 | 29 | 378 |
| Roadworks time delays | £ k | 194,531 | 12,944 | 4,029 | 177,558 |
| Accidents | £ k | 12,599,736 | 3,830,889 | 4,354,493 | 4,414,354 |
| Carbon (Embodied in materials) | £ k | 14,019 | 4,839 | 3,536 | 5,643 |
| Total Scenario HMA costs | £ k | 427,581,258 | 115,320,728 | 134,985,766 | 177,274,764 |
| Change in accident costs | £ k | - 3,976,508 | - 1,784,668 | - 1,609,409 | - 582,430 |
| Change in travel time costs | £ k | 32,370,234 | 7,745,799 | 10,229,659 | 14,394,776 |
| Change in cost of CO ₂ emissions | £ k | 7,819,936 | 1,602,506 | 2,338,810 | 3,878,620 |
| Total Network Benefits costs | £ k | 36,213,663 | 7,563,637 | 10,959,060 | 17,690,967 |
| Congestion charge | £ k | 3,032,844 | 852,599 | 860,693 | 1,319,552 |
| Tolls | £ k | 1,261,641 | 354,282 | 357,628 | 549,731 |
| Total Public Income | £ k | 4,294,485 | 1,206,882 | 1,218,320 | 1,869,282 |
| aGVA | £ k | 913,588,459 | 209,419,076 | 247,011,776 | 457,157,607 |
| Per Capita aGVA | £ | 60,730 | 58,694 | 60,174 | 62,017 |
| Tax receipts | £ k | 122,886,710 | 29,068,925 | 33,450,033 | 60,367,752 |
| Employment | No. | 599,625 | 141,778 | 163,116 | 294,732 |
| Total Economic Impacts | £ k | 1,036,475,169 | 238,488,001 | 280,461,809 | 517,525,359 |

Figure 10-1 HMEA Summary results - Undiscounted costs

| Discounted costs | Unit | Total for Case Study - General | Region 1 | Region 2 | Region 3 |
|---|------|--------------------------------|-------------|-------------|-------------|
| Expenditure by Treatment | £ k | 323,608 | 111,713 | 81,626 | 130,269 |
| Vehicle Operating Costs | £ k | 184,143,266 | 49,190,834 | 57,953,923 | 76,998,508 |
| Travel Time | £ k | 49,334,775 | 13,722,115 | 15,668,310 | 19,944,349 |
| Carbon (vehicle fuel) | £ k | 5,995,793 | 1,521,806 | 1,854,322 | 2,619,666 |
| Roadworks Accidents | £ k | 6,803 | 3,614 | 1,931 | 1,258 |
| Carbon (vehicles in roadworks) | £ k | 328 | 81 | 18 | 228 |
| Roadworks time delays | £ k | 121,665 | 7,873 | 2,508 | 111,284 |
| Accidents | £ k | 7,994,855 | 2,430,797 | 2,763,037 | 2,801,020 |
| Carbon (Embodied in materials) | £ k | 7,906 | 2,729 | 1,994 | 3,183 |
| Total Scenario HMA costs | £ k | 247,605,391 | 66,879,850 | 78,246,044 | 102,479,496 |
| Change in accident costs | £ k | - 2,531,056 | - 1,114,382 | - 1,013,088 | - 403,586 |
| Change in travel time costs | £ k | 19,243,157 | 4,605,937 | 6,082,813 | 8,554,407 |
| Change in cost of CO ₂ emissions | £ k | 4,336,923 | 888,777 | 1,301,338 | 2,146,809 |
| Total Network HMA costs | £ k | 21,049,024 | 4,380,332 | 6,371,062 | 10,297,630 |
| Congestion charge | £ k | 2,200,496 | 638,403 | 644,291 | 917,802 |
| Tolls | £ k | 910,767 | 263,997 | 266,420 | 380,349 |
| Total Public Income | £ k | 3,111,262 | 902,400 | 910,711 | 1,298,151 |
| aGVA | £ k | 561,139,574 | 128,703,572 | 151,806,725 | 280,629,278 |
| Per Capita aGVA | £ | 22,394 | 21,643 | 22,189 | 22,869 |
| Tax receipts | £ k | 75,479,646 | 17,865,013 | 20,557,481 | 37,057,152 |
| Total Economic Impacts | £ k | 636,619,220 | 146,568,585 | 172,364,206 | 317,686,430 |

Figure 10-2 HMEA Summary results - Discounted costs

11 HMEA Collator

As discussed in Section 2.1 the HMEA process involves running the models (HMA and HMEA) for each scenario and then comparing the results. The HMEA Collator collects, in one place, the results from the HMEA analyses run for the scenarios in one place as illustrated in Figure 11-1.

