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Transport Infrastructure Ireland

# TII Publications



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## Project Appraisal Guidelines Unit 6.3 – Guidance on using TUBA

**PE-PAG-02022**  
December 2023

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## TII Publications



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**Updates to TII Publications resulting in changes to  
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This document supersedes PE-PAG-02022 dated October 2016. This version of the document has been updated to incorporate changes to TUBA procedures for v1.9.8 and later. Amendments have been made to the following sections:

- a) Section 3.1 TUBA v1.9.8 and later has been added.
- b) Section 4.6 Matrix Data has been updated.

Section 4.7 TUBA v1.9.8 and later has been added.

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Updated PAG Unit to comply with the Transport Appraisal Framework (June 2023) and to introduce the use of the TII Road Emissions Model (REM) to monetise emissions impacts in Cost Benefit Analysis

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# 1. Introduction

## 1.1 Overview

TUBA is a computer program, developed by the UK Department for Transport (DfT), for undertaking transport economic appraisals. TUBA draws information directly from transport models and applies economic parameters to calculate benefits and costs associated with travel time, vehicle operating cost and emissions changes.

This PAG Unit provides information on the processes required to undertake a TUBA assessment. It deals with data collection, the links with the transport model, and the parameter values that should be used for assessments at the different phases of the proposed scheme.

This PAG Unit also provides advice on where to seek guidance on using the TUBA program and how TUBA assessments should be audited.

Note that TUBA does not calculate benefits that are due to changes in collision costs. The derivation of collision cost impacts should be undertaken using the COBALT program or using manual techniques based on standard parameter values. Separate guidance is available for the use of COBALT under PAG Unit 6.4.

## 1.2 Monetisation of Emissions in CBA

In December 2022, TII published their Road Emissions Model (REM)<sup>1</sup> which can be used to assess the change in emissions associated with a proposed intervention. The TII REM can also monetise these emissions changes in line with the same economic parameters which underpin TUBA. It is therefore recommended that the TII REM is used to monetise emissions impacts for use in the Cost Benefit Analysis (CBA) of TII projects instead of using the outputs generated by TUBA.

Details of how the TUBA monetised emissions values can be replaced by the TII REM monetised emissions values in the CBA summary outputs tables is provided in Unit 6.1 – Guidance on Undertaking CBA.

## 1.3 TUBA Versions

The UK (DfT) maintains and updates TUBA to reflect the needs and requirements of their Transport Analysis Guidance (TAG) commonly referred to as WebTAG. For TII projects it is recommended that TUBA v1.9.7 or v1.9.8 is used. More recent versions of TUBA released by the DfT can be used, however some Irish specific parameters are not currently available for use in these more recent versions (e.g. traded carbon values, values of time by distance etc.). Guidance should be sought from the TII Strategic and Transport Planning section within TII if non-standard parameters are used in CBA.

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<sup>1</sup> GE-ENV-01107 (tiipublications.ie)

## 2. Data Requirements

### 2.1 Overview

TUBA has the flexibility for a number of input parameters to be modified by the user to better reflect local conditions. However, the use of standard values and relationships is central to the CBA concept and, at the early stages of scheme assessment, this avoids the need for time consuming and costly data collection exercises.

The decision to use local or national default values depends on the phase of the scheme assessment. At Phase 2 (Option Selection), local values may be used where available, although national values are normally acceptable. However, at Phase 3 (Design and Environmental Evaluation), local data should be input where it is both reliable and significantly different from national values.

TUBA Input data is presented in two distinct groups. These are:

- The **Economics File**: this is a standard file for all TUBA runs. It contains all the basic economic data required such as value of time, discounting rates, taxes, growth in costs, fuel consumption, etc.
- The **Scheme Data File**: this contains information regarding the specific scheme under consideration. This will include scheme costs, scheme years, vehicle types, time periods, modes, person types and details of the skimmed matrices to be input

For TUBA, scheme data is extracted directly from the transport models. As such, the use of local or national data for information such as vehicle proportions, network information and speed flow relationships will have been defined prior to the development of the transport models. Guidance from 'PAG Unit 5.1 - Construction of Transport Models' is therefore also relevant to TUBA appraisals.

Both the economic input file and an example scheme-specific input file are available from the "Downloads" section of the TII Publications website under section PE-PAG-02022\_Unit 6.3.

## 3. The Economics File

### 3.1 Overview

The economics file(s) is standard to all TUBA appraisals, with values linked to those set out in PAG Unit 6.11 - National Parameter Values Sheet.

