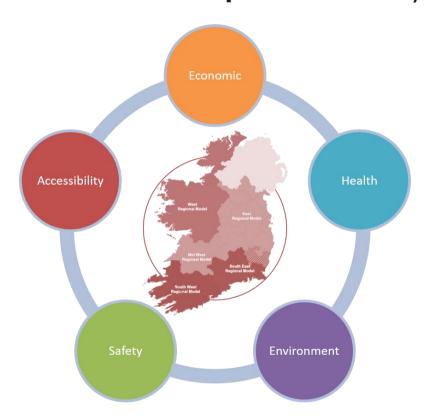


National Transport Authority



Accessibility & Social Inclusion Module

Development report

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

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1 Introduction

1.1 Background

Jacobs/SYSTRA were commissioned by the National Transport Authority to develop a set of Appraisal Modules linking to the outputs of its Regional Modelling System. Appraisal modules were developed for each of the following aspects of standard transport scheme assessment and appraisal:

- Safety Appraisal
- Economic Appraisal
- Environmental Appraisal
- Health Appraisal
- Accessibility and Social Inclusion Appraisal

The Accessibility and Social Inclusion Appraisal Module has been developed using model parameters and outputs from all the regional models. The user must be bear in mind that a number of items will need to be need considered when the appraisal module is used with each of the Regional Models. Those items are described in Section 4, Incorporating the Accessibility and Social Inclusion Appraisal Module into each of the Regional Models.

The Accessibility and Social Inclusion Appraisal Module has been developed in accordance with the methodology outlined in the Accessibility Overview note, December 2016, and is accompanied by a User Guide, "Accessibility_Social_Inclusion_User_Guide_v3.1.0, March 2021."

Following this introductory section, the remainder of this note is structured as follows:

- Section 2: Overview of Accessibility and Social Inclusion Appraisal Module Development, including input assumptions, current limitations and potential future enhancements;
- Section 3: Testing and Sense Checking, including a description of tests and checks undertaken; and
- Section 4: Incorporating the Accessibility and Social Inclusion Appraisal Module into the other regional transport models, including an outline of items to consider.

2 Overview of Accessibility & Social Inclusion Appraisal Module Development

2.1 Introduction

The Accessibility and Social Inclusion Appraisal Module is a Cube Voyager (version 6.4.2), Excel spreadsheet and ArcGIS based application that has been developed for the National Transport Authority (NTA). The Accessibility and Social Inclusion Appraisal Module forms part of the NTA appraisal toolkit for efficient manipulation of regional model outputs that will support strategy development, assessment and scheme appraisal.

Three measures are used to assess accessibility and social inclusion changes between a 'With-Scheme' and 'Without-Scheme' forecast scenario. These are: a **Travel Time Measure** and a **Simple Hansen Measure** for the Accessibility assessment, and an **Income-based Geographic User Benefits Indicator** for the Social Inclusion assessment. Note that the appraisal tool also provides analysis for the base year scenario but it does not provide any comparisons between the base and forecast year scenarios.

The modelled inputs into the process are travel times and generalised costs by mode and user class, cost deterrence lambda values, forecast population and employment levels, and non-business user benefits also by mode and user class (those non-business user benefits are obtained from the Economic Appraisal Tool from the exported detailed TUBA file).

The non-modelled inputs to the process are base year population and employment levels, incomebased deprivation indices (obtained from POBAL Haase and Pratschke (HP), September 2017) and locations of key activity / service areas that people may want to reach.

The Accessibility and Social Inclusion Appraisal Module has two distinct elements; the Cube Voyager application element which processes transport model output and is used to inform the Accessibility and Social Inclusion measures and uses various macros in excel; and the ArcGIS element which is used to display those measures via a graphical user interface. The Cube Voyager and ArcGIS elements are fully automated processes and run according to a set of user-specified commands.

An overview of the Accessibility and Social Inclusion Appraisal Module process is shown in Figure 1 below.

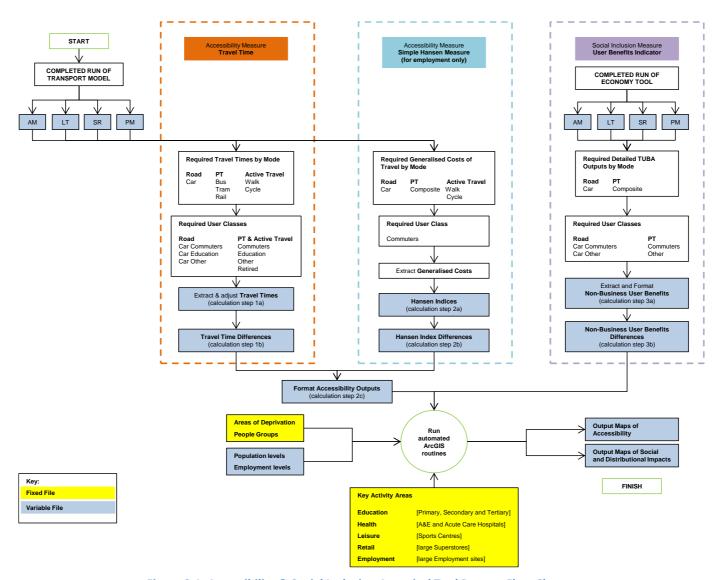


Figure 2.1: Accessibility & Social Inclusion Appraisal Tool Process Flow Chart

2.2 Cube Voyager Catalogue

Preparing Accessibility Measures Inputs

The Accessibility measures use four time periods specific assigned road, active travel and public transport travel time, and generalised / composite costs skims from the Base, Do-Minimum and Do-Something modelled scenarios. It is those modelled outputs in conjunction with demographic information and ArcGIS maps showing locations of key activity areas that ultimately provide the necessary information for measuring changes in accessibility between a 'With-Scheme' and 'Without-Scheme' forecast scenario.

Preparing Social Inclusion Measure Inputs

The Social Inclusion measure uses four time period specific non-business user benefits (in the form of Travel Time and Vehicle Operating Cost (VOC) benefits) from the Base, Do-Minimum and Do-Something modelled scenarios. Those benefits are obtained automatically from the Economic Appraisal Tool from the exported detailed TUBA file. It is those Economic Appraisal Tool outputs in conjunction with demographic information and ArcGIS maps showing areas of deprivation that ultimately provides the necessary information for measuring changes in social inclusion between a 'With-Scheme' and 'Without-Scheme' forecast scenario.

The Cube Voyager Interface process automatically obtains (and creates) the necessary inputs for the Accessibility and Social Inclusion measures, and adjusts those inputs using different macros so that they are in the appropriate format for use with ArcGIS.

There are three overarching calculation steps which are shown in the process flow chart in Figure 1 above and are described in more detail below.

Calculation Steps

Step 1a - Extract and Adjust Travel Times

This initial calculation step extracts and adjusts travel times (in minutes) from the transport model. These travel times are 'actual' travel times (as opposed to perceived travel times) and cover car, active travel and public transport modes by user class.

- ROAD_Skims_{Time Period}_{RunID}{Growth}{YY}.MAT
- AAM {Time Period} {RunID}{Growth}{YY}.MAT
- {Time Period}_PT_{UC}.MAT

Where {Time Period} = Time Period (e.g AM), {RunID} = Base Run ID, {Growth} = Base Demand Scenario, {YY} = Base Model Year, {UC} = User Class Type

The transport model includes seven public transport sub-modes. As such, a necessary adjustment is made so that bus, tram and rail travel times (as aggregate sub-modes) are obtained. Adjustments are made to boarding penalty, in-vehicle time and transfer penalty as required and dependant on meeting specified criteria. The criteria used in the adjustments are provided in Appendix A.