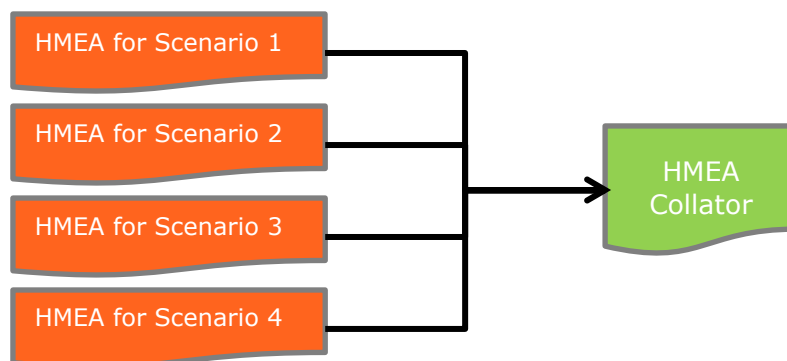


Figure 11-1 Collecting together HMEA results for analysis

The HMEA collator tool contains two worksheets. The first “Import data” manages the selection and importing of the HMEA results. The second worksheet “Summary” provides the summary values from the HMEA analyses along with the cost-benefit ratios.

11.1 Import data

11.1.1 Selecting HMEA files

The blue buttons on this worksheet (“Select folder for HMEA files” and the “...” buttons) are used to identify the HMEA files to be compared (see Figure 11-2).

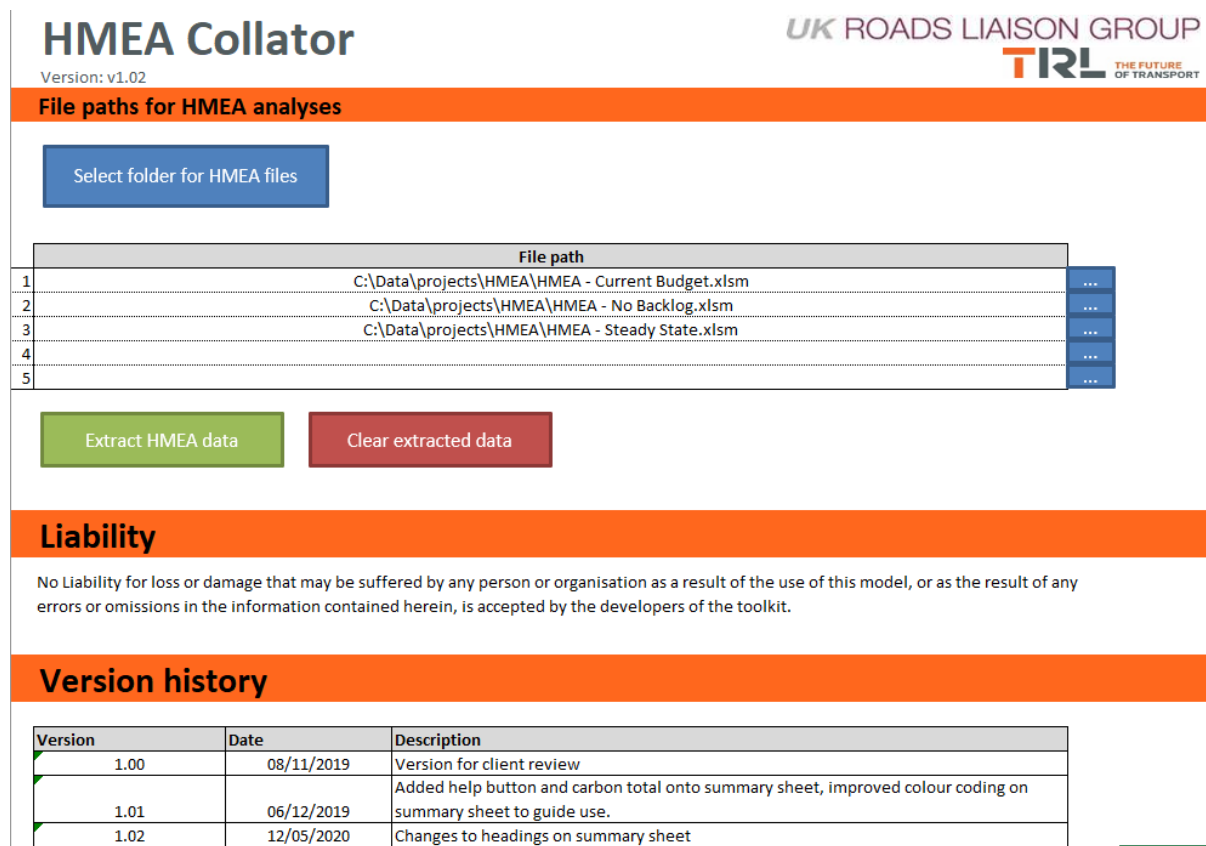
Using the “Select folder for HMEA files” button will add the names of the Excel files in the selected folder to the table. If the number of files in the folder exceeds the size of the table (maximum of five) then the process will be aborted.

The buttons within the table containing “...” can be used to select each file individually.

