Carmen-Alexandrina Buja
Digitally signed by Carmen-Alexandrina Buja
Date: 2023.08.11 16:44:02 +03'00'

Project Appraisal Guidelines

for the economic assessment of transport investments in Romania

April 2023

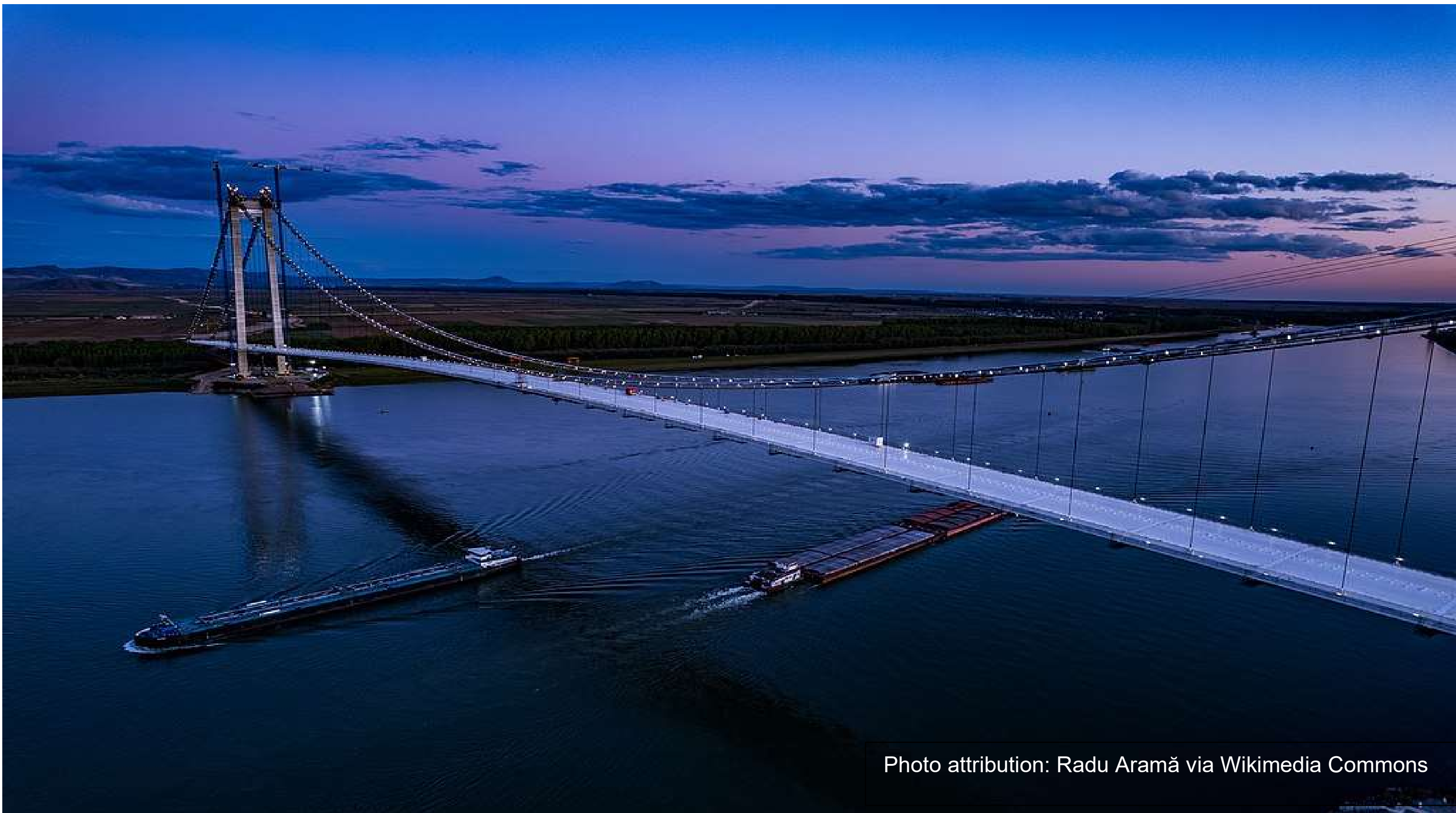


Photo attribution: Radu Aramă via Wikimedia Commons

Project Appraisal Guidelines

for the Economic Assessment of Transport Investments in Romania

JASPERS (Joint Assistance in Supporting Projects in European Regions) is a partnership between the European Commission (EC) and the European Investment Bank (EIB).