Table 1: Travel Times, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
MATRIX	Travel Time, Sub-Group 2	Base	4, 8, 12, 13
MATRIX	Travel Time, Sub-Group 5	Do-Minimum	6, 13, 20, 21
MATRIX	Travel Time, Sub-Group 8	Do-Something	6, 14, 20, 21

Step 1b - Travel Time Differences

The second part of the initial calculation step calculates 'actual' travel time differences between the Do-Minimum [i.e. Without Scheme] scenario and a Do-Something [i.e. With Scheme] forecast scenario. The calculation covers car, active travel and public transport modes by user class, and takes into account any travel time adjustments made in Step 1a. Travel differences will only be calculated during a Do-Something Model Type run where relevant Do-Minimum transport model outputs are available.

Table 2: Travel Time Differences, Voyager Program Location

Voyager Program	Location	Model Type	Module Execution Number
MATRIX	Travel Time, Sub-Group 10	Do-Something	7, 14, 21, 22

Step 2a - Hansen Indices

Step 2 creates the Simple Hansen Measure indices and covers car, active travel and public transport (composite) modes by commuter user class only.

The Simple Hansen Measure takes into account both the attractiveness of an activity and the deterrence associated with reaching that activity. This incorporates the Gravity Model ¹when calculating costs and applies a 'weight' depending on whether the model is Origin or Destination-based. The Accessibility and Social Inclusion Appraisal Module uses the Origin-based model.

The Origin-based model considers one or more origin zones and determines, for a given set of destination zones (which supply a service or activity), some form of Accessibility measure for each destination zone. Each destination zone would have an index calculated. This form of model is therefore able to recognise that some zones may be very accessible to others, but if they do not have the appropriate land use activity (destination) or contain the population requiring the activity (origin) then accessibility would be low.

In formula terms, the Simple Hansen Measure (Origin-based) is:

$$H(A^k, S)_i = \sum_{j=1}^{selzones} A_j^k \times e^{\left(-\lambda^s c_{ij}^s\right)}$$

Where:

- H(A^k,S)_i = The weighted number of the service or activity k for the population in segment "S" relative to the origin zone at location i. **This is the index (or accessibility indicator) per origin zone the higher the index the 'better' the accessibility**;
- $A_i^k = Activity$ or service k located in destination j;
- λ^s = A positive coefficient used in the cost deterrence calculation for person in segment "S"; and
- c_{ij}^s = Cost of travel between zone i and j for segment.

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¹ A gravity model is a model that describes the relationship between two objects based on distance and mass (population, jobs, etc.)

The generalised cost input files are:

- ROAD _{Time Period}_{RunID}{Growth}{YY}.RCM
- AAM_{Time Period}_{RunID}{Growth}{YY}_Skims.MAT
- {Time Period}_PT_COMPCST.MAT

Where {Time Period} = Time Period (e.g AM), {RunID} = Base Run ID, {Growth} = Base Demand Scenario, {YY} = Base Model Year, {UC} = User Class Type

The population and employment data input file is **Base Zonal Data.CSV** (for base year) and **Forecast_{YYYY}_Zonal Data.CSV** [NB example Forecast Year]. The Simple Hansen Measure is weighted by employment in each destination zone and hence population in each zone is currently set to one. The forecast zonal data file needs to be produced for each individual model run, as it needs to use the growth folder that is created as part of every RMS run.

The cost deterrence lambda values have been provided by the NTA and have been coded into the Cube Voyager application using a series of catalogue keys. These values cover car, public transport, walk and cycle modes have been calculated from the POWSCAR (2016) and NHTS (2017) data for all of the 5 regions, as calculated for the RMS v3 demand models. The default values in the CUBE script are for the ERM, the values for the other tools can be found in the user guide. – see Section 4.2, Items to Consider.

Table 3: Hansen Indices, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
MATRIX	Hansen Measure, Sub-Group 2	Base	5
MATRIX	Hansen Measure, Sub-Group 4	Do-Minimum	7
MATRIX	Hansen Measure, Sub-Group 6	Do-Something	7

Step 2b - Hansen Index Differences

This step calculates Hansen Index differences between the Do-Minimum [i.e. Without Scheme] scenario and a Do-Something [i.e. With Scheme] forecast scenario. The calculation covers car, active travel and public transport (composite) modes by commuter user class only. Hansen Index differences will only be calculated during a Do-Something Model Type run (if requested by the user) and if the relevant Do-Minimum transport model output(s) is available.

Table 4: Hansen Index Differences, Voyager Program Location

Voyager Program	Location	Model Type	Module Execution Number
MATRIX	Hansen Measure, Sub-Group 8	Do-Something	7

Step 2c - Format Accessibility Measures Outputs

This calculation step converts the format of the Travel Times and Hansen Indices from CSV file format (as produced by Cube Voyager) to TXT file format for use with ArcGIS. In doing so, the transport model zone system, in which the Travel Times and Hansen Indices are obtained or calculated, is converted to the ArcGIS zone system – the ArcGIS zone system is hierarchical and is numbered differently to the model zone system.

The Accessibility Measures input files are;

- {Time Period}_{Mode} {UC} Travel Times.CSV
- {Time Period} Hansen Indices for {Mode} Commuters.CSV
- Time Period}_PT_COMPCST.MAT
 Where {Time Period} = Time Period (e.g AM), {Mode} is the mode of transport, {UC} = User
 Class Type

The zone system correspondence list is named {RMS_Model}_zonal_system.xlsx.

The formatting of the Accessibility Measures inputs for use with ArcGIS is carried out by an Excel Macro Spreadsheet file named **Format_Accessibility_v1.xlsm**.

Table 5: Format Accessibility Measures Inputs, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
PILOT	Format Accessibility Outputs	Base	6
PILOT	Format Accessibility Outputs	Do-Minimum	14
PILOT	Format Accessibility Outputs	Do-Something	23

Path File Locations File

Finally, Step 2c creates the path file locations file which is named **Accessibility_run_files.txt**. This file consists of the locations of the required input files (described above) to run the **Format_Accessibility_v1.xlsm** Excel Macro Spreadsheet file. The calculation is hard coded into the relevant Voyager script file and it uses a selection of catalogue keys to define the path file locations.

Table 6: Path File Locations File for Accessibility Measures Inputs, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
Accessibility Measu	res:		
MATRIX	Format Accessibility Outputs	Base	4
MATRIX	Format Accessibility Outputs	Do-Minimum	12
MATRIX	Format Accessibility Outputs	Do-Something	21

Step 3a – Extract and Format Non-Business User Benefits

This third and final step extracts non-business user benefits from the Economic Appraisal Tool output and converts the format of those benefits for use with ArcGIS. In doing so, the transport model zone system, in which the user benefits are obtained, is converted to the ArcGIS zone system – the ArcGIS zone system is hierarchical and is numbered differently to the model zone system. Purposes 4/5 from TUBA which relate to education and retired get converted to purpose 3 other, to keep the outputs consistent with the ArcGIS script.

The extraction and formatting of those benefits is carried out by an Excel Macro Spreadsheet file named **Format_Social_Inclusion_v1.xlsm**. The input files are;

- TUBA_Outputs_{RunID}_{Growth}{YYYY}.txt
- zonal system.xlsx

Where {RunID} = Run ID, {Growth} = Demand Scenario, {YYYY} = Model Year,

The default detailed TUBA output file is in Comma Separated Value (CSV) format (Excel). However, given that Excel cannot fully load the contents of the detailed TUBA output file (due to its size); the CSV file has its file extension renamed to TXT (text file) so that all the contents of the detailed TUBA output file can be read by the macro.

User Benefits is only concerned with home-based non-business car and public transport trips [i.e. car and PT commuters, and car and PT other journey purposes]. Although it is recognised that using an assignment model based on Origins and Destinations the origin of a trip is not necessarily home. To overcome this, the zonal benefits in the AM Peak are the total of the benefits from that zone, and in the PM Peak the zonal benefits are the total of the benefits to that zone. For the School Run (SR) and Inter Peak (IP) periods the zonal benefits are an average of the sum of the benefits to and from each zone.