If a file has been incorrectly selected then this can be corrected by using the matching “...” button to either select a new file or to clear out the entry by selecting “Cancel” in the file prompt that opens.

Note: Lines can be left blank in this list (e.g. paths entered for rows 1, 2 and 5 in the table) and the files will be loaded.

Any changes to the file paths will result in the extracted HMEA data being cleared from the Collator (a warning prompt will be presented before this happens).



HMEA Collator
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File paths for HMEA analyses

Select folder for HMEA files

| | File path | |
|---|--|-----|
| 1 | C:\Data\projects\HMEA\HMEA - Current Budget.xlsm | ... |
| 2 | C:\Data\projects\HMEA\HMEA - No Backlog.xlsm | ... |
| 3 | C:\Data\projects\HMEA\HMEA - Steady State.xlsm | ... |
| 4 | | ... |
| 5 | | ... |

Extract HMEA data Clear extracted data

Liability

No Liability for loss or damage that may be suffered by any person or organisation as a result of the use of this model, or as the result of any errors or omissions in the information contained herein, is accepted by the developers of the toolkit.

Version history

| Version | Date | Description |
|---------|------------|--|
| 1.00 | 08/11/2019 | Version for client review |
| 1.01 | 06/12/2019 | Added help button and carbon total onto summary sheet, improved colour coding on summary sheet to guide use. |
| 1.02 | 12/05/2020 | Changes to headings on summary sheet |

Figure 11-2 HMEA Collator - File import

11.1.2 Loading and clearing data

When the HMEA files have been selected the data can be loaded into the Collator using the green “Extract HMEA data” button (see Figure 11-2).

To clear the data and the file names use the red “Clear extracted data” button. However, to just clear only the data (and not the file paths) use the HMEA files buttons “...” as with the other file selection worksheets.

11.2 Summary

This Summary worksheet (see Figure 11-3) provides a summary of the results from each of the HMEA analyses (i.e. the data from the “Summary (life analysis)” worksheet in HMEA). In addition, nine measures of economic contribution are presented to aid the comparison of the scenarios. At the top of this worksheet the selection buttons are used to select the base case scenario to which the other scenarios are compared.


The economic contributions are shown green for positive values and red for negative values.


The first economic contribution measure, the “Overall economic contribution” is equal to the savings in total cost divided by the increase in direct cost. This includes all the costs included in the HMEA tool. The remaining economic contribution measures provide different combinations of costs to help show the causes for the differences in the “Overall economic contribution” between the different scenarios.

HMEA Collator

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| | | | | | |
|--------------------|---|---|---|---|---|
| Analysis Name | | | | | |
| Base Case Selector | ● | ○ | ○ | ○ | ○ |

| | | | | | |
|------------------------------------|--|--|--|--|--|
| Overall Economic Contribution (EC) | | | | | |
| EC: HMA + HMEA (Economic) | | | | | |
| EC: HMEA (Excluding Economic) | | | | | |
| EC: HMEA (Excluding HMA) | | | | | |
| EC: HMEA (Net Ben + Public Inc.) | | | | | |
| EC: HMEA (Economic) | | | | | |
| EC: HMA | | | | | |
| EC: HMEA (Network Benefit) | | | | | |
| EC: HMEA (Public Income) | | | | | |

Discounted costs

| | | | | | |
|--------------------------|----|--|--|--|--|
| Direct Cost: Maintenance | £k | | | | |
| HMA Indirect Costs | £k | | | | |
| Total Carbon costs | £k | | | | |
| Network benefits | £k | | | | |
| Public Income | £k | | | | |
| Economic Impacts | £k | | | | |

| | | | | | |
|------------------------------------|--|--|--|--|--|
| Overall Economic Contribution (EC) | | | | | |
| EC: HMA + HMEA (Economic) | | | | | |
| EC: HMEA (Excluding Economic) | | | | | |
| EC: HMEA (Excluding HMA) | | | | | |
| EC: HMEA (Net Ben + Public Inc.) | | | | | |
| EC: HMEA (Economic) | | | | | |
| EC: HMA | | | | | |
| EC: HMEA (Network Benefit) | | | | | |
| EC: HMEA (Public Income) | | | | | |

Figure 11-3 HMEA Collator – Summary

Alternative scenarios have different direct maintenance costs over the analysis period. If the base case has direct maintenance costs of D_0 and an alternative scenario has direct maintenance costs of D_A , the increase in cost of the alternative scenario is $(D_A - D_0)$.

HMA analyses assess the effect of alternative maintenance scenarios. There are various components of the total cost calculated in HMA but the aim is to show the extra maintenance costs $(D_A - D_0)$ in the alternative scenario will reduce the future costs for that

scenario (H_A) compared to the future cost of the base case (H_0). The HMA benefit of the alternative scenario is therefore $(H_0 - H_A)$.