JASPERS aims are to improve the preparation of projects to be co-financed by the Cohesion Fund and the European Regional Development Fund (ERDF) across all Member States, providing support for individual projects, capacity building and strengthening of public administration. In a similar way, JASPERS is also involved in the Eastern Neighbourhood (focussing on the transport sector) and the Pre-accession countries (all infrastructure sectors), supporting gradual improvements in practices and processes required for the absorption of EU funds.

JASPERS assistance is provided in good faith, and with reasonable care and due diligence (diligentia quam in suis).

JASPERS does not warrant the accuracy or completeness of the information contained in this Guidance document nor does it assume any legal liability or responsibility, direct or indirect, for any damages or loss caused or alleged to be caused by or in connection with the use of or reliance on materials contained in this document.

The comments expressed in this report do not necessarily state or reflect the views of the JASPERS partners, European Commission and the European Investment Bank. In particular, the views expressed herein cannot be taken to reflect the official opinion of the European Union.

JASPERS would like to acknowledge the important and valuable input of AJM Economics Ltd into the preparation of this Guidance Document.

CONTENTS

TABLE OF ABBREVIATIONS

AECOM	A firm of consulting engineers, originally an acronym for Architecture, Engineering, Consulting, Operations and Maintenance
CAPEX	Capital expenditure
CBA	Cost-benefit analysis
CEA	Cost-effectiveness analysis
CNSP	Romanian National Commission for Strategy and Forecast
CO_2	Carbon dioxide
CPR	Common provisions regulation
CursBNR	National Bank of Romania exchange rate calculator
DG MOVE	Directorate General for Mobility and Transport
EA	Economic assessment (or appraisal)
EAV	Economic Appraisal Vademecum
EC	European Commission
EIB	European Investment Bank
EIU	Economist Intelligence Unit
ENPV	Economic net present value
ERTMS	European rail traffic management system
ETCS	European train control system
EU	European Union
EU28	The 28 countries of the EU, prior to the United Kingdom leaving
EUR	Euro
FDR	Financial discount rate
FNPV	Financial net present value
FRR	Financial rate of return
GDP	Gross domestic product
GHG	Greenhouse gas
GJT	Generalised journey time
GTMP	General transport master plan
HGV	Heavy goods vehicle
HICP	Harmonised index of consumer prices
ICE	Internal combustion engine
INSSE	Romanian National Institute of Statistics
IWT	Inland waterway transport
IWTOC	Inland waterway transport operating cost
JASPERS	Joint assistance to support projects in European regions
LCA	Least-cost analysis
LGV	Light goods vehicle (up to 3.5 tonnes gross weight)
MA	Managing authority
MCA	Multi-criteria analysis
NOx	Nitrogen oxides
NPV	Net present value
NMVOCs	Non-methane volatile organic compounds
NTM	National transport model
NRTM	National road transport model
O&M	Operation and maintenance
PCR	Project completion report
$PM_{2.5}$	Particulate matter of 2.5 microns
PM_{10}	Particulate matter of 10 microns
PV	Present value

RON	Romanian Leu
SDR	Social discount rate
SOx	Sulphur oxides
TOC	Train operating cost
ToR	Terms of reference
TP	2021-2027 Romanian Transport Programme
UK	United Kingdom
VOC	Vehicle operating cost
VOC	Volatile organic compound
VoT	Value of time
WebTAG	UK Government transport analysis guidance
WOP	Without project
WP	With project

1 PREAMBLE

The central purpose of project appraisal is to ensure that scarce public funds (from both national and European Union sources) are allocated efficiently by establishing a framework against which both the project's costs and benefits can be assessed.

Throughout both the 2007-2013 and the 2014-2020 programming periods, to ensure scarce public resources were allocated efficiently, Romania required that all EU-funded transport projects undergo rigorous appraisal in line with EU requirements, typically (for projects above defined thresholds) in the form of a project cost benefit analysis (CBA). For such 'major projects'[1] the European Commission formally decided upon them after the receipt and review of project documentation.

EU appraisal requirements were designed to aid the decision-maker at key decision milestones, in deciding whether e.g., intervention is needed and, if so, what the proper scope of the intervention should look like. This requirement for CBA has contributed significantly to ensuring good value for money and has encouraged rigour in the project selection process. It is now established practice that project appraisal should occur at various points in the project development cycle (e.g., in deciding the appropriate option to select and prior to the decision to finance the project).

The requirement to undertake appraisals on all major transport projects has necessitated building up of substantial appraisal capacity (in the form of expertise in e.g., transport modelling, and economic/financial analysis) at both the level of Engineering Consultants (who typically develop project Feasibility Studies), as well as at the level of the transport agencies and within government Ministries.