The following information may be changed in the economics file:

- **Time Periods:** Additional time periods may be defined as necessary to enable annual scheme impacts to be fully appraised
- **Vehicle Occupancy:** Default values may be substituted with Local Values for Vehicle Occupancy if information is reliable, and differs significantly from national values
- **Default Purpose Split:** Default values may be substituted with Local Values for Vehicle Purpose if information is reliable, and differs significantly from national values
- **Preparation and Supervision Costs:** Default values may be substituted with scheme specific data at Phase 3 Design and Environmental Evaluation, Phase 5 Enabling and Procurement and Phase 7 Closeout and Review.

All changes to the standard economics file(s) will require consent of the TII Strategic & Transport Planning Unit.

### 3.2 TUBA v1.9.8 and later

The DfT updated their TAG process in 2017 to incorporate new values of travel time savings (VTTS). The new approach is incorporated into TUBA v1.9.8 and later which includes three methods for value of time to be specified in the TUBA economics file:

- **Method 1:** values of time are specified using the new continuous (logistic) function
- **Method 2:** values of time are specified using the new distance bands
- **Method 3:** values of time are specified using average values of time for all distances

For the appraisal of Irish transport projects, Method 3 should be used along with the values of time specified in PE-PAG-02030 (PAG Unit 6.11). An additional TUBA economics file is now provided for use with TUBA v1.9.8 and later in the “Downloads” section of [www.tiipublications.ie](http://www.tiipublications.ie).



## 4. The Scheme Input File

### 4.1 Scheme Specific Parameters

This first section provides basic information about the scheme. The user can specify the following:

- Scheme name
- Scenario names
- Modelled years
- Current year
- Scheme horizon year
- Number of warnings

### 4.2 Time Slices

The TUBA user can specify both the time periods modelled and the annualisation factors that will be used to convert the modelled periods to average annual equivalents. Descriptions of the time slices can be entered for each time slice specified. Time slices might comprise one or more of:

- Single 1 hour time slice for an average AM peak hour
- Hourly time slices across a period (e.g. 0700-0800, 0800-0900, 0900-1000)
- 30-minute time slices across a whole period
- Single hour time slices for a fixed time period

### 4.3 Annualisation Factors

To understand the full impacts of a modelled scheme it is necessary to extrapolate the data to represent a full year. A number of separate annualisation factors may need to be applied depending upon the modelled periods.

The annualisation factor is the most influential parameter in a CBA as it is converts impacts modelled for a short period time slice, to an annual value. Therefore, the correct use of annualisation factor should be carefully considered.

Annualisation hours should be based on local data collected from travel surveys or traffic surveys. Only hours (outside of the modelled periods) which experience the same travel conditions as those modelled should be included.

Economic annualisation of benefits differs significantly in this regard from demand annualisation and the appraisal should take this into account. Further guidance and checks regarding annualisation factors is provided in PAG Unit 6.6 – CBA Audit Checklist.

The annualisation factor describes the factor that is applied to the various time slices to define a full year. Standard divisions of the year are used as follows:

- 253 peaked weekdays
- 52 weekends
- 10 bank holidays

If there are no modelled time slices for a given time period then TUBA cannot calculate benefits for that time period. It will often be the case that the modelled time slices cover only part of a time period. For example, a model may only cover 1900-2200 of the off-peak period. This first part of the off-peak period is unlikely to be representative of the remaining period 2200-0700 and it may be inappropriate to extend the model results from the first part to cover the second part.

In general it will be extremely unlikely that a transport model covers every hour of the week. It is therefore necessary to make a compromise when calculating the benefits for time periods (or parts thereof) to cover unmodelled periods. There are two options:

- Ignore unmodelled periods
- Adapt the output from modelled periods to cover unmodelled periods

Modelled periods can be ignored if it can be assumed that their contributions to overall benefits/disbenefits are negligible (this is likely to be the case for much of the off-peak) or, given the results from the other periods we can expect the user benefits to be positive and we can accept a conservative estimate of total benefits. If the benefits, or disbenefits, from an unmodelled period (or part) are likely to be significant, then it is necessary to adapt the model output from other periods.

It is not possible to make general recommendations as it very much depends on local circumstances, for example major shopping centres can be busier at weekends than during the weekday peaks, while other areas may have very little traffic at weekends.

## 4.4 Scheme Costs

The preparation of scheme costs should follow the guidance set out in PAG Unit 6.2 - Preparation of Scheme Costs. The TUBA Input allows the total costs to be allocated amongst the various cost categories.

Costs can be included for the Do Minimum and Do Something scenarios. For many schemes, there will be no costs associated with the Do-Minimum option. Note that this is distinct from the Traffic management Option which should be appraised as one of a number of Do-Something alternatives.

Default spend profiles and allocation of costs to preparation and supervision costs will be assumed unless specified otherwise. For any costs associated with construction or land acquisition, the relevant RPI will need to be applied to factor the costs to the purchase year.