Changes in the economy are modelled in the HMEA analyses. This covers overall economy along with the benefit of the Network and public income. To account for the different maintenance scenarios, the traffic levels are modified based on the changing condition of the network over the analysis period resulting in changes to the benefits calculated.

The benefit from the overall economy for the alternative scenario arises from the increase in the economy over the base case and is given by the sum of the $(E_A - E_0)$ values for each year where E_A is the future economic cost of the alternative scenario and E_0 is the economic cost of the base case.

Network benefits arise from the lower costs from the use of the analysed network compared to the specified alternative network. If the traffic using the analysed network is the same for the two scenarios, the Network Benefits of the analysed network is the same for both the base case scenario and the alternative scenario. If there is an improvement in condition of the analysed network caused by adopting the alternative scenario over the base case then there is expected to be an increase in the traffic using the analysed network (compared to the base case). The benefit of the alternative scenario is the difference in the two Network Benefit values calculated using these different traffic levels (N_A for the alternative scenario and N_0 for the base case). For the calculation of the economic contribution, the benefit is the sum over the analysis period of the values for $(N_A - N_0)$ in each year.

Public Income represents an income from congestion and/or tolls. In the same way as with Network Benefits, if the traffic levels on two scenarios are the same there is no benefit of one scenario compared to the other. However, if the difference in road condition in an alternative scenario changes the traffic then there will be a change in the Income. The Public Income benefit of an alternative scenario is the difference between the Public Income from that scenario (P_A) compared to the Public Income from the base case (P_0). The effect on the increase in traffic providing the Public Income caused by changes in road network condition is calculated in the same way as the effect on the increase in traffic using the network.

The total benefit from an alternative scenario, compared to the base case is therefore:

$$[(H_0 - H_A) + (E_A - E_0) + (N_A - N_0) + (P_A - P_0)]$$

And the economic contribution for the alternative scenario compared to the base case is:

$$\frac{[(H_0 - H_A) + (E_A - E_0) + (N_A - N_0) + (P_A - P_0)]}{(D_A - D_0)}$$

Note that for any or all of H_A , E_A , N_A or P_A , the effect of the alternative scenario may be better or worse than the base case.

The economic contribution cells in the Collator are coloured green or red depending on the comparison between the alternative scenario and the scenario selected as the base case. If the economic contribution from the alternative scenario is less than from the base case, the cell is coloured red. However, it may still be a good option with a high economic contribution per £1 of direct cost.

- The cells are coloured green if:
 - The economic contribution of the alternative scenario is bigger than the contribution from the base case and the direct cost of the alternative scenario is higher than the base case
 - The economic contribution of the alternative scenario is smaller than the contribution from the base case and the direct cost of the alternative scenario is smaller than the base case
- The cells are coloured red if:
 - The economic contribution of the alternative scenario is smaller than the contribution from the base case and the direct cost of the alternative scenario is smaller than the base case
 - The economic contribution of the alternative scenario is smaller than the contribution from the base case and the direct cost of the alternative scenario is higher than the base case

12 References

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Department for Transport (2019). Transport Analysis Guidance. WebTAG National data. Available from:

<https://www.gov.uk/guidance/transport-analysis-guidance-webtag>

Office for National Statistics, (2009). UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007). Fareham: ONS.

UKRLG Asset Management Board (2019). HMEP Life-cycle Planning Toolkit Guidance. Available at:

<http://www.ukroadsliaisongroup.org/en/guidance/hmep-lcp-toolkits.cfm>

13 Abbreviations

| | |
|--------|--|
| aGVA | Approximate Gross Value Added |
| GDP | Gross Domestic Product |
| HMAT | Highway Maintenance Assessment Toolkit |
| HMEA | Highways Maintenance Economic Appraisal |
| HMEP | Highway Maintenance Efficiency Programme |
| NIC | National Insurance Contributions |
| ONS | Office of National Statistics |
| SIC | Standard Industrial Classification |
| UKRLG | United Kingdom Roads Liaison Group |
| VAT | Value Added Tax |
| WebTAG | Web based Transport Appraisal Guidance |

Appendix A Additional data required for HMAT when HMEP is disabled

If the HMEP tool is disabled in HMAT (i.e. future network condition and maintenance need is forecast using another tool or in stand-alone analyses with the HMEP Toolkit) then the results from these other analyses will need to replicate the format of the HMEP results tables in HMAT prior to copying those results into HMAT.

For example, when assembling the data, the order of road types must be the same as in the HMAT model analyses as HMAT relies on the order to make sure the data is attached to the correct road type. Three sets of data are needed for input into the appropriate worksheets in HMAT:

- Condition of the network for each road type, condition band and year of the analysis period (i.e. percentage in each condition band for each road type for each year).
 - This is Tab “2 - Condition by Year” in HMAT.
- Maintenance work quantity for each year of the analysis period
 - For each road type and each treatment type, the area* treated
 - This is Tab “3 – Work Quantity” in HMAT

* Note: If Length is available rather than Area, the Length data can be used with the carriageway widths (input to HMAT) to manually create the Area table.