According to the common provisions regulation (CPR)[2] approved in June 2021 for the 2021-2027 programming period, there are no longer any legal requirements for 'major projects' with EU ex ante approval as in previous programming periods.

Although the regulations do not explicitly mention the need to perform a CBA, the art. 73.2(c) does require the Managing Authorities to *"ensure that selected operations present the best relationship between the amount of support, the activities undertaken and the achievement of objectives"*.

In this context, in order to meet the above requirement and also ensure proper value for money is achieved from projects to be financed with EU Funds, the Romanian Managing Authority (MA) for Transport continues to require systematic appraisal of transport projects.

These guidelines outline the requirements for appraisal of EU-financed transport projects in Romania under the Transport Programme 2021-2027. This covers all national, regional, and inter-urban projects in the road, rail, port/inland waterway, and intermodal transport sectors.

The basic principles of these guidelines apply to all transport projects to be financed from public funds, regardless the source of their financing.

[1] According to Article 100 of Regulation (EU) No 1303/2013, a major project is "an operation comprising a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds" either EUR 75 million (for projects proposed under Thematic Objective 7), or EUR 50 million (all other projects).

[2] Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Instrument for Financial Support for Border Management and Visa Policy.

These guidelines:

- Provide an overview of best practices and set out minimum standards for demand modelling and economic/financial/risk appraisal of road, rail, and other public transport projects in Romania.
- Cover various forms of economic appraisal methods, including cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and multi-criteria analysis (MCA), in line with the EC guidance, including requirements on when each of these would apply.
- Map out the key project development stages for the main transport sub-sectors and indicate at which stages economic appraisal should be undertaken.
- Contain as an annex an associated Excel database of agreed parameter values for use in the economic assessment of transport projects. This provides the 'level playing field' against which all transport projects are assessed. While the majority of parameters should be taken directly from this source (e.g., social discount rate, value of time), certain parameters (e.g., O&M unit rates, vehicle occupancy rates, accident rates) may be overridden based on more appropriate, localised data.

Although not directly applicable to projects financed under other programmes/sources, the Guidelines can be used *mutatis mutandis* to support sound project preparation and appraisal for wider transport investments, (i.e., not under the aegis of the Ministry of Transport, such as municipal transport projects).

The document is meant to be neither exhaustive nor limitative. Whilst it provides general principles and methodological guidance expected to cover most of the typical investments under the sector/programme, specific project particulars may require adaptations or additional considerations. In such cases, consultation with the Managing Authority is recommended at the earliest stage relevant.

It is assumed that the reader is familiar with basic concepts relating to appraisal. There is extensive published documentation to which reference may be made for further information on appraisal; such reference documents are listed in Chapter 2.

2 REFERENCE DOCUMENTS

The Guidelines draw on the Reference Documents listed below.

European Commission (2014) ***Guide to Cost Benefit Analysis of Investment Projects***[3]. This document contains detailed guidelines on how to appraise EU financed projects in the 2014-2020 programming period. It includes specific guidelines for transport sector projects and the general principles still apply. This document is referred to in the current Guidelines as the **2014 CBA Guide**.

European Commission (2021) ***Economic Appraisal Vademecum 2021-2027***[4]. A more recent document provides general principles and sector advice for co-financed projects in the 2021-2027 programming period. It is intended to supplement, rather than replace, the 2014 CBA Guide and in general provides for a more flexible and sometimes simplified approach. It is subsequently referred to as the **EAV**.

European Commission (2019) ***Handbook on the External Costs of Transport***[5], prepared by CE Delft on behalf of DG MOVE. This document presents a set of parameter values for external costs including accidents, air pollution, GHG emissions, noise etc. It supersedes the previous 2014 edition. It is supplemented by an Excel database of country specific values. This document is referred to as the **2019 Handbook**. (The previous version is referred to as the **2014 Handbook**.)

JASPERS (2017) ***Guidance on Appraising the Economic Impacts of Rail Freight Measures***[6]. This document provides general guidance on the assessment of investment in rail freight facilities, and includes some suggested parameter values including train operating costs, freight values of time, tonnage, reliability, track maintenance etc. It is referred to as **JASPERS Rail Guidance**.

AECOM (2014) ***Guide to Economic and Financial Cost Benefit Analysis and Risk Analysis***[7]. The AECOM guide relates specifically to Romania and was prepared within the context of the General Transport Masterplan (GTMP). It includes an appendix of parameter values that were used in Romania in the 2014-2020 programming period. The guide provided a good base for some of the current parameter values. The document is referred to as the **AECOM Guide**.