## 4.5 Scheme Data: User Classes

The TUBA user can specify the level of breakdown between different types of vehicle and user that will be appraised during the analysis. The level of detail that can be used depends mainly on the level of disaggregation provided by the traffic model, although default proportions for vehicle types and trip purposes can be requested. For each user class to be reported on the following needs to be specified:

- Vehicle type/sub mode
- Purpose
- Person type

The top-level of aggregation in TUBA is 'mode' which is then followed by 'sub-mode' (or vehicle type). For car, the 'mode' would be road and the 'sub-mode' vehicle type i.e. Car, LGV, OGV etc. For public transport, the 'mode' would be type of public transport i.e. rail, bus etc and the 'sub-mode' vehicle type i.e. light rail, heavy rail etc.

TUBA will automatically use the person types specified within the standard economic file to calculate the VOT per vehicle.

## 4.6 Matrix Data

The input matrix data consists of ‘matrix skims’ from the relevant transport models. Data from both highway and public transport models (if appropriate) can feed into the TUBA run. Input matrices are always required for demand in each time period, and some or all of travel distance, travel time and user charges depending on the type of scheme being assessed. Separate skimmed matrices will be required for:

- Each modelled year
- Each modelled time period
- Each modelled mode
- Each user class.

The matrix data section of the scheme file gives a filename and pathname for each matrix data file, and informs TUBA of the type of data, the units of data and the format of the data included in the file. One line is required for each input matrix file. All standard transport modelling software is capable of producing costs in the required format for TUBA.

When inputting matrix files, each file requires classification as follows:

- File number, entered in sequence for each file starting at 1
- Userclass, referencing the user classes covered by the matrix in accordance with the information under the heading USER\_CLASSES in the Scheme Input File
- Timeslice, referencing the time slice covered by the matrix in accordance with the information under the heading TIME\_SLICES in the Scheme Input File (specified as “X” for “Reference Distance” matrix in TUBA v1.9.8 or later)
- Type, indicating the content of the matrix. (V=vehicle flows, T=time, D=distance, P=Passenger Trips, Cn=Charge, R = Reference Distance in TUBA v1.9.8 or later)
- Format, indicating the format of the matrix. Three matrix formats are available, for details see Appendix C of the TUBA User Manual
- Scenario, where 0 = Do Minimum and 1 = Do Something (specified as “X” for “Reference Distance” matrix in TUBA v1.9.8 or later)
- Year to which demand matrix relates (specified as “XXXX” for “Reference Distance” matrix in TUBA v1.9.8 or later)
- Factor applied to the matrix (this will normally be 1.0)
- Filename and path

## 4.7 TUBA v1.9.8 and later

As noted in Section 3.2, the UK TAG incorporates an updated approach to using values of travel time savings (VTTS) in TUBA v 1.9.8 and later. This approach impacts on the TUBA scheme input file where a “Reference Distance” matrix needs to be specified. The TUBA manual recommends that this matrix be a demand weighted distance matrix from the base year transport model.

An additional TUBA scheme input sample file is provided for use with TUBA v1.9.8 and later in the “Downloads” section of [www.tiipublications.ie](http://www.tiipublications.ie).

## 5. TUBA Input Checks

Matrix definition is an important element of the scheme file and it is relatively easy to make errors in doing this. For example, a user can input a matrix corresponding to a different time period (e.g. a PM peak time matrix when the AM is required). Similarly, matrices relating to different user classes can easily be confused - especially if file names are ambiguous.

Such errors will not always be picked up by the checks described above; however they may become apparent in the next series of checks, which compare matrices from the Do-Minimum (DM) and Do-Something (DS).

TUBA also undertakes a check on the ratio ( $r$ ) of Do Minimum to Do Something costs (time and distance) as outlines in Table 6.3.1.

**Table 6.3.1 Internal Checks within TUBA**

Value of $r$	Action
$r < 0.33$ or $r > 3.0$	Serious warning
$0.33 < r < 0.67$ or $1.5 < r < 3.0$	Warning
$0.67 < r < 1.5$	OK, no warning

These checks are made because, in the case of large changes in cost, the rule of a half which is used to calculate user benefits may not be valid. The TUBA Manual provides advice on how users should deal with situations when this is the case. It should also be borne in mind that large changes in costs may also be due to modelling errors and assumptions. For example, forecast delays at locations in the network could have been adversely influenced by inaccurate assumptions regarding traffic signal times.

Warnings and serious warnings therefore indicate possible anomalies in the input data and should be investigated. Errors will cause the TUBA calculation to stop and must be resolved before TUBA can run to completion.

## 6. The Scheme Output File

### 6.1 Overview

The output files from TUBA contain the following summary information:

- Warnings
- Input summary
- Scheme trips summary
- Scheme costs summary
- Total user costs
- User benefits and revenues
- Economic efficiency of the transport system table (TEE)

### 6.2 Warnings

A warnings output file will appear at the beginning of the output results. This will detail both 'serious' and 'non-serious' warnings. A warning is triggered when the difference between the Do Minimum (DM) and Do-Something (DS) costs are outside the expected range.