- Expenditure by treatment for each year of the analysis period
 - For each road type and each treatment type, the maintenance expenditure in each year of the analysis period
 - This is Tab “4. - Exp by Treatment” in HMAT

The cells in these worksheets in HMAT are unprotected so data can be copied directly into the relevant cells on the worksheets.

Tables A-1 to A-3 show example data for the analysis of a road network using a short (10 years) analysis period with one road type in each of rural and urban environments, representing carriageway condition in four condition bands and using three maintenance treatments.

Note that the order for each road type, treatment type and condition band should be the same as the order specified in the HMAT data.

Table A-1. Example HMAT condition data for each road type and condition band

| Road Type | Condition Band | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|-----------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| A - DUAL(Rural) | VG | 14.48% | 6.27% | 2.86% | 5.51% | 5.18% | 15.73% | 25.17% | 25.31% | 24.72% | 29.45% | 30.29% |
| A - DUAL(Rural) | G | 62.33% | 58.68% | 8.19% | 18.88% | 13.46% | 13.46% | 0.00% | 4.39% | 2.22% | 5.00% | 4.16% |
| A - DUAL(Rural) | F | 23.18% | 35.05% | 21.83% | 68.80% | 66.43% | 61.65% | 62.38% | 44.97% | 14.22% | 4.87% | 3.90% |
| A - DUAL(Rural) | P | 0.00% | 0.00% | 0.06% | 6.81% | 14.93% | 9.16% | 12.45% | 25.33% | 58.83% | 60.68% | 61.65% |
| A - DUAL(Urban) | VG | 3.21% | 4.61% | 0.74% | 96.08% | 96.08% | 96.63% | 93.62% | 93.62% | 68.49% | 2.17% | 3.57% |
| A - DUAL(Urban) | G | 63.69% | 63.69% | 1.17% | 3.37% | 1.60% | 0.00% | 0.00% | 3.01% | 28.14% | 94.47% | 93.07% |
| A - DUAL(Urban) | F | 33.09% | 31.69% | 0.71% | 0.55% | 1.77% | 3.37% | 6.38% | 3.37% | 1.60% | 1.60% | 0.00% |
| A - DUAL(Urban) | P | 0.00% | 0.00% | 0.00% | 0.00% | 0.55% | 0.00% | 0.00% | 0.00% | 1.77% | 1.77% | 3.37% |

Table A-2. Example HMAT work quantity data for each road type and treatment type

| Road Type | Maintenance Treatment | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|-----------------|-----------------------|------|------|------|------|------|------|------|------|------|------|------|
| A - DUAL(Rural) | T1 | 1142 | 31 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |
| A - DUAL(Rural) | T2 | 5459 | 140 | 183 | 183 | 183 | 183 | 183 | 183 | 183 | 183 | 183 |
| A - DUAL(Rural) | T3 | 1100 | 2942 | 3694 | 3694 | 3694 | 3694 | 3694 | 3694 | 3694 | 3694 | 3694 |
| A - DUAL(Urban) | T1 | 12 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| A - DUAL(Urban) | T2 | 52 | 68 | 68 | 68 | 68 | 68 | 68 | 68 | 68 | 68 | 68 |
| A - DUAL(Urban) | T3 | 1093 | 1372 | 1372 | 1372 | 1372 | 1372 | 1372 | 1372 | 1372 | 1372 | 1372 |

Table A-3. Example HMAT expenditure data by treatment type for each road type

| Road Type | Maintenance Treatment | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|-----------------|-----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| A - DUAL(Rural) | T1 | 47,073 | 58,155 | 58,155 | 58,155 | 58,155 | 58,155 | 58,155 | 58,155 | 58,155 | 58,155 | 58,155 |
| A - DUAL(Rural) | T2 | 81,842 | 115,954 | 115,954 | 115,954 | 115,954 | 115,954 | 115,954 | 115,954 | 115,954 | 115,954 | 115,954 |
| A - DUAL(Rural) | T3 | 585,363 | 725,151 | 725,151 | 725,151 | 725,151 | 725,151 | 725,151 | 725,151 | 725,151 | 725,151 | 725,151 |
| A - DUAL(Urban) | T1 | 1,212 | 1,213 | 1,213 | 1,214 | 1,214 | 1,215 | 1,216 | 1,216 | 1,217 | 1,217 | 1,218 |
| A - DUAL(Urban) | T2 | 25,890 | 31,985 | 31,985 | 31,985 | 31,985 | 31,985 | 31,985 | 31,985 | 31,985 | 31,985 | 31,985 |
| A - DUAL(Urban) | T3 | 53,198 | 75,370 | 75,370 | 75,370 | 75,370 | 75,370 | 75,370 | 75,370 | 75,370 | 75,370 | 75,370 |

Note:

If Length is available rather than Area, the Length data can be used with the carriageway widths to create the Area table.