JASPERS (2014) **Guidance on the Use of Transport Models in Transport Planning and Project Appraisal**[8]. This document provides guidance on the development of Transport Models for use in the development and appraisal of transport projects. It is referred to as **JASPERS Transport Models Guidance**.

EIB (2020) **Climate Bank Roadmap 2021-2025**[9] sets out the EIB's commitment to climate action and environmental sustainability. It includes data on the proposed evolution of shadow costs of carbon.

EIB (2022) **EIB Project Carbon Footprint Methodologies**[10] for the assessment of project greenhouse gas emissions and emission variations, version 11.3. This document sets out the methodologies used by the EIB for calculating the carbon footprint of investment projects and includes a wide range of emission factors in the annexes.

EMEP-EEA (2019) **Air Pollutant Emission Inventory Guidebook**[11]**.** This document provides technical guidance on how to prepare national emission inventories.

CE Delft (2018) **Review GHG Emission Factors for Transport for the EIB**.

Other documents and sources are referenced in footnotes throughout the Guidelines.

[3] EC (2014) Guide to Cost-Benefit Analysis of Investment Projects
[4] EC (2021) Economic Appraisal Vademecum 2021-2027: General Principles and Sector Applications
[5] EC (2019) Handbook on the External Costs of Transport
[6] JASPERS (2017) Guidance on Appraising the Economic Impacts of Rail Freight Measures
[7] AECOM (2014) Guide to Economic and Financial Cost Benefit Analysis and Risk Analysis
[8] JASPERS (2014) Guidance on the Use of Transport Models in Transport Planning and Project Appraisal
[9] EIB (2020) EIB Group Climate Bank Roadmap 2021-2025
[10] EIB (2022) EIB Project Carbon Footprint Methodologies: Methodologies for the assessment of project greenhouse gas emissions and emission variations, Version 11.3
[11] EMEP-EEA (2019) EMEP/EEA air pollutant emission inventory guidebook 2019: Technical guidance to prepare national emission inventories

3 OVERVIEW OF ECONOMIC APPRAISAL

Available resources for the development of transport infrastructure are limited and insufficient to satisfy all potential transport demand through the construction of ever larger and more extensive infrastructure. The need to make choices between transport projects competing for scarce resources is inevitable. Therefore, a mechanism is required to assess the relative attractiveness of alternative investments.

Economic analysis (EA) aids the decision-making process at key project milestones and may also be used at the programme level to rank and/or to prioritise projects.

3.1 The project development cycle

The project development cycle can be variously illustrated, but in a simple form consists of six stages of the planning and execution of actions at programme and project level.

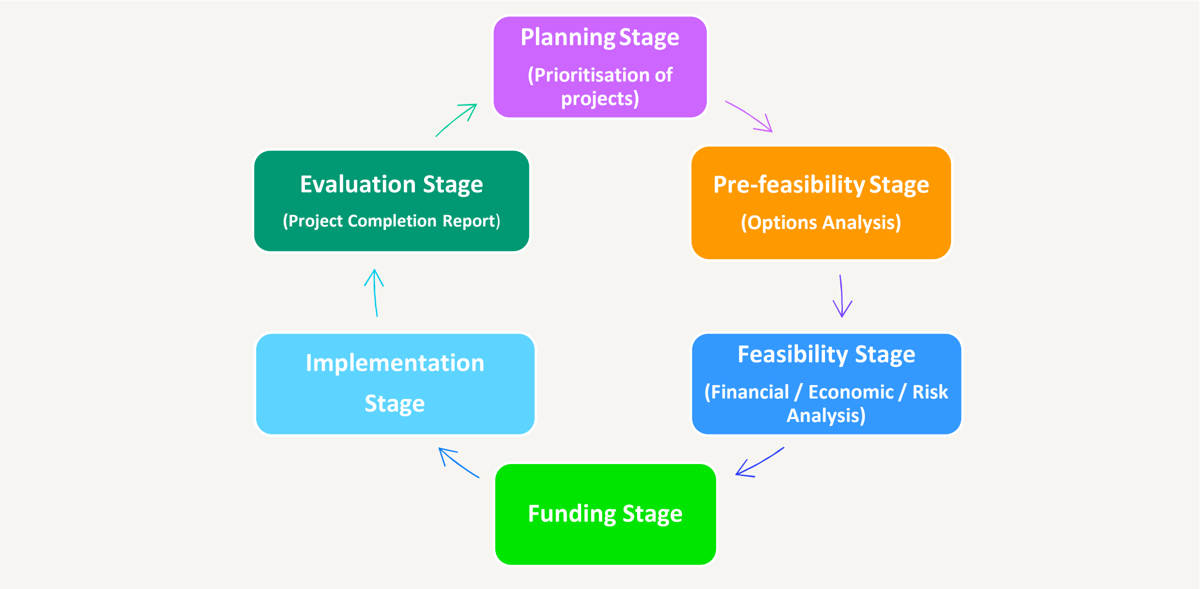


Figure 3.1: The project cycle

Source: Based on various Project Cycle Management handbooks including Handbook for EU Project Design and Project Cycle Management