Table 7: Non-Business User Benefits, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
PILOT	Social Inclusion, Sub-Group 2	Base	3
PILOT	Social Inclusion, Sub-Group 5	Do-Minimum	5
PILOT	Social Inclusion, Sub-Group 8	Do-Something	5

Step 3B - Non-Business User Benefits Differences

This step calculates and formats non-business user benefits differences between the Do-Minimum [i.e. Without Scheme] scenario and a Do-Something [i.e. With Scheme] forecast scenario. The calculation covers car and public transport (composite) modes by commuter and 'other user classes.

Non-business user benefits differences will only be calculated during a Do-Something Model Type run (if requested by the user) and if the relevant Do-Minimum transport model output(s) is available. The formatting of benefits differences is carried out by an Excel Macro Spreadsheet file named Format_Social_Inclusion_Differences_v1.xlsm. In doing so, the transport model zone system, in which the user benefits differences are obtained, is converted to the ArcGIS zone system.

Table 8: Non-Business User Benefits Differences, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
PILOT	Social Inclusion, Sub-Group 10	Do-Something	5

Path File Locations File

Finally, this step creates the path file locations file which is named **Social_Inclusion_run_files.txt**. This file consists of the locations of the required input files (described above) to run both the **Format_Social_Inclusion_v1.xlsm** and **Format_Social_Inclusion_Differences_v1.xlsm** Excel Macro Spreadsheet files. The calculation is hard coded into the relevant Voyager script file and it uses a selection of catalogue keys to define the path file locations.

This file also consists of many criteria to facilitate the extraction of home-based non-business car and public transport trips from the Economic Appraisal Tool output. These criteria are provided in Appendix B.

Table 9: Path File Locations File for Social Inclusion Measure, Voyager Program Locations

Voyager Program	Location	Model Type	Module Execution Number
MATRIX	Social Inclusion, Sub-Group 2	Base	1

MATRIX	Social Inclusion, Sub-Group 5	Do-Minimum	3
MATRIX	Social Inclusion, Sub-Groups 8 & 10	Do-Something	3 & 4

A summary of all the input and output files that are required for the Accessibility and Social Inclusion Appraisal Module is shown in Table 10 below.

Table 10: Accessibility and Social Inclusion Appraisal Module Input and Output Files

Input File	Description	Example Location		
Cube Voyager Application Inputs for Accessibility Analysis:				
Road_Skims_AM_BY06A612.MAT * * example Time Period, Base Run ID, Base Demand Scenario, Base Model Year	Road Network Skims that are time period and scenario specific, and in Voyager format. They contain the required car travel time skims to inform the travel time accessibility measure. This is a variable file and its inputs will change according to differing transport model runs. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\R oad\AM * *Base Model Year, Base Run ID, Base Demand Scenario, Time Period, Regional Model		
AAM_AM_BY06A612_Skims.MAT * * example Time Period, Base Run ID, Base Demand Scenario, Model Year	Active Travel Mode Network Skims that are time period and scenario specific, and in Voyager format. They contain the required walk and cycle travel time skims to inform the travel time accessibility measure and the Simple Hansen accessibility measure. This is a variable file and its inputs will change according to differing transport model runs. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\ Active\AM * *Model Year, Base Run ID, Base Demand Scenario, Time Period, Regional Model		
AM_PT_COM.MAT * * example Time Period, User Class	Public Transport Network Skims that are time period and scenario specific, and in Voyager format. They contain the required bus, tram and rail travel time skims to inform the travel time accessibility measure. This is a variable file and its inputs will change according to differing transport model runs. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\P T\AM * *Model Year, Base Run ID, Base Demand Scenario, Time Period, Regional Model		
Road_AM_BY06A612.RCM * * example Time Period, Base Run ID, Base Demand Scenario, Model Year	Road Network Generalised Cost Skims that are time period and scenario specific, and in Voyager format. They contain the required car commuter generalised cost skims to inform the Simple Hansen accessibility measure. This is a variable file and its inputs will change according to differing transport model runs. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001 }\Road\AM * *Model Year, Base Run ID, Base Demand Scenario, Time Period, Regional Model		
AM_PT_COMPCST.MAT * * example Time Period	Public Transport Network Composite Cost Skims that are time period and scenario specific, and in Voyager format. They contain the required public transport commuter composite cost skims to inform the Simple Hansen accessibility measure. This is a variable file and its inputs will change according to differing transport model runs. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\P T\AM * *Model Year, Base Run ID, Base Demand Scenario, Time Period, Regional Model		

Base Zonal Data.csv	Base Employment Numbers that are in Excel comma separated value format. It contains the level of employment for each model zone. This is a fixed file and its inputs do not change. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Program\Accessi bility Module\Hansen
Forecast_2022_ Zonal Data.csv * * example Model Year (up to a maximum of five forecast years)	Forecast Year Employment Numbers that are in Excel comma separated value format. It contains the level of employment for each model zone and for each forecast year. The forecast year files are variable files and their inputs will change according to differing forecast year travel demand scenarios. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Program \Accessibility Module\Hansen
DummyInput.txt	Empty File that facilitates printing of the run parameters and file paths contained within Accessibility_run_files.txt (see below). This is a fixed file and its inputs (empty) do not change. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Program \Accessibility Module
Input File	Description	Example Location
Cube Voyager Application Inputs for Accessib	ility Analysis:	
Accessibility_run_files.txt	Path File Locations File consisting of files locations for input to the Format_Accessibility_v1 macro spreadsheet. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type and for the Accessibility or All run options.	{Catalog_Dir}\Program \Accessibility Module
Format_Accessibility_v1.xlsm	Accessibility Measure Macro Spreadsheet used to convert the format of the travel times and Hansen indices for use with ArcGIS. It is run automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type and for the Accessibility or All run options NB this macro also calculates differences between Do-Minimum and Do-Something scenarios if the user selects "Yes" in the "Calculate DS vs DM Differences" catalogue key for a Do-Something model type only.	{Catalog_Dir}\Program \Accessibility Module
zonal_system.xlsx	Model Zone System to ArcGIS Zone System Correspondence List that is used to convert the zone system of all modelled inputs (and non-modelled inputs where relevant) for use with ArcGIS. It is run automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type and Run Option.	{Catalog_Dir}\Program \Accessibility Module
Input File	Description	Example Location
Cube Voyager Application Inputs for Social Inclusion Analysis:		

Input File	each Model Type and Run Option. Description	Example Location
zonal_system.xlsx	Model Zone System to ArcGIS Zone System Correspondence List that is used to convert the zone system of all modelled inputs (and non-modelled inputs where relevant) for use with ArcGIS. It is run automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for	{Catalog_Dir}\Program \Accessibility Module
Format_Social_Inclusion_Differences_v1.xl sm	Social Inclusion Measure Differences Macro Spreadsheet used to convert the format differences of the detailed TUBA outputs between Do-Minimum and Do-Something scenarios for use with ArcGIS. It is run automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process if the user selects "Yes" in the "Calculate DS vs DM Differences" catalogue key. If "Yes" is selected, this macro will be run for a Do-Something model type only, and for the Social Inclusion or All run options.	{Catalog_Dir}\Program \Accessibility Module
Format_Social_Inclusion_v1.xlsm Social Inclusion Measure Macro Spreadsheet convert the format of the detailed TUBA out use with ArcGIS. It is run automatically Accessibility and Social Inclusion Appraisal I Cube Voyager element process for each Mod and for the Social Inclusion or All run options.		{Catalog_Dir}\Program\Accessi bility Module
Social_Inclusion_run_files.txt	Path File Locations File consisting of files locations for input to the Format_Social_Inclusion_v1 and Format_Social_Inclusion_Differences_v1 macro spreadsheets. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type and for the Social Inclusion or All run options.	{Catalog_Dir}\Program \Accessibility Module
DummyInput.txt	Empty File that facilitates printing of the run parameters and file paths contained within Social_Inclusion_run_files.txt (see below). This is a fixed file and its inputs (empty) do not change. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	
TUBA_Outputs_BY06_A62012.csv * * example Base Run ID, Base Demand Scenario, Model Year	TUBA Output file that is scenario specific and in Excel comma separated value format. It consists of detailed economic appraisal results which are used to inform the Income-based Geographic User Benefits Indicator. This is a variable file and its inputs will change according to differing transport model runs. It is not created by the Accessibility and Social Inclusion Appraisal Module process but obtained from the Economic Appraisal Tool.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_\{Regional_Model}_{YY}_{G} rowth}_{RunID}_Input_v0001\ Economic * *Model Year, Base Run ID, Base Demand Scenario, Regional Model