Appendix B Data links for HMEA and HMAT data

Possible sources of data for use in HMEA:

VAT and NIC

National values are available from:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833379/Aug19_Receipts_NS_Bulletin_Final.pdf

Tax from income

National values for 2017 and 2018 are available from:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/782862/NS_Table_3_11_1617.xlsx

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803473/Disaggregated tax and NICs receipts - statistics table.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803473/Disaggregated_tax_and_NICs_receipts_statistics_table.pdf)

aGVA

aGVA by industry sector is published information (e.g. at the following websites).

<https://www.statista.com/statistics/285023/gross-value-added-gva-in-the-uk-by-sector/>
[Gross Value Added \(Average\) at basic prices: CP SA £m - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk/economy/grossvalueadded/articles/grossvalueaddedaverageatbasicprices)

Population

[Estimates of the population for the UK, England and Wales, Scotland and Northern Ireland - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk/peoplepopulationandcommunity/ethnicityandnationality/articles/estimatesofthepopulationfortheukenglandandwalesscotlandandnorthernireland)

Annual growth rate - aGVA

The background growth (GDP deflator, as given in the WebTAG databook) would give the real terms aGVA growth per year.

<https://www.gov.uk/guidance/transport-analysis-guidance-webtag>

Annual growth rate - Tax from income, VAT, NIC

The Institute of Fiscal Studies (and others) suggest VAT, NIC and Tax from Income will each increase at a similar rate to aGVA (i.e. have only a small increase in the percent of GDP in the future).

[Institute of Fiscal Studies. The UK's public finances in the long run: the IFS model. IFS Working Paper W13/29](#)

Employment

Employment by industry sector is published information (e.g. at the following websites).

<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employmentbyindustryemp13>

<https://statswales.gov.wales/Catalogue/Business-Economy-and-Labour-Market/People-and-Work/Employment/Jobs/Employees-Only/Business-Register-and-Employment-Survey-SIC2007/employeejobs-by-area-year>

Annual growth rate - Employment

UK Economic Outlook March 2016 (later editions don't refer to employment) suggests employment to rise (in the UK) at 0.9% per year.

<https://obr.uk/forecasts-in-depth/the-economy-forecast/labour-market/>

Discount rate

Discount rates for transport analyses are part of the WebTAG guidance.

<https://www.gov.uk/guidance/transport-analysis-guidance-webtag>

Accidents

Accident data is available from the DfT Tag Data Book: Table A4.1.4 and Cobalt 2 worksheets.

<https://www.gov.uk/guidance/transport-analysis-guidance-webtag>

The following data sources were used in the analysis of the benefits of the Strategic Road Network in Wales:

Tax receipts and National Insurance Contributions

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833379/Aug19_Receipts_NS_Bulletin_Final.pdf

Population

<https://statswales.gov.wales/Catalogue/Population-and-Migration/Population/Estimates/Local-Authority/populationestimates-by-localauthority-year>

aGVA

<https://statswales.gov.wales/Catalogue/Business-Economy-and-Labour-Market/Regional-Accounts/Gross-Value-Added-GDP/gvainwales-by-industry>

Employment

<https://statswales.gov.wales/Catalogue/Business-Economy-and-Labour-Market/People-and-Work/Employment/Jobs/Employees-Only/Business-Register-and-Employment-Survey-SIC2007/employeejobsinwales-by-industry-year>

Road Lengths

<https://statswales.gov.wales/Catalogue/Transport/Roads/Lengths-and-Conditions/roadlength-by-typeofroad-year>

Traffic

<https://statswales.gov.wales/Catalogue/Transport/Roads/Road-Traffic/volumeofroadtraffic-by-localauthority-roadclassification> and

<https://statswales.gov.wales/Catalogue/Transport/Roads/Road-Traffic/volumeofroadtraffic-by-roadclassification-typeofvehicle>

Road Accidents

<https://statswales.gov.wales/Catalogue/Transport/Roads/Road-Accidents/accidents/roadaccidents-by-severity-area>

CO₂ emissions

<https://www.ons.gov.uk/economy/grossvalueaddedgva/qmis/regionalgrossvalueaddedincomeapproachqmi>

Appendix C Suitable folder structure for the HMEA and HMAT analysis files

There are various files used in HMEA and HMAT analyses and access to those files is generally by the name of the folder holding those files. This Appendix describes a file structure that can help accessing the relevant files and storing the results of the analyses.

Where external analyses of future network condition and maintenance are used with HMAT, rather than the HMEP toolkit contained within HMAT, the external analyses can be stored separately from the HMAT and HMEA files. If the HMEP toolkit within HMAT is used, the results are all held as part of the HMAT file. Figure C-1 shows an example file and folder layout for HMAT and HMEA analyses comprising a network made up of a number of regions and the analysis of three maintenance scenarios. The HMEA Collator will compare the results of the analyses of the three maintenance scenarios.

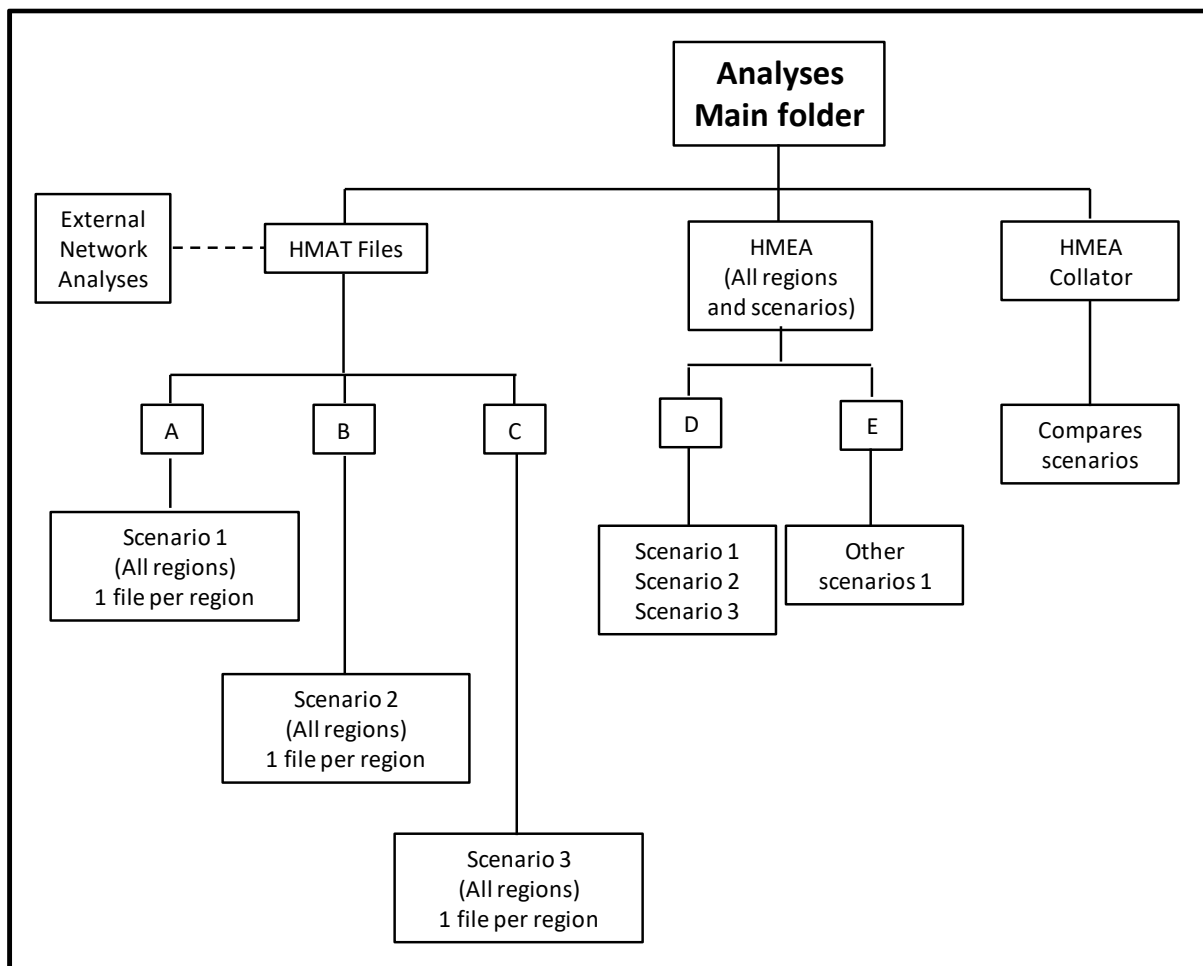


Figure C-1 Example file and folder layout for HMAT and HMEA analyses

It is assumed the results from the HMEP analyses are stored separately and the results from those files (i.e. network condition, work quantity and expenditure by treatment for each year of the analysis period) are copied into the HMAT files for each Region and each maintenance scenario.

Folder A contains the HMAT files for the regions (one HMAT file per region) for maintenance scenario No. 1. Folders B and C contain the HMAT files for maintenance scenarios No. 2 and No. 3.

Folder D contains three HMEA files (one per maintenance scenario). For scenario No. 1 the HMEA file accesses the HMAT files in Folder A. The HMEA files for maintenance scenarios No. 2 and No. 3 access the HMAT files in Folder B and Folder C respectively.

If further maintenance scenarios have been analysed and are to be compared in the HMEA Collator, these should be located in other HMEA folders (e.g. Folder E).

If more than six economic sectors are used for the HMEA analysis, more than one HMEA file will be needed and the HMEA files for the first six sectors and the remaining sectors will need to be in separate folders if the results are to be compared in the HMEA Collator. The Collator will not combine the results from the first six sectors and the remaining sectors, this will need to be done manually (see Appendix D).

Appendix D Combining results from HMEA analyses and the HMEA Collator

To examine the impacts of more than 6 economic sectors, HMEA analyses need to be undertaken separately for 6 sectors and the remaining sectors. Results from the separate analyses can be combined to show the overall effect of all the economic sectors.

The number of economic sectors has no effect on:

- Direct cost of maintenance or the indirect costs calculated in HMAAT
- Network benefits
- Public income

Only the economic impacts are changed by the number of sectors.

In the calculation of Overall Economic contribution from the road network, the Total contribution is the sum of the Economic Impact, Network Benefits and Public Income, less the indirect costs calculated in HMAAT

Table D-1 shows a summary of the results from an HMEA analyses as given in the HMEA Collator files for an analysis using 9 economic sectors. The results are shown from an analysis of three scenarios with scenario 1 selected as the base case. The 9 sectors have been analysed using HMEA for 6 sectors and 3 sectors analyses. The analyses were undertaken with network condition effects on economic and traffic growth included in the analyses. The economic impacts for the 6 sectors and 3 sectors are added to give the overall impact for the 9 sectors.

For employment, the numbers employed in the 9 sectors is the sum of those employed in 6 and 3 sectors.

Per Capita aGVA is calculated by the aGVA divided by the number employed. The Per Capita aGVA for the 9 sectors is therefore the sum of the aGVA in 6 and 3 sectors divided by the total employed in the 6 and 3 sectors.

Note that where the analyses are undertaken with no effect from network condition on economic and traffic growth, the economic impacts are unchanged between the 3 scenarios and the aGVA and employment in year 1 of the analysis period is the same for the different maintenance scenarios if the sectors are not changed.

Table D-1 Analysis results for the 6 sector and 3 sector analyses*

| Source | | | Scenario 1 (Base Case) | Scenario 2 | Scenario 3 |
|-------------------------|---------------------------------|----|---------------------------|---------------|---------------|
| HMAT | Direct Cost: Maintenance | £k | 362,007 | 513,568 | 473,593 |
| | Change in Direct Cost | | | 151,561 | 111,586 |
| HMAT | HMAT Indirect Costs | £k | 244,224,536 | 250,446,244 | 248,734,973 |
| HMAT | Total Carbon costs | £k | 5,251,144 | 5,528,255 | 5,553,952 |
| HMEA | Network benefits | £k | -6,866,337 | -6,613,044 | -6,586,513 |
| HMEA | Public Income | £k | 3,750,865 | 7,578,681 | 7,578,681 |
| HMEA - 3 sectors | Economic Impacts | £k | 301,190,442 | 311,750,877 | 311,750,877 |
| HMEA - 6 sectors | Economic Impacts | £k | 895,439,717 | 926,795,712 | 926,795,712 |
| 9 sectors | Total economic impact | £k | 1,196,630,159 | 1,238,546,589 | 1,238,546,589 |
| | Change in economic contribution | £k | | 39,775,832 | 41,513,634 |
| 9 sectors | Overall economic contribution | | | 262.44 | 372.03 |
| 3 sectors | Overall economic contribution | | | 55.55 | 91.03 |
| 6 sectors | Overall economic contribution | | | 192.76 | 277.39 |
| 9 sectors | Economic contribution | | | 276.57 | 375.64 |
| 6 sectors | Economic contribution | | | 206.89 | 281.00 |
| 3 sectors | Economic contribution | | | 69.68 | 94.64 |

* Source: HMEA Collator files for the scenario analyses

Highways Maintenance Economic Assessment (HMEA) User Guide



The Highways Maintenance Economic Assessment (HMEA) tool and HMEA Collator, are used to process and assess the economic impacts of different road network maintenance treatment scenarios, the value of the road network and income from other public sources over a specified analysis period. This includes the estimation of impacts to aGVA (approximate Gross Value Added, an estimate of the total output of an economy), Value Added Tax (VAT), Tax from Income, National Insurance Contributions (NIC) and employment with the impacts to road users directly associated with the use of the road network.

HMEA and the HMEA Collator are Microsoft Excel spreadsheet tools and this user guide describes how they are used.

The pre-existing Highways Maintenance Assessment Toolkit (HMAT) is used as part of this process and provides the assessment of the indirect impacts on road users and society from the condition of the road network. The HMAT analysis is separate from HMEA and HMEA accesses the results from the HMAT analyses. The HMAT User Guide is available separately.

This Guide provides possible data sources for use with HMEA and HMAT and describes an example analysis using the model.

Other titles from this subject area

- CPR2884** Development of the Highways Maintenance Economic Assessment (HMEA) Model
- CPR2136** Highways Maintenance Appraisal Tool (HMAT) User Guide
- CPR2137** Valuing the Benefits of Road Maintenance

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