- The project cycle begins at the **Planning stage**, where programme preparation takes place. Here, in the context of budgetary constraints, projects are ranked or prioritised.
- Next, individual projects are carried forward to the **Pre-feasibility Stage**, where an analysis of alternative project options and a preliminary assessment of the project economic viability are undertaken.
- The preferred option is then carried forward to the project **Feasibility stage**, where the proposed project is further developed and optimised.

  Pre-feasibility and Feasibility stages may be either undertaken together (wherein one complete project Feasibility Study covering both stages is undertaken) or separated into two processes: pre-feasibility and feasibility stages.
- At **Funding stage** projects determined to be feasible are put forward for financing.
- Projects which receive funding are then completed during the **Implementation stage**.
- Good practice requires projects to be evaluated once completed, at the **Evaluation stage**, to gauge the extent to which the expected outcomes were met and to record lessons learned for future planning. This stage is not mandatory for all projects. However, the MA should identify the projects for which this evaluation stage will be undertaken.

3.2 The role of appraisal in the project development cycle

The first stage at which appraisal is undertaken is the **Planning Stage**, as outlined above. This should involve the systematic appraisal and prioritisation of individual proposed projects using CBA and/or MCA.

The prioritised projects are then further developed and appraised as follows (see Figure 3.1 above):

- **Pre-feasibility/Feasibility Stage**. During this stage(s), a decision needs to be taken on which option to select from the myriad of available possibilities. To assist in the decision-making process, an **Options Analysis** is undertaken.

  When there is a large number of potential options, an initial filtering process to reduce the number of options is often needed. This filtering process may be skipped if there is only a limited number of reasonable options (e.g., 2-5 sensible options). The appraisal techniques during this initial filtering process may vary according to circumstances but generally would likely include either CEA or MCA.

  Once limited numbers of reasonable alternatives are defined, a detailed Options Analysis, which assesses each option against a set of predefined criteria, is undertaken. The resulting selection of the preferred option would typically be based on an economic CBA and/or MCA.

  Once a preferred option is selected the design and cost estimate are firmed up, and a detailed CBA is normally undertaken confirming whether the preferred variant is financially sustainable and economically viable. There may be a limited number of projects for which a CBA is impractical (e.g., for compliance projects), and alternate methodologies may apply in such circumstances (see Figure 3.2 below). At the end of this project stage the final financing decision is taken.

- **Evaluation Stage**. For projects which have been selected for evaluation, a Project Completion Report (PCR) is prepared. For the purposes of completing a PCR, a combination of quantitative and qualitative analysis is typically used. For instance, early-stage cost and demand estimates (options analysis, feasibility study) are compared against actual outturn cost and demand. The PCR also assesses 'lessons learned' during construction (e.g., contract management issues). The MA may from time-to-time review PCRs with a view to determining which issues are arising on transport projects (e.g., cost underestimation, demand overestimation) and proposing changes to appraisal procedures and practices to ensure these issues are addressed over time.

The table below illustrates the typical appraisal tools used at each project Appraisal Stage:

Table 3.1. Typical appraisal tools for each project stage

Project Appraisal stage	Purpose	Tool(s) generally recommended
Option Analysis - filtering	Filtering from a longer list of potential options identified to a shortlist of most relevant options (typically 2-5).	**MCA** including **CEA** or **CBA**
Option Analysis – detailed analysis	Comparing in more detail the shortlisted options to select the preferred alternative.	**MCA** including **CEA** or **CBA**
Feasibility Decision	Evaluating if the proposed investment (preferred option) is of economic benefit for society and is financially sustainable.	**CBA** (e.g., Economic / Risk Analysis)
Evaluation Stage	Ex-post analysis of projects with a view to seeing whether early-stage estimates of cost and project demand were accurate, and what were the lessons learned in implementation.	**Quantitative** and/or **Qualitative** assessment

Source: JASPERS

The identified appraisal tools are discussed in turn below.

3.3 Economic appraisal tools

Ex-ante project economic appraisal tools include cost-benefit analysis (CBA), cost-effectiveness analysis (CEA), and multi-criteria analysis (MCA). This section considers each method and makes recommendations on when each might be applied.