A 'serious' warning indicates that the difference between the DM and DS costs is so significant that a user check of the input data and parameters should be undertaken.

### 6.3 Input Summary

The second set of data that outputs from TUBA is a summary of the user inputs and/or input file. The key data summarised includes:

- Scheme file
- Names of schemes
- Standard economics file name
- First year that the scheme incurs costs
- First appraisal year
- Last appraisal year
- Modelled years
- Total time periods

### 6.4 Scheme Trips Summary

This provides a summary of all matrix totals as input by the user. Matrix totals are provided for each time slice and annualised. Data is provided separately for each user class.

## 6.5 Scheme Costs Summary

This presents the scheme costs for the DM scenario, the DS scenario and the Present Value Costs. The DM scenario and DS scenario present all the cost types, undiscounted but with a market price adjustment and RPI factors added (if applicable). The costs are presented in 2016 prices.

## 6.6 Total User Costs

A DM and DS user cost gives the total costs for each scenario. This provides an overview of the total changes in cost between the two scenarios and allows an initial comparison to be made of the allocation of costs. This includes such indicators as: total time, total fuel consumption, total charges and total non-fuel costs.

The output also includes further detailed tables of the fuel and environmental costs of the schemes.

## 6.7 User Benefits and Revenues

User benefits and revenues are reported in mode, sub-mode, person type, purpose and period. They show the user benefits and changes in user time, user public transport charges, fuel VOC, non-fuel VOC, operator public transport revenue and indirect taxes.

The figures are presented as plus and minus figures. A minus figure in the benefits values denotes a disbenefit to users. A minus figure in the revenues columns indicates a reduction in revenues.

## 6.8 Transport Economic Efficiency Table (TEE)

The core output from the TUBA run is the monetised present value of benefits presented in the TEE table. This information is presented by trip purpose, by mode of transport and by impact (time, vehicle operating costs etc).

The key items used in the estimation of user benefits include:

- Changes in travel time
- Changes in user charges – fares, tariffs and tolls
- Changes in vehicle operating costs as they apply to the user

In the monetised costs and benefits table, there will be summaries of the following:

- Consumer user benefits (costs/benefits to travellers not on business trips)
- Business user benefits (business or goods trips)
- Private sector provider benefits
- Other benefits
- Carbon benefits
- Net present value of benefits
- Net present value of costs
- Overall summary net present value
- Benefit to cost ratio (BCR)

Note again that TUBA does not consider the cost of collisions. Inclusion of collision benefits in a TUBA appraisal requires the calculation of benefits by some other means (using COBALT, see Unit 6.4), and the incorporation of that output into the scheme appraisal results.

In addition, it is recommended that the monetised emissions outputs of the TII REM are used to replace the emissions impacts calculated by TUBA. These TII REM values should be used in the TEE table as part of the overall summary of monetised impacts.

The TEE will form a core section of the overall appraisal document and will provide the core monetised assessment of costs and benefits. However, in addition to the quantitative evidence provided by the TEE table, any qualitative evidence should be noted in the Standard Appraisal Table.

Current guidance from the DoT TAF requires that a shadow price factor should be adopted for public funds. The TAF also mandates that economic appraisals in the transport sector should be estimated on the basis of a shadow price of labour. The values for both these parameters can be found in PAG Unit 6.11 – National Parameters Value Sheet.

## 7. Sensitivity

An important output from TUBA is the SENSITIVITY table. The information in this table can be used to assess the sensitivity of the user benefits to the level of convergence in the transport model. The smaller the numbers reported in this table, the more sensitive the results. The following guidance is provided to assist in determining whether model convergence is adequate, given the size of the scheme benefits.

The required level of convergence needs to be linked to the scale of the benefits of the scheme being appraised, relative to the network size. For instance the calculation of benefits from small schemes in large networks will be much more sensitive to convergence than large schemes in small networks.

On the basis of testing it has been discovered that ideally the user benefits, as a percentage of network costs, should be at least 10 times the % Gap achieved in the Do-Minimum and Do-Something scenarios. The estimation of user benefits can be estimated either by using matrix manipulation of the Do Minimum and Do Something trip and skimmed generalised cost matrices to produce an estimate of the consumer surplus by the rule of a half, or by using TUBA program. In either case the worst-case convergence of the Do Minimum and Do Something scheme runs should be taken as the one to compare with the size of the benefits.



## **8. Further Guidance**

Further guidance on the use of TUBA is available at:

<https://www.gov.uk/government/publications/tuba-downloads-and-user-manuals>.





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