Modelling Services Framework

Regional Model Development

Appraisal Tools - Safety

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National Transport Authority,
Dun Scéine,
Harcourt Lane,
Dublin 2.

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Contents

Page

Contents

Tables

No table of figures entries found.

Figures

No table of figures entries found.

1 Introduction

1.1 Background

As part of the Modelling Services Framework, Systra/Jacobs were commissioned by the National Transport Authority to develop a system of multi-modal transport models for each regional city in Ireland. As part of this commission, a scoping process was initiated in September 2014 to define the most appropriate suite of appraisal tools to compliment the regional models.

1.2 Purpose of this note

This note provides an overview of the proposed safety appraisal tools to be incorporated into the regional models. It includes a discussion of the safety appraisal process for transport schemes, outlines the required datasets and software to be incorporated into the models and provides a framework for the implementation of the tools into the regional models.

1.3 Review of Existing Safety Appraisal Module

The current GDA model outputs include a macro-enabled spreadsheet called “Extractions_v4.2”. This reads in a series of output files and produces appraisal summary tables for each of the CAF objectives. The safety appraisal component of this analysis appears to apply default accident rates from the NRA PAG to create a summary table of accidents by severity for each modelled time period.

The NRA accident rates are applied based on a defined relationship between the model link capacity indices and the COBA link classifications. It is assumed that accident numbers are then calculated by calculating annual million vehicle km per link and multiplying this by the NRA accident rates.

1.4 Proposed use of COBALT software

Based on the scoping process undertaken with the NTA, it is proposed to use the UK DfT COBALT (COst and Benefit to Accidents - Light Touch) software tool developed for safety appraisal of transport schemes. COBALT has been developed to replace the safety appraisal elements that were incorporated into the COBA program.

The preferred approach for appraisal of transport user and provider benefits in recent years is to use the TUBA program in place of COBA. However, TUBA does not incorporate an appraisal of scheme safety benefits and therefore a separate analysis is required. COBALT is a small version of COBA which assesses only the safety aspects of transport schemes (primarily road schemes).

The COBALT program can be simply adapted for use in Ireland through the incorporation of Irish based parameters such as accident rates and accident costs. However, the COBALT manual notes that in order to remain consistent with the DfT guidance, users should not edit the economics file. Therefore it is recommended that the NTA contact the DfT to outline the intention to modify the COBALT program for use in Ireland, therefore ultimately creating an Irish version of the software.

2 Overview of the Safety Appraisal Process

A safety appraisal of a transport scheme is typically undertaken by comparing forecasts of accidents on the transport network and their severity between a 'with scheme' and 'without scheme' scenario. The inputs into the process are road network characteristics, accident rates and costs, and forecast traffic volumes.

The network characteristics such as link type, length and speed and traffic flow forecasts are specified by the user for each scheme. Generally this information is directly extracted from a transport model.

Accident costs are standard inputs based on empirical data. Values have been derived for the prevention of fatal, serious and minor casualties and include the human costs, loss of output due to injury and hospital costs. In addition, values of cost of damage to vehicles and property, insurance costs and Gardaí costs are incorporated into the analysis.

Accident rates have been developed for various road link type based on analysis of historical data and are output in the format of PIA (Personal Injury Accidents) per million vehicle kilometres travelled on a road link. Standard factors have also been developed to estimate the typical proportion of accidents (fatal, serious and minor) by road type and the average numbers of casualties per accident.

For the safety appraisal of a transport scheme, the forecast accidents occurring in the 'with scheme' and 'without scheme' scenarios are assigned costs from the values outlined above. The safety benefits of a scheme would typically comprise a monetary value on the forecast reduction of accidents in the 'with scheme' scenario.

2.1 Road Schemes

The safety appraisal process has mainly been developed for the appraisal of road schemes. For example a new motorway scheme would provide safety benefits by the accident and casualty reduction impacts of motorists switching to a safer standard of road, i.e. a reduction of total vehicle kilometres travelled on less safe local and regional roads and an increase in vehicle kilometres travelled on safer motorway routes.

2.2 Public Transport Schemes

The introduction of a public transport scheme may have an influence on traffic volumes on the surrounding road network. For example, the opening of a new bus corridor and associated services may reduce the demand for travel by car along road links immediately parallel to the new corridor. This would have an impact on the total number of accidents through a reduction in vehicle kilometres travelled on the road network. Therefore the public transport scheme will result in safety benefits associated with road accident reduction.

In addition there are safety impacts to consider for passengers on a new public transport service. At present there is no published data on accident rates for travel by bus and rail in Ireland. While accident costs can be estimated based on existing data, until reliable estimates of bus and rail safety characteristics are available, it is not intended to consider incorporating this into the Regional Model safety appraisal tool.

Furthermore, the proportion of transport related accidents for bus and rail passengers is substantially lower than that for road accidents. Research undertaken in the USA[1] over the period 2000-2009 showed that there were 36,321 average annual fatalities associated with accidents involving pedestrians, bicycles, motorcycles, cars, light trucks and large trucks. For accidents involving bus and rail passengers, there was an annual average of 59 fatalities. When considering the safety impacts of public transport for the purposes of scheme appraisal, it is appropriate to focus on road accident related benefits only, given that the vast majority of safety impacts are pertaining to road accidents.

2.3 Active Modes

The numbers of people walking and cycling may be impacted by road or public transport schemes. In addition, a specific scheme that improves facilities for pedestrians and cyclists could be expected to have a lower accident risk for active modes than the scenario without the scheme. Conversely, a scheme that results in an increase in walking and cycling on the network, will also result in an increase in the number of accidents, if they are new trips or switch from a mode with a lower accident risk.

There are significant challenges in forecasting active mode accidents. It is very difficult to establish an accident rate for a particular type of walking or cycling scheme due to the influence of local conditions and specific design details.

The NTA Regional Models incorporate a high level representation of the walking and cycling network, which is appropriate for the strategic nature of the models. Therefore, even if the local impacts are known and there is associated data available on accident rates, it is not always possible to fully represent this in the models. In general, forecasting of active mode accident rates is more appropriate to be undertaken on at a local scheme level and not via the use of a regional transport model.

It is therefore not intended to incorporate that the accident reduction impacts for active modes into the safety appraisal tools for the Regional Models. Other impacts on active modes can be considered however, such as health benefits and absenteeism benefits. This is discussed further in ref.

[1] http://journalistsresource.org/studies/environment/transportation/comparing-fatality-risks-united-states-transportation-across-modes-time#

3 Datasets Required

3.1 Outcome of the Initial Data Review

3.1.1 COBALT Software

The UK Department for Transport (DfT) provides the COBALT software, user manual, parameter inputs and worked examples on the WebTAG webpage[2]. A review of this was undertaken to determine its appropriateness for use with the Regional Models and the equivalent Irish parameters required.

COBALT is a tool written in Visual Basic for Applications, based within Microsoft Excel. All of the calculations are undertaken within a single Excel file. As such, the file can be stored anywhere on a hard drive or network drive. The main inputs into the COBALT model are:

- **Economic Parameter file:** information on standard accident rates, accident costs and cost growth forecasts and other parameters. The DfT produce a standard economics file for UK transport schemes; and
- **Scheme Input Files:** information on the scheme network and traffic flows. This can be extracted from the highway element of the Regional Models in SATURN. Historical accident rates can also be recorded in this input file.

3.2 Economic Parameter Data Required

In order to create an Irish version of COBALT, an update to the economic parameter file is required. This update can draw on the Irish parameters developed by the Department of Transport in the 2009 CAF and the 2011 NRA PAG parameters, developed for use in COBA by TRL Ltd. The various parameters and the source for Irish data is outlined overleaf in Table 3.1.

Note that the previous Irish version of COBA maintained by the NRA worked with link and junction combined accident rates and proportions only. Junction specific data can be assessed in detail, using separate link and junction only accident rates and proportions. However this is generally reserved for a local analysis and CBA. As the nature of scheme appraisal using the NTA Regional Models will be strategic, it is intended to retain the combined link and junction based approach for the NTA safety appraisal tools.

The sources in Table 3.1 are based on currently adapted guidance by DTTAS and the NRA. We are aware that DTTAS are in the process of producing updated appraisal parameters. We believe that when these are adopted, the Irish COBALT Economics file can be readily updated.

[2] https://www.gov.uk/government/publications/cobalt-software-and-user-manuals

Table 3.1: Summary of sources for Irish values for COBALT economics file.

Parameter	Source for Irish Value
Version	Version number for Irish parameter file
Cost Base Year	2009
Appraisal Period	30/60 year as per CAF
Discount Rate	5% as per Public Spending Code[3]
Cost per Casualty (by severity)	CAF A1 Section 4 NRA PAG 6.11 Table 4 (2009 prices)
Cost per Accident (by severity, component part)	CAF A1 Section 4 NRA PAG 6.11 Table 4
Compound Annual Rates of Growth of Accident Values	NRA PAG 6.11 Table 4
Number of Damage Only Accidents per PIA	To be obtained from RSA database
Link and Junction Combined Accident Proportions	NRA PAG 6.11 Table 21
Link and Junction Combined Accident Rates	NRA PAG 6.11 Table 20
Link and Junction Combined Accident Change (Beta) Factors	NRA PAG 6.11 Table 23
Link and Junction Combined Accident Beta Factor Changes over Time	NRA PAG 6.4 Section 4.35
Link and Junction Combined Casualty Change Factors	NRA PAG 6.11 Table 23

A draft Irish COBALT Economic parameter file has been prepared and is included in Appendix A.

3.3 Model Data Required

3.3.1 COBALT Scheme File

The initial input into the COBALT scheme file is general information including the scheme name, the appraisal year and modelled years for the without scheme (Do Minimum) and with scheme (Do Something) transport models. A scheme opening year must also be defined.

The first output from the regional models into COBALT will consist of link attributes, which can be exported from the transport model. This includes the link name, a link type (corresponding to those specified in the economics parameter file), the link length in km and the link speed in mph. A sample output is shown below:

Link Name	Road Type	Length (km)	Speed Limit (mph)
5321_5320	4	0.100	40
12135_5369	9	0.169	30
6246_5372	8	0.214	30
6257_5373	9	0.498	30

The next set of link attributes required is the link flow information. This requires the Average Annual Daily Traffic (AADT) of each link to be inputted for each modelled year and for each scenario, i.e. with and without the scheme. A sample output is shown below:

[3] http://www.per.gov.ie/project-discount-inflation-rates/

Link Name	Base Year Flows	Without-Scheme Flows Year 1	Without-Scheme Flows Year 2	With-Scheme Flows Year 1	With-Scheme Flows Year 2
5321_5320	12364	14289	16187	17232	12922
12135_5369	273	341	323	319	342
6246_5372	1778	2421	2481	2652	2102
6257_5373	7563	7703	7941	7984	7697

The final set of link attributes to be entered is the local accident rates for all, some or none of the links in the transport models. It is possible to generate a full set of local accident rates for each link in the Regional Models using information from the RSA accidents database. This would be based on geospatial analysis of accident locations on a link over time, with reference to the traffic flows on each link. This is a detailed analysis task to cover the entire modelled networks.

This data is usually collated on a scheme by scheme basis using information from the RSA accidents database. It is generally accepted that for the purposes of safety appraisal, the user may define an area of influence of a propose scheme and enter local accident data for that area only. In addition the levels of model noise must be considered. The safety appraisal should generally limit the calculation of accident reduction benefits to those that can be reasonably attributable to a scheme and also should exclude areas of the model impacted by noise, if applicable.

The attributes required on local accident data per link for the COBALT scheme file include the link name, the observed number of accidents for consecutive years (comma separated values) or an observed accident rate (PIA per million vehicle km) with an 'R' suffix. Examples of both formats are shown below:

Link Name	Observed Accidents	First Accident Year
L119	8,3,5	2007
L120	0.311R	2007

Note that at present, the current version of COBALT does not have the capability to incorporate additional local data on accident severity.

3.3.2 Regional Model outputs

The SATURN program includes a utility called 'SATCOBA' for exporting model network and flow data to COBA formatted input files. The input files for COBALT are of a slightly different format and it is therefore recommended that a simple SATURN batch file or appropriate script file be developed that produces the appropriate scheme input files for COBALT as outlined above. This is a relatively straightforward task once the SATURN model files are available for all modelled years, time periods and scheme scenarios.

Some additional scripting will be required to incorporate the following elements into the COBALT scheme input files:

- Relationship between link capacity types in the models and standard accident rates; and
- The default calculation of AADT for each of the regional models

It may also be useful to incorporate a network area selection function into the batch files or script files process to specify the extent of the network to use for safety appraisal.

4 Implementation of the Safety Appraisal Process

4.1 Overview

The following steps were specified in the Task Order for the economy appraisal, and are discussed below.

- create process;
- test process;
- sign off;
- documentation;
- training;
- ongoing support;
- potential enhancements;
- additional research; and
- integrate / polish.

4.2 Creating the Process

4.2.1 Write standard economics file

A proposed Irish standard COBALT economics file is included in Appendix A. This is based on currently adapted guidance from the DoT (now DTTAS) and NRA.

As the current accident parameters are currently under review by DTTAS, the final economic parameters will be agreed with DTTAS and NTA. It is a relatively simple process to update the economics file to a new version as and when new economic parameters are adopted.

4.2.2 Write Voyager scripts to output COBALT scheme file

Voyager scripts will be created to output the scheme files in the format required by COBALT. This will include an option to specify the area of the modelled network to be used for the safety appraisal.

The function to specify network areas would require an input data file that defines the SATURN links required. This could be specified by the selection of the Regional Model sectors which Are related to link numbers. . If no areas are specified, the full network of the Regional Model will be used for the COBALT runs.

In addition, this process requires an incorporation of the factors for converting traffic flows in the modelled time periods of each of the Regional Models to AADT to represent a typical day. This will be applied to the link based flow output of each time period and scenario to create AADT inputs for COBALT.

This scripting functionality could be automated within the regional model Voyager process.

4.2.3 Write Voyager scripts to run COBALT

Voyager scripts will be created to run the COBALT program using the standard economics file and scheme files.

4.2.4 Set up standard output analysis processes

The output files from COBALT can be exported to a database or spreadsheet which can be more easily interrogated by users. The spreadsheet will allow users to review the outputs such as the breakdown of safety benefits by year and isolation of savings by accident severity. Standard sector based statistics can also be taken from the database, to facilitate consistent reporting and summary datasets from the multi-criteria appraisal process.

The link based accident statistics section of the output file can also be exported to GIS shapefiles. This will facilitate very useful map based plots of areas of safety benefits on the network.

4.2.5 Process specifications

Process	Tool	Inputs	Reference for detailed approach	Outputs
Create standard economics file	n/a – text format	DTTAS and NRA guidance on appraisal parameters UK DfT economics file (as examples of formats)	COBALT User Manual	Standard COBALT economics file
Scheme file generation	Voyager (matrix program)	DTTAS guidance on appraisal periods. Regional Model AADT factors. Optional specification of network area.	COBALT User Manual	Script to generate a scheme file for specified do minimum and do something scenarios
Run COBALT analysis	Voyager (matrix program)	Standard economics file and scheme file created from Regional Model	COBALT User Manual	Script to run COBALT from within the Voyager interface
Standard analysis processes	Excel and ArcGIS	Format specification for COBALT output files	Specification of analyses to be agreed with NTA	Spreadsheet tools and GIS shapefiles to facilitate analysis and interrogation of safety appraisal results.

4.3 Testing the Process and Sign Off

Steps in testing and signing off the processes will be:

- peer review of standard economic file;
- detailed (independent) checking that the scheme file is as expected;
- run some checks of AADT outputs for scheme files against SATURN based outputs;
- check that link/network specification functionality in the scheme file output process performs as expected;
- run COBALT for a sample scheme and sense check headline appraisal results; and
- check that headline appraisal results can be reproduced in the output analysis process.

4.4 Documentation, Training and Support

Documentation will include user note(s) for each process and evidence of testing.

A training programme will be agreed with NTA. Training topics could include:

- principles of safety appraisal;
- overview of processes;
- step-by-step training in running and checking processes; and
- worked exercises in assessing appraisal outputs.

It may be most appropriate to develop training courses for two types of user:

- users who will make use of summary outputs;
- users who will work with the detailed TUBA outputs, and interrogate model inputs results to debug or understand appraisals.

4.5 Potential Enhancements and Research

NTA may wish to develop their own scripts, spreadsheets or software to implement safety appraisal calculations within the Regional Models rather than use COBALT. This would be feasible because the calculations are relatively straight forward. It may be desirable so that NTA could adapt new methodologies e.g. public transport passenger accident rates or incorporate Irish historic accident data directly into the regional models.