3.3.1 Cost benefit analysis

CBA is an analytical tool used to assess the economic advantages or disadvantages of an investment decision by quantifying the welfare changes attributable to its implementation. It aims to quantify all benefits and costs for society in monetary terms. These include economic, social, and environmental impacts. It was a general requirement in the 2014–2020 programming period for major projects financed by the European Regional Development Fund or the Cohesion Fund and continues to be a requirement of the MA Transport for the 2021–2027 programming period.

3.3.2 Cost-effectiveness analysis

Cost-effectiveness analysis (CEA) is used to compare two or more project options in relation to their effectiveness and life-cycle costs in accomplishing a single policy-specific objective. By combining information on effectiveness and costs, the project promoter can determine which investment option has the highest effect for a given cost. A variant of CEA determines the investment option that provides the best effect at the lowest cost and is referred to as least-cost analysis (LCA). CEA can thus take the form of cost minimisation and/or effect maximisation.

CEA differs from CBA because it does not evaluate the benefits in monetary terms. This assumes that all options considered are technically and economically viable and deliver the same single type of output (or process the same single type of input) even if in different volumes.

If the options achieve the same output with the same intensity/volume, and differ only in costs, the CEA can be simplified to an LCA, whereby options are compared based only on the present value of their life-cycle costs.

CEA usually aims to identify the possible alternatives for achieving a set goal and the related costs and to choose the most effective option. That is, it determines which one among several alternatives is the most cost-effective but does not indicate if an alternative is worthwhile in some absolute sense. In other words, unlike CBA, CEA cannot indicate if the preferred option provides a net benefit to society. Therefore, it is always useful to compare the results of the analysis with established benchmarks to verify that the chosen option meets the generally acceptable cost performance criteria.

In the transport sector, its main usage in the 2014–2020 funding period was for national elements of European-level projects, which represent legal compliance objectives such as the implementation of the ERTMS in the railway sector, where the output has been defined in terms of simple physical outputs such as length in kilometres. Where such simple physical outputs are considered, CEA is generally advisable only when the outputs of the options have the same quality and functionality, otherwise the CEA is not a fair comparison.

Cost-effectiveness ratios allow appraisers to rank the options, eliminate those whose cost-effectiveness ratio is higher than others, and then identify the optimal options.

The ratios could and should be expressed in different ways depending on the project particulars, but examples could range from simple measures of cost per kilometre, or per unit of time saving, to more complex formulas possibly involving elements such as traffic, lifecycle costs, externalities, etc.

3.3.3 Multi-criteria analysis

Multi-criteria analysis (MCA) is appropriate for prioritising projects in a development programme or for screening multiple project options. MCA is used in transport for project option analysis when a project has multiple key objectives or impacts for assessment, which cannot be easily monetised and comprehensively or practically assessed using CBA.

This tool is used to rank alternatives or select the best alternative in reference to a set of rational criteria, generally related to technical, economic, environmental, and social characteristics and impacts of the project.

When defining the criteria to be used in the MCA, consideration should be given to avoid double counting. For example, if ERR is used in the MCA, care needs to be taken to ensure its constituent components (i.e., investment cost, O&M, time savings, vehicle operating costs, accidents, climate change, air pollution, noise) are not double counted.

The analyst must provide a description of the rationale behind each criterion and sub criterion and explanations on how it is scored.

The analysis may or may not involve application of criteria weights and option scores, depending on the project particulars and especially on the range and complexity of the key criteria with significant differential impacts across options.

When the analysis involves the application of weights and scores, a sensitivity analysis to changes to the weights attributed to the different criteria should be performed to evaluate if the options selection process is robust and unbiased. The analysis is done by increasing the weight of each group of criteria whilst proportionally adjusting the weights of the rest of the criteria groups with the scope to understand how the ranking of the options is impacted.

An alternate approach would be to test various weightings and scoring systems prior to undertaking the multicriteria analysis with the view to determining the optimal weighting and scoring system for the proposed project. The final decision on the weighting and scoring system should then be taken prior to starting the analysis.

3.3.4 Choice of tool

In theory, the choice of the appropriate ex-ante EA tool (CEA, MCA, or CBA) should be made depending on factors such as: type/nature of the project, the size/value of the investment, and the relevant stage in the project development cycle (see Section 3.1 above).

In the context of the 2021-2027 Romanian Transport Programme (TP), the MA requirements in terms of:

a) when the different approaches to economic appraisal are applicable, and

b) the review/validation requirements by the MA before moving to the following project development stage

are outlined in the Table 3.2 below.