ERM_4_2.shp * *example Regional Model Name	Regional Master Shapefile that is used to display model zones. The zone system shapefile forms the basis from which to display the Accessibility and Social Inclusion Measures. This shapefile also contains base year socio-demographic data for each zone, including population and employment levels, car-owning households and income-based deprivation indices. It also contains locations (by zone) of each key activity / service area. This is a variable file but currently would have to be updated manually (see Section 2.4, Future Enhancements). It is not created automatically by the Accessibility and Social Inclusion Appraisal Module	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\GIS\Shapefile* *Model Year, Base Run ID, Base Demand Scenario		
Hansen Indices.lyr * * example Measure Type	Layer Properties File for each Measure Type that is used to apply the appropriate symbology and scale ranges to the final output ArcGIS maps. There are separate layer files for each measure type which include Travel Times and Hansen Indices (Accessibility Measures), and Travel Time and Vehicle Operating Cost Benefits (Social Inclusion Measure). This is a fixed file and its inputs do not change. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\GIS\LayerTemplates* *Model Year, Base Run ID, Base Demand Scenario		
Primary Education.lyr * * example Activity Area	Layer Properties File for each Key Activity / Service Area that is used to apply the appropriate symbology to each activity area defined within the attributes of the Regional Model Zone System Shapefile. These activity areas include Primary, Secondary & Tertiary Education; Large Employment Areas; Large Supermarkets; Sports Centres; and A&E and Acute Care Hospitals. This is a fixed file and its inputs do not change. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\ Appraisal_Tools\ GIS\Layer Templates\ * *Model Year, Base Run ID, Base Demand Scenario		
Deprivation Index.lyr * * example Social Demographic Data	Layer Properties File that is used to apply the appropriate symbology and scale ranges to demographic data that is contained with the Regional Model Zone System Shapefile. It can be displayed as a background in the final output ArcGIS maps. The socio-demographic data which can be mapped to each zone are population and employment levels, carowning households and income-based deprivation indices. This is a fixed file and its inputs do not change. It is not created by the Accessibility and Social Inclusion Appraisal Module process.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\GIS\LayerTemplates* *Model Year, Base Run ID, Base Demand Scenario		
Output File	Description	Example Location		
Cube Voyager Application Outputs for Accessibility Analysis (To inform ArcGIS Mapping):				
AM_Car Commuter Travel Times.txt * * example Time Period, User Class	Car Travel Times that are time period, user class and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type, and for the Accessibility or All run options. NB where relevant, differences in Car Travel Times between Do-Minimum and Do-Something scenarios will be stored using this same filename but appended with the word "Differences." This difference file will be located in a separate folder named "DS minus DM" under the example location shown here.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\Accessibility\Road\Formatted* *Model Year, Base Run ID, Base Demand Scenario, Regional Model		

Public Transport Travel Times that are time period, sub-mode, user class and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created {Catalog_Dir}\Runs\{Regional_ automatically by the Accessibility and Social Inclusion Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr Appraisal Module: Cube Voyager element process for AM_Bus Commuter Travel Times.txt * each Model Type, and for the Accessibility or All run owth}_{RunID}_Input_v0001\ Appraisal_Tools\ * example Time Period, PT sub-mode, User Accessibility\PT\Formatted* NB where relevant, differences in Public Transport Travel Times between Do-Minimum and Do-*Model Year, Base Run ID, Something scenarios will be stored using this same Base Demand Scenario, filename but appended with the word "Differences." **Regional Model** This difference file will be located in a separate folder named "DS minus DM" under the example location shown here. Active Travel Mode Travel Times that are time period, sub-mode, user class and scenario specific. This is a variable file and its inputs will change {Catalog_Dir}\Runs\{Regional_ according to differing transport model runs. It is Model}\{YY}\{RunID}\4_Outpu created automatically by the Accessibility and Social ts_{Regional_Model}_{YY}_{Gr Inclusion Appraisal Module: Cube Voyager element owth}_{RunID}_Input_v0001\ AM_Cycle Times Commuter.txt * process for each Model Type, and for the Accessibility Appraisal_Tools\ or All run options. Accessibility\Active\ * example Time Period, Active Mode, User NB where relevant, differences in Active Travel Mode Formatted* Travel Times between Do-Minimum and Do-*Model Year, Base Run ID, Something scenarios will be stored using this same Base Demand Scenario, filename but appended with the word "Differences." **Regional Model** This difference file will be located in a separate folder named "DS minus DM" under the example location shown here. Car Commuter Hansen Indices that are time period and scenario specific. This is a variable file and its inputs will change according to differing transport {Catalog_Dir}\Runs\{Regional_ model runs. It is created automatically by the Model}\{YY}\{RunID}\4_Outpu Accessibility and Social Inclusion Appraisal Module: ts_{Regional_Model}_{YY}_{Gr owth} {RunID} Input v0001\ Cube Voyager element process for each Model Type, **AM Hansen Indices for Car** and for the Accessibility or All run options. Appraisal_Tools\Social Commuters.txt* Inclusion\Road\User Benefits NB where relevant, differences in Car Commuter Indicator\Formatted * * example Time Period Hansen Indices between Do-Minimum and Do-Something scenarios will be stored using this same *Model Year, Base Run ID. filename but appended with but appended with the Base Demand Scenario, word "Differences." This difference file will be located **Regional Model** in a separate folder named "DS minus DM" under the example location shown here. Public Transport (composite) Commuter Hansen Indices that are time period and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created {Catalog_Dir}\Runs\{Regional_ automatically by the Accessibility and Social Inclusion Model}\{YY}\{RunID}\4_Outpu Appraisal Module: Cube Voyager element process for ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\ each Model Type, and for the Accessibility or All run AM Hansen Indices for PT Commuters.txt * Appraisal Tools\ options. Accessibility\PT\Formatted * * example Time Period NB where relevant, differences in Public Transport (composite) Commuter Hansen Indices between Do-*Model Year, Base Run ID, Minimum and Do-Something scenarios will be stored Base Demand Scenario. using this same filename but appended with the word **Regional Model** "Differences." This difference file will be located in a separate folder named "DS minus DM" under the example location shown here.

AM Hansen Indices for Cycle Commuters.txt * * example Time Period, Active Mode	Active Travel Mode Hansen Indices that are time period, sub-mode and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type, and for the Accessibility or All run options. NB where relevant, differences in Active Travel Mode Hansen Indices between Do-Minimum and Do-Something scenarios will be stored using this same filename but appended with the word "Differences." This difference file will be located in a separate folder named "DS minus DM" under the example location shown here.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\Accessibility\Active\Formatted* *Model Year, Base Run ID, Base Demand Scenario, Regional Model
AM_Car Commuters Travel Time Benefits.txt * * example Time Period, User Class, Benefit Type	Car User Benefits that are time period, user class, benefit type [i.e. travel time or VOC] and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type, and for the Social Inclusion or All run options.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\SocialInclusion\Road\User BenefitsIndicator\Formatted* * Model Year, Base Run ID, Base Demand Scenario, Regional Model
AM_PT Commuters Travel Time Benefits.txt * * example Time Period, User Class	Public Transport (composite) Travel Time Benefits that are time period, user class and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for each Model Type, and for the Social Inclusion or All run options.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\Social Inclusion\PT\User Benefits Indicator\Formatted* * Model Year, Base Run ID, Base Demand Scenario, Regional Model
AM_Car Commuters Travel Time Benefits_DS_Minus_DM.txt * * example Time Period, User Class, Benefit Type	Differences in Car User Benefits between Do-Minimum and Do-Something scenarios that are time period, user class, benefit type [i.e. travel time or VOC] and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for the Do-Something Model Type only, and for the Social Inclusion or All run options. NB this difference file will be located in a separate folder named "DS minus DM" under the example location shown here.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_\{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\Social Inclusion\Road\User Benefits Indicator\Formatted* * Model Year, Base Run ID, Base Demand Scenario, Regional Model

AM_PT Commuters Travel Time Benefits_DS_Minus_DM.txt * * example Time Period, User Class	Differences in Public Transport (composite) Travel Time Benefits between Do-Minimum and Do-Something scenarios that are time period, user class and scenario specific. This is a variable file and its inputs will change according to differing transport model runs. It is created automatically by the Accessibility and Social Inclusion Appraisal Module: Cube Voyager element process for the Do-Something Model Type only, and for the Social Inclusion or All run options. NB this difference file will be located in a separate folder named "DS minus DM" under the example location shown here.	{Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growth}_{RunID}_Input_v0001\Appraisal_Tools\SocialInclusion\PT\User BenefitsIndicator\Formatted* * Model Year, Base Run ID, Base Demand Scenario, Regional Model
Output File	Description	Example Location
ArcGIS outputs for Accessibility and Social In	iclusion Analysis:	
Zone_2000.shp * * example Zone Number	Origin Zone Shapefile that facilitates the display of the user selected origin zone. It has many accompanying files which define the attribute data, projected co-ordinate system and spatial indexes. This is a variable file and its inputs will change according to the zone that is selected for analysis. It is created automatically by the Accessibility and Social Inclusion Appraisal Module.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\ Appraisal_Tools\GIS\GIS Outputs\2000* * example Base Model Year, Base Run ID, Base Demand Scenario, Zone Number
AM Hansen Indices for Car Commuters_Zone_2000.shp * * example Accessibility/Social Inclusion output file, Zone Number	Accessibility or Social Inclusion Measure Data Shapefile for the selected origin zone. This is a variable file and its inputs and filename will change according to the type of analysis undertaken [i.e. Accessibility or Social Inclusion]. It is created automatically by the Accessibility and Social Inclusion Appraisal Module.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\ Appraisal_Tools\GIS\GIS Outputs\2000* * example Base Model Year, Base Run ID, Base Demand Scenario, Zone Number
AM Hansen Indices for PT Commuters_Zone_13001.mxd * * example Accessibility/Social Inclusion output file, Zone Number	ArcGIS Map Document that displays the accessibility or social inclusion outputs for the selected origin zone. The map document contains the Origin Zone Shapefile and the Accessibility or Social Inclusion Measure Data Shapefile (as described above) which are formatted using the input Layer Property files (also described above). This is a variable file and its inputs and filename will change according to the type of analysis undertaken [i.e. Accessibility or Social Inclusion]. It is created automatically and opened by the Accessibility and Social Inclusion Appraisal Module.	{Catalog_Dir}\Runs\{Regional_ Model}\{YY}\{RunID}\4_Outpu ts_{Regional_Model}_{YY}_{Gr owth}_{RunID}_Input_v0001\ Appraisal_Tools\GIS\GIS Outputs\13001* * example Base Model Year, Base Run ID, Base Demand Scenario, Zone Number

2.3 Automated ArcGIS Routines

The GIS script element of the Accessibility and Social Inclusion Appraisal Module has been developed using ArcGIS Desktop 10.7.1 and the Python 2.7.5 programming language. The script is designed to automate the display of results from the Cube Voyager element of the tool along with sociodemographic data and location of key activity areas using functions from the python package ArcPy.

Preparing Inputs for the Automated ArcGIS Routines

The main inputs to the script are the formatted output files from the Cube Voyager element of the appraisal tool (those output files can be imported directly into the script); the Regional Master Shapefiles; Layer Property Template files (which format how the output shapefiles are displayed); and the ArcGIS Template file / ArcMap Document in which the results are displayed.

The Regional Master Shapefiles must contain fields that provide information on the location of key activity areas and socio-demographic data by zone. The fields must be formatted correctly with the correct character type and field names as shown in Table 11 below. The shapefile should be stored in the GIS folder within the scenario results folder as described in the accompanying User Guide. The co-ordinate system of the shapefiles does not affect the script but it is considered best practice to use Irish Transverse Mercator (ITM).

Table 11: Regional Master Shapefile Field Names

Field Name	Description	Character Type
ZONE_NUMBR	Regional Model Zone Number	Integer
POPULATION	Population within each zone	Integer
POP_UNEMPL	Unemployed population	Integer
POP_STUDEN	Student Population	Integer
POP_RETIRE	Retired Population	Integer
EMPLOYMENT	Population employed for each zone (by residence zone)	Integer
AVG_CAR_HH	Average number of cars per household within each zone	Float
DEPRIVATIO	HP Deprivation Index for each zone	Float
LRG_EMPLYM	Large Employment Area	Integer
EDU_PRI	Primary Education	Integer
EDU_SEC	Secondary Education	Integer
EDU_TER	Tertiary Education	Integer
HOSPITAL	A&E and Acute Care Hospitals	Integer
LRG_SUPMKT	Large Supermarket	Integer
SPORT_CENT	Sport Centre	Integer

The current version of the regional master shapefiles have been developed for 5 Regional models for the internal zones (ERM - 1907, SERM - 625, SWRM - 822, MWRM - 615, WRM - 801).

The following sources have been used to calculate the underpinning data:

- Population per zone, population employed/unemployed/retired and students: derived from 2016 Census data.
- Average number of cars per household: derived from 2016 Census data.
- Deprivation Index: obtained from POBAL Haase and Pratschke (HP), September 2017.
- Large Employment Areas: calculated based on work attractions from Place of Work, School,
 College (POWSCAR), 2016 Census data. The threshold used to identify Large Employment

Areas was based on the mean employment (excluding zero values) within ERM region, which equated to 435.

- Primary/Secondary Education: OpenstreetMap data was used to identify the location of schools. As the differentiation between primary and secondary schools in OpenstreetMap data is insufficiently detailed, trip attractions for primary and secondary education from POWSCAR 2016 Census data was used to split the schools into the two categories.
- Tertiary Education: the location of Tertiary Education was identified directly from OpenstreetMap data for colleges and universities.
- Hospitals: OpenstreetMap data for hospitals was used to identify the location of hospitals.
- Large Supermarkets and Sport Centres: were identified using GeoDirectory data, provided by NTA.

Layer Property Template files have been prepared to facilitate formatting of the final shapefiles in the output ArcGIS Template File / ArcMap document. The layer property templates are based on the field names shown in Table 11 (NB these will not be applied correctly if field names are changed). There are a total of 18 Layer Property Template files which format the symbology of each of the Accessibility and Social Inclusion Measures, the location of the key activity areas and the sociodemographic data.

The Layer Property Template files must be stored in the GIS folder within the demand scenario folder. This is selected as the 'modelling output folder' in the script parameters [e.g {Catalog_Dir}\Runs\{Regional_Model}\{YY}\{RunID}\4_Outputs_{Regional_Model}_{YY}_{Growt h}_{RunID}_Input_v0001\Appraisal_Tools\GIS\Layer Templates\]. See the accompanying User Guide for more details.

If changes are required to any of the script templates, for example during future enhancement work, then this can be done manually within ArcMap. To save the changes right click on the layer within the ArcMap Table of Contents and select 'Save As layer file.' Layers must be saved with the same name as before.

2.4 Current Limitations and Future Enhancements

This subsection outlines current limitations of the Accessibility and Social Inclusion Appraisal Module as well as highlighting potential future enhancements.

Current Limitations

The current limitations are listed and described below:

- The Accessibility and Social Inclusion Appraisal Module can only be run using the geographic information system ArcGIS software;
- There is no mechanism in place that would allow separate journey times or generalised costs of travel for unemployed people and retired people to be obtained from the transport models. Therefore, the Accessibility Measures use the same journey times and generalised costs for both unemployed people and retired people;
- The definition of the ERM model zone system means that the Accessibility and Social Inclusion Appraisal Module is suited to capturing regional or strategic changes in Accessibility and Social Inclusion measures rather than changes at a detailed / local level;
- Public transport travel times are based on an average of Sub-Modes which could mask individual journey times.

- The locations of the key activity / service areas have been identified using a mix of data sources, including 2016 Census, Geodirectory and OpenstreetMap data. All of these model and third party data sources come with their own inherent data limitations that affect the quality of the data used [e.g. how often are demolitions or new builds considered in the updates of those third party data sources? Do the data sources provide a full and comprehensive list of all facilities? How accurate are the locations of those facilities?];
- The Social Inclusion Measure calculations are based on detailed TUBA outputs from the Economic Appraisal Tool. Any changes to TUBA input parameters such as introducing new modes will require an update to the Excel Macro Spreadsheet files. Also, any changes to TUBA economic parameters by its developers and subsequent use of an updated release version of TUBA will require a review (and possible update) of the Social Inclusion Measure calculations;
- The Regional Master Shapefile contains Base Year socio-demographic information only;
- Areas of deprivation are based on the POBAL HP Deprivation Index (Haase and Pratschke, September 2017) which, themselves, are based on 2016 census data. Future updates to the POBAL HP deprivation index and subsequent use will require a review (and possible update) of the deprivation area ArcGIS shape files; and
- The ArcGIS script is designed to work with ArcGIS Version 10.7.1 and Python Version 2.7.16. It is likely that minor changes to the script will be required as versions are updated.
- It is not possible within the current ArcGIS script to interactively select the origin zone it must be input as a text parameter.

Future Enhancements

Potential future enhancements are listed and described below:

- The Travel time adjustment calculation could be revised so that the average travel time is replaced by the fastest travel time. This adjustment would be designed to remove instances where average travel times are either faster or slower than the quickest public transport mode, and remove any potential bias towards faster travel times in the Do-Minimum scenario when compared to a Do-Something scenario (NB before incorporating this change, the scale of effect should be quantified as the number of instances may be few and far between, and may have no real material impact on the output analysis);
- The Travel Time accessibility measure could be updated to include an additional level of sophistication whereby the forecast total number of people affected by a transport intervention could be obtained from origin-destination travel demand (using the transport models) rather than using population by zone;
- Improve or expand the measures related to social inclusion and deprivation, and expand spatial data for trip attractors, improving on feature attributes.
- Some elements of the complimentary analysis described in the Accessibility and Social Inclusion Appraisal Module Overview Note, Section 2.3.2, could be included in the tool to provide additional detail to the output analysis.
- In terms of the Social Inclusion Measure, the ArcGIS user interface should be updated so
 that the option to select an origin zone is switched off as this is not relevant to the Social
 Inclusion analysis;
- If an Air Quality and Noise module is developed by the NTA, outputs could be included in the GIS mapping of outputs.
- Update the ArcGIS scripting process so that the naming convention between the Cube Voyager and ArcGIS processes is consistent;

- An automated Cube Voyager process could be created so that the Regional Master Shapefile would be updated automatically with forecast population and employment data from the regional models rather than using the current manual process;
- The Total Base Year Population contained within the Regional Master Shapefile has been split by People Group [i.e. Employed, Unemployed, Retired and Students / Education] using 2016 Census data. In forecast mode, the total population could also be split by People Group; and
- The presentation of the ArcGIS maps could be improved by including place names, facility / service area names and the road and public transport networks. Furthermore, the maps could also be updated so that the Accessibility and Social Inclusion Measures are displayed according to modelled origin-destination movements. This would remove irrelevant origin-destination movements (NB travel times and generalised costs are provided by the regional models for every zone-to-zone pair irrespective of travel demand) as well as improve clarity.

3 Testing and Sense Checking

The Accessibility and Social Inclusion Module has been tested on all the regional models and for each of these models a sample scenario was used. For the ERM sample scenario, economic zone by zone TUBA outputs from the Economic module were used for Social Inclusion calculations.

The purpose of these tests is to access the functionality and compatibility of the Accessibility and Social Inclusion Module for the ERM and Regional Models, represented in this report by the WRM. These tests were carried out on the consultant machines, with an additional ERM sample scenario used to test on an NTA server. The tests on both the NTA server and consultant machines were ran successfully.

3.1 **ERM**

The ERM test was successfully run through both the Accessibility and Social inclusion modules on a consultant machine

3.1.1 Setup

The Accessibility and Social Inclusion Module was successfully set up to read model outputs from a network location.

3.1.2 Accessibility

The Accessibility module successfully calculated journey time inputs for the GIS process.

3.1.3 Social Inclusion

The social inclusion successfully read the zone to zone TUBA outputs produced by the Economic module test run.

3.1.4 GIS Automated Procedure

The outputs from the Accessibility and Social inclusion modules where fed through the Automated GIS outputs tool to produce the maps in Figures 3.1, 3.2 and 3.3.

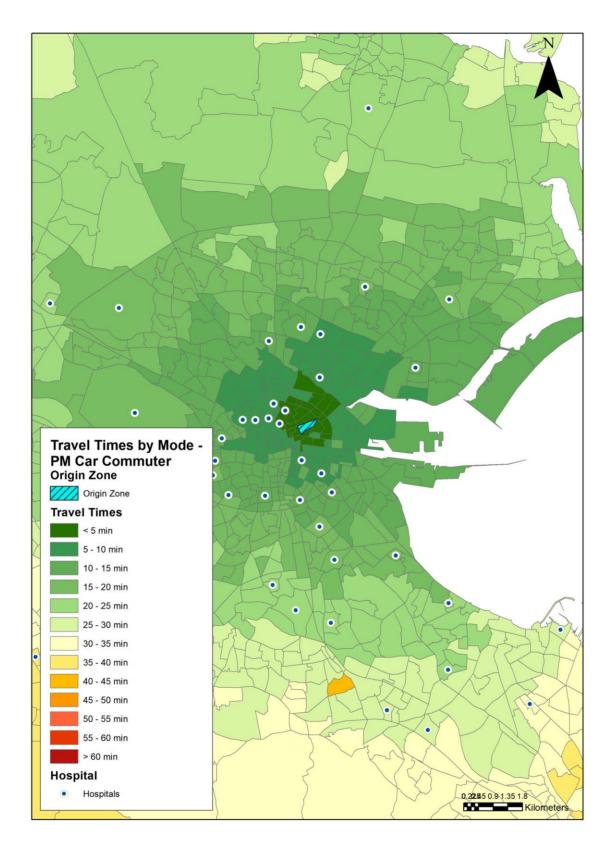


Figure 3.1 Car Travel Times with Hospitals overlaid

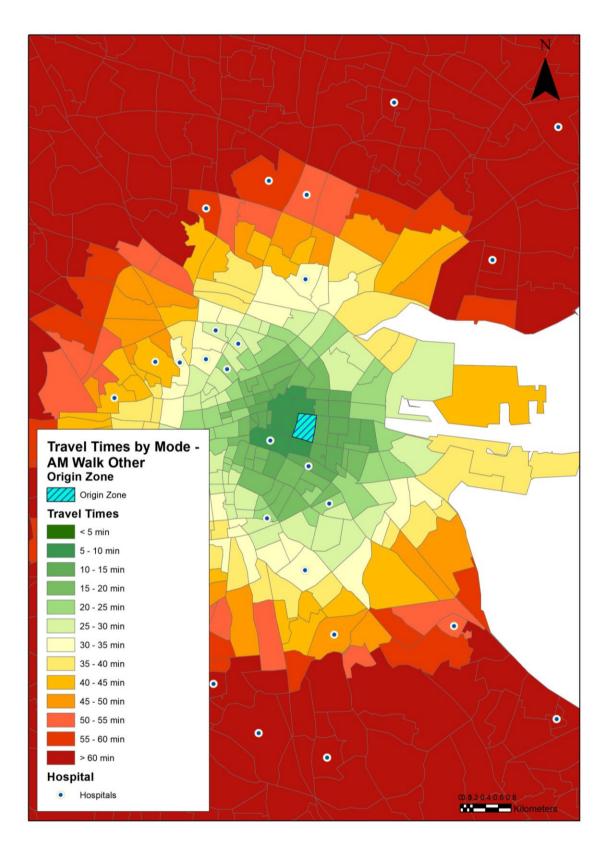


Figure 3.2 Walk Travel Times with Hospitals overlaid

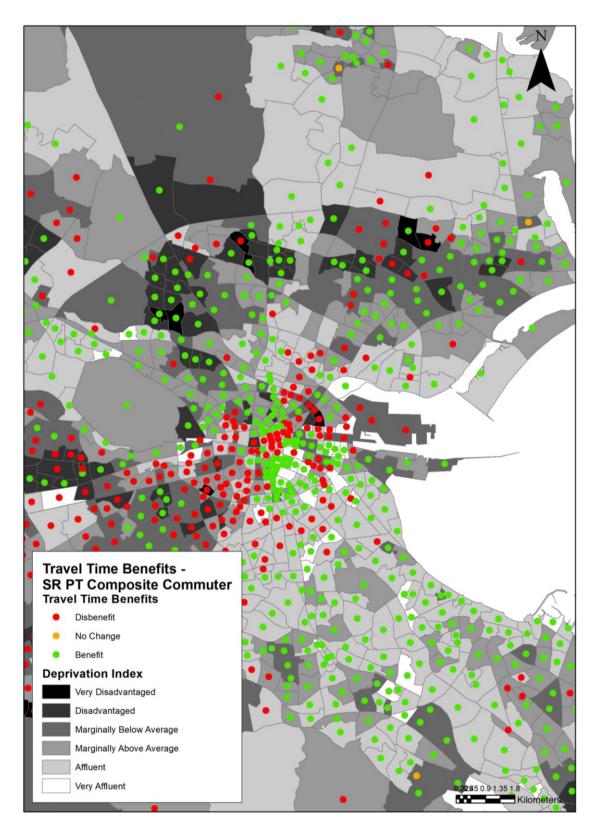


Figure 3.3 Travel Time Benefits for PT Composite

3.2 WRM

The WRM test was successfully run through both the Accessibility and Social inclusion modules.

3.2.1 **Setup**

The Accessibility and Social Inclusion Module was successfully set up to read model outputs from a network location.

3.2.2 Accessibility

The Accessibility module successfully calculated journey time inputs for the GIS process.

3.2.3 GIS Automated Procedure

The outputs from the Accessibility and Social inclusion modules where fed through the Automated GIS outputs tool to produce the maps in Figure 3.4, 3.5 and 3.6.

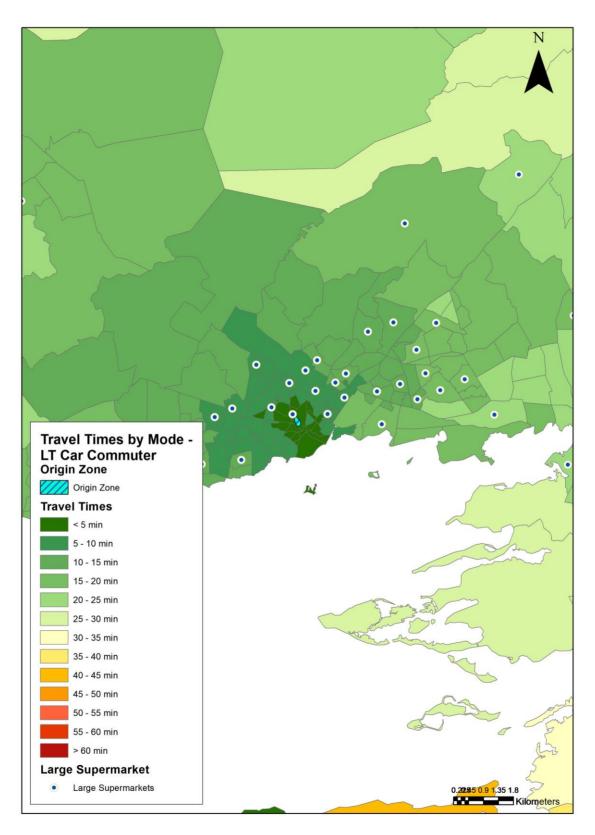


Figure 3.4 Travel Times by Car with Supermarkets overlaid

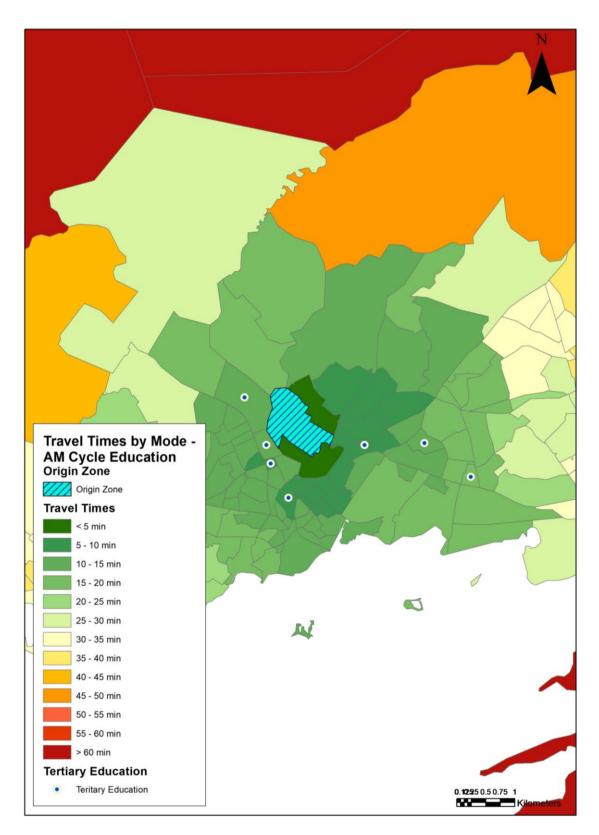


Figure 3.5 Travel Times by Bike with Tertiary Education overlaid

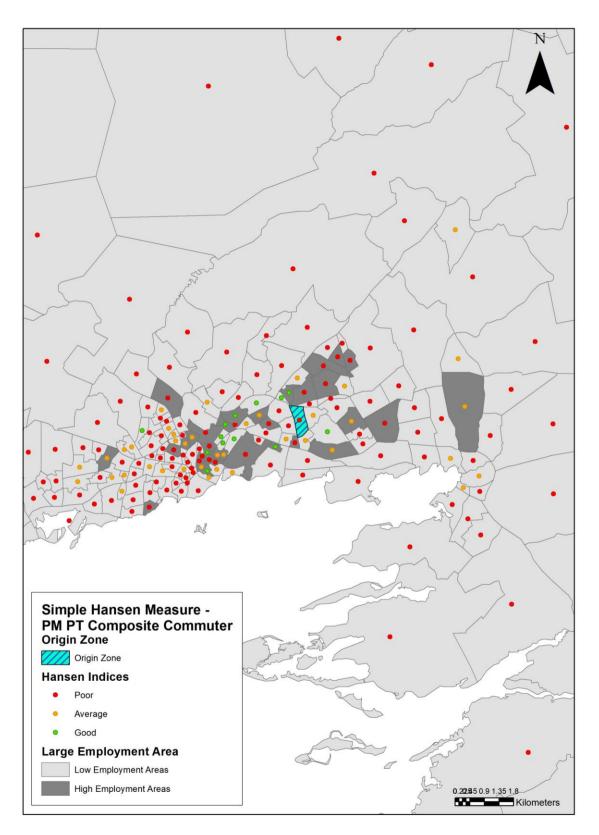


Figure 3.6 Simple Hansen Measure for PT Composite with Employment Areas classification

3.3 Other Testing

An update on other items that have been undertaken as part of the Testing and Signing Off process is shown in Table 12 below.

Table 12: Steps in Testing and Signing Off the Accessibility and Social Inclusion Appraisal Module Process

Item	Completed	Comment
Check Cube Voyager operation	Yes	An operational check has been made on all run options available to the user. The Cube Voyager element has also been installed on the other regional model directory structures. These operational checks have confirmed that the Cube Voyager element is performing as expected.
Run some checks to confirm difference calculations undertaken by Voyager are performing as expected	Yes	The Travel Time and Hansen Index differences have been calculated manually and then crosschecked with those created automatically by the appraisal tool. Both methods have produced the same answer.
Check Excel Macro Spreadsheet files are performing as expected	Yes	A detailed line-by-line check of the VBA code in each of the three macro spreadsheet files has been made that confirms the macros are (a) picking up the correct Voyager outputs and (b) correctly formatting the output for use with ArcGIS. Difference calculations have also been carried out manually and crosschecked with outputs created by the appraisal tool. Both methods have produced the same answers.
Check ArcGIS operation	Yes	An operational check has been made on all run options available to the user. The ArcGIS element has also been installed on the other regional model directory structures. These operational checks have confirmed that the ArcGIS element is performing as expected.
Run some checks on ArcGIS shape files to confirm locations of key activity areas and deprivation areas are as expected	Yes	The ArcGIS script has been run and the output ArcGIS Map Document displays the locations of key activity / service areas and deprivation areas as expected. The Map Document also displays underlying socio-demographic as expected.
Run Appraisal Tool for a sample scheme and sense check headline appraisal results	No	Presented in Sections 3.1 and 3.2.

4 Incorporating the Accessibility and Social Inclusion Appraisal Module into different Regional Models

4.1 Introduction

As noted in the introductory chapter, the appraisal tool has been developed for use with all 5 regional models. This subsection outlines several items that will need to be considered when the Accessibility and Social Inclusion Appraisal Module is used with any of the regional models.

4.2 Items to Consider

There are a number of items to consider which are listed and described below:

- Cost deterrence lambda values. Cost deterrence lambda values are different for each regional model.
- Number of modelled zones. All of the Regional Models consist of different number of zones: ERM (1953 total, 1907 internal), SERM (654 total, 625 internal), SWRM (834 total, 822 internal), MWRM (650 total, 615 internal), WRM (836 total, 801 internal). Currently the GIS tool has been developed for the internal zones for each of the Regional models. Any changes to the zoning systems or the underpinning data (including locations of key service / activity areas, population and employment data and areas of deprivation) would require update of the ArcGIS files.
- ArcGIS Shape Files. The ArcGIS shape files containing locations of key service / activity
 areas, base year population and employment data and areas of deprivation have been
 developed for each regional model. These shape files have been created using the number
 of zones for each regional model as described above;
- Cube Voyager Tokens. The user needs to be aware that when the Accessibility and Social Inclusion Appraisal Module is incorporated into the other regional transport models, the user will be prompted to update path file names automatically. This prompt arises because of a change in directory structure. The user should say 'Yes' to this prompt. However, the user should be aware that file path locations which include 'tokens' may not be automatically updated, or in some instances, the file path locations may be completely removed. This is a 'quirk' of Cube Voyager and not the appraisal tool. It is advised that the user keeps a copy of the Accessibility and Social Inclusion Appraisal Module which has been issued so that a check can be made between original and updated script files should run problems be encountered [e.g. run errors such as file path could not be found]; and
- Regional Models Structure. The Accessibility and Social Inclusion Appraisal Module assumes the same model directory structure is in place for each regional model. Any changes in directory structure between those models would require updates to the governing processes that control the appraisal tool.

Appendix A – Travel Time Adjustment Criteria

Bus Travel Time adjustment

(NB the same method applies for adjusting bus boarding and transfer penalties)

Condition 1: are there travel times for all bus sub-modes (urban, inter-urban and BRT) for the same origin-destination pair and travel demand for all bus sub-modes for the same origin-destination pair? If YES, use an average of urban bus, inter-urban bus and BRT travel times to represent bus travel times.

Condition 2: are there travel times for urban bus and inter-urban bus only for the same origindestination pair and travel demand for urban bus and inter-urban bus only for the same origindestination pair? If YES, use an average of urban bus and inter-urban bus travel times to represent bus travel times.

Condition 3: are there travel times for urban bus and BRT only for the same origin-destination pair and travel demand for urban bus and BRT only for the same origin-destination pair? If YES, use an average of urban bus and BRT travel times to represent bus travel times.

Condition 4: are there travel times for inter-urban bus and BRT only for the same origin-destination pair and travel demand for inter-urban bus and BRT only for the same origin-destination pair? If YES, use an average of inter-urban bus and BRT travel times to represent bus travel times.

Condition 5: Otherwise, if travel demand for urban bus is greater than zero, then use urban bus travel times, or if travel demand for inter-urban bus is greater than zero, then use inter-urban bus travel times, or if travel demand for BRT is greater than zero, then use BRT travel times to represent bus travel times.

Tram Travel Time adjustment

(NB the same method applies for adjusting tram boarding and transfer penalties)

Condition 1: are there travel times for both tram sub-modes (LUAS and Metro) for the same origin-destination pair and travel demand for both tram sub-modes for the same origin-destination pair? If YES, use an average of LUAS and Metro travel times to represent tram travel times.

Condition 2: Otherwise, if travel demand for LUAS is greater than zero, then use LUAS travel times, or if travel demand for Metro is greater than zero, then use Metro travel times to represent tram travel times.

Rail Travel Time adjustment

(NB the same method applies for adjusting rail boarding and transfer penalties)

Condition 1: are there travel times for both rail sub-modes (DART and Irish Rail, National) for the same origin-destination pair and travel demand for both rail sub-modes for the same origin-destination pair? If YES, use an average of DART and Irish Rail (national) travel times to represent rail travel times.

Condition 2: Otherwise, if travel demand for DART is greater than zero, then use DART travel times, or if travel demand for Irish Rail (national) is greater than zero, then use Irish Rail (national) travel times to represent rail travel times



Appendix B – Economic Appraisal Tool Output, Selection Criteria

The path file locations file, which is named **Social_Inclusion_run_files.txt**, consists of many criteria to facilitate the extraction of home-based non-business car and public transport trips from the Economic Appraisal Tool output. These criteria are appended to the path file locations file and are shown below.

- A. Time Period is based on what is contained in the TUBA Scheme Inputs File. Currently, this assumes AM is 1, LT is 2, PM is 3 and SR is 4;
- B. Sub-mode 1 is Car;
- C. Sub-mode PT is a combination of Bus (sub-mode 5) and Rail (sub-modes 6 and 7);
- D. Purpose 2 is 'Commuting' as defined in the TUBA Economic parameters file;
- E. Purpose 3 is 'Other' as defined in the TUBA Economic parameters file; and
- F. Home-based non-business user benefits differences will only be calculated when the catalogue key 'Model Type' equals Do_Something and the relevant Do-Minimum run is available. This therefore assumes detailed Economic Appraisal Tool outputs will be available for both the Do-Minimum and Do-Something scenarios.