Table 3.2. Recommended approach to the economic appraisal of projects in the transport sector (for projects with costs ≥ 100 MRON)

Sector	Investment type	Option analysis to select preferred option		Selected option for investment approval	
		Tools	Validation requirements by MA TP	Tools	Validation requirements by MA TP
ROADS	New motorways, expressways, interurban single carriageway roads	MCA including CBA	Yes, all projects	CBA	Yes, all projects
	By-passes	MCA including CBA	Only if > e.g. 50 MEUR or cost per km > e.g. 10 MEUR	CBA	Only if > e.g. 50 MEUR or cost per km > e.g. 10 MEUR
	Road rehabilitation, upgrading	MCA including CBA	Only if > e.g. 50 MEUR or cost per km > e.g. 2 MEUR	CBA	Only if > e.g. 50 MEUR or cost per km > e.g. 2 MEUR
	Road safety	Prioritisation based on CEA/MCA	Only if > e.g. 50 MEUR	CEA or CBA	Only if > e.g. 50 MEUR
RAIL	Rail corridor sections	MCA including CEA or CBA	Yes, all projects	CBA	Yes, all projects
	Metropolitan rail	MCA including CEA or CBA	Yes, all projects	CBA	Yes, all projects
	ERTMS	Not necessarily required in quantitative terms	Only if > e.g. 100 MEUR	CEA or CBA	Only if > e.g. 100 MEUR
	Rail safety (e.g., level crossings)	MCA including CEA or CBA	Only if > e.g. 50 MEUR	CEA or CBA	Only if > e.g. 50 MEUR
	Rail stations	MCA including CEA or CBA	Only if > e.g. 20 MEUR	CEA or CBA	Only if > e.g. 20 MEUR
	Bridges rehabilitations	MCA including CEA or CBA	Only if > e.g. 50 MEUR	CEA or CBA	Only if > e.g. 50 MEUR
	Rolling stock	Not necessarily required in quantitative terms	Only if > e.g. 50 MEUR	CBA	Only if > e.g. 50 MEUR
WATER	Ports infrastructure	MCA including CEA or CBA	Only if > e.g. 50 MEUR	CBA	Only if > e.g. 50 MEUR
	Fairway	MCA including CEA or CBA	Only if > e.g. 50 MEUR	CBA	Only if > e.g. 50 MEUR
INTERMODAL	IM Terminals (IMT)	Market analysis key to confirm demand, size and location	Only if > e.g. 10 MEUR	CBA	Only if > e.g. 10 MEUR
URBAN	Metro	MCA including CEA or CBA	Yes, all projects	CBA	Yes, all projects

4 COST BENEFIT ANALYSIS GUIDELINES

The use of the CBA methodology is relevant to several proposed sources of EU funding in the financial perspective for 2021–2027 and, in particular, for the TP managed by the Ministry of Transport.

The CBA structure is based on the approach recommended by the European Commission. This is to ensure that projects which seek EU funding will have undertaken adequate analysis while providing a standardised approach across all projects in Romania, needed for effective national project prioritisation.

The 2014 CBA Guide to Cost Benefit Analysis of Investment Projects introduces during the Pre-feasibility and Feasibility Stages the following seven steps for appraisal. These aspects are discussed in turn below:

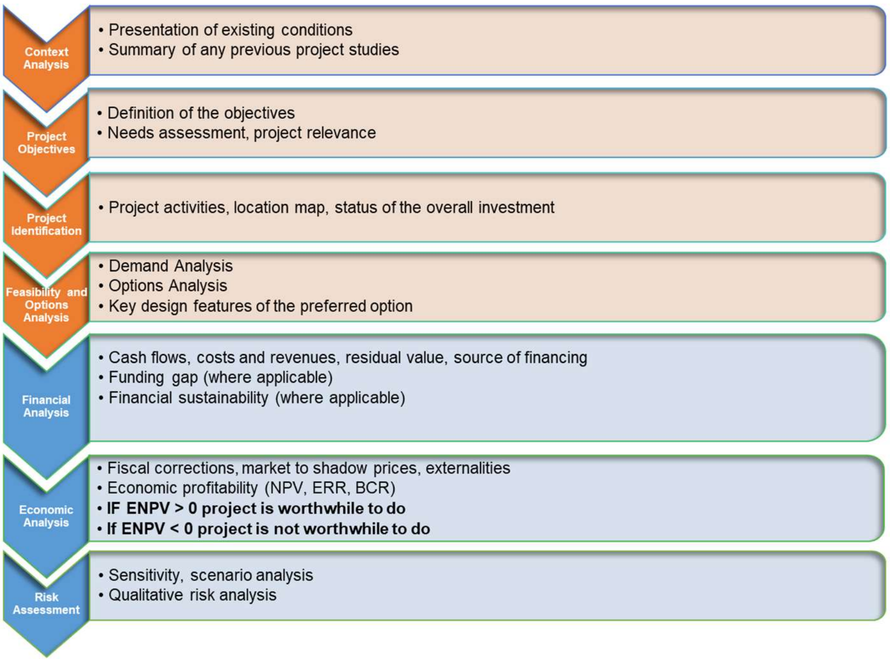


Figure 4.1. Steps for project appraisal

Source: JASPERS

4.1 Context analysis

4.1.1 Existing conditions

A description of the existing conditions in the area of the proposed project should include the following elements:

- detailed information about the existing transport infrastructure;
- information about competition from alternative transport modes;
- planned and/or recently executed investments that may affect the project performance;
- information about historic and present traffic patterns, including the identification of main flows (passenger and/or freight segments and any key origins/destinations) to understand the functionality;
- statistics in motorisation, mobility, and accessibility;
- technical characteristics of the service currently provided;
- service quality, frequency, and safety;
- existing infrastructure capacity.

The examination of the existing conditions is the starting point for the identification of current problems and needs. Proposed interventions that are developed should be designed to alleviate current problems. The scope, design, and size of the proposed interventions should be proportionate with the scale of identified deficiencies and reflect current and forecast demand.

4.1.2 Summary of previous project studies

If the project has undergone previous studies, a summary of the history of project identification and option selection process must be provided, and the rationale behind the choices explained. It is necessary to gather all the outputs from previous project-related studies including pre-feasibility studies, feasibility studies, technical reports and any relevant project data that may be used in the CBA.

4.2 Project objectives

The project objectives are to be derived based on the needs assessment and must be aligned with the priorities identified in the TP and Transport Master Plan/Investment Plan.

The main objectives of a transport project "are generally related to the improvement in travel conditions for goods and passengers both inside the impact area and to and from the impact area (accessibility), as well as improvements in both the quality of the environment and the wellbeing of the population served. In more detail, projects will typically deal with the following objectives:

- reduction of congestion within a network, link, or node by resolving capacity constraints;
- improvement of the capacity and/or performance of a network, link, or node by increasing travel speeds and by reducing operating costs and accidents;
- improvement of the reliability and safety of a network, link, or node;
- minimisation of GHG emissions, pollution, and limitation of the environmental impact (important examples are projects supporting the shift from individual, i.e., cars, to collective transport);
- adjustment to EU standards and completion of missing links or poorly linked networks: transport networks have often been created on a national and/or regional basis, which may no longer meet the transport requirements of the single market (this is mainly the case with railways);
- improvement of accessibility in peripheral areas or regions.

When feasible, the objectives should be quantified and targeted with the use of indicators, logically linked to the project benefits. For example, indicators including expected traffic volumes, travel times, average speeds, etc., can be used to show the link between the materialisation of the project benefits and the achievement of the stated objectives."

4.3 Project identification

The project description should include, at least, the elements described below:

- description of project works, activities or services (type of infrastructure (e.g., road, railway line, etc.), type of intervention (e.g., new construction, rehabilitation, upgrade, etc.), service provided (e.g., cargo traffic);
- project location map indicating main project components;
- status of the overall investment (in case of the project being a phase or a stage of a larger overall investment);
- context of the project in relevant Strategies and Plans defining Project objectives.

The project activities should be consistent with the project's objectives.

Typical investment typologies are suggested in the 2014 CBA Guide (section 3.4) including:

- new infrastructure that satisfies increasing transport demand;

- completion of existing networks through the construction of missing links;
- extension or rehabilitation of existing infrastructure;
- investment in safety measures on existing infrastructure;
- improved use of existing infrastructure;
- improved inter-modality and inter-operability;
- improved infrastructure investment management.

4.4 Feasibility and option analysis

4.4.1 Demand analysis

A transport project should ideally find its strategic justification in the framework of a comprehensive transport plan, set up at the appropriate territorial level. Such a plan will generally be supported by a demand model.

Consideration should be given to the use whenever possible of either the National Transport Model - NTM (for public transport projects) or the National Road Transport Model - NRTM developed by CESTRIN (for road projects), or the revised NTM developed for railways by the Railway Reform Authority for assessing the project types listed below:

- strategic inter-urban highway schemes;
- rail infrastructure and service proposals including major investments such as corridor line upgradings or metropolitan rail developments;
- investment in inland waterway port infrastructure and navigation;
- national and regional bus strategy development;
- terminals supporting intermodal transport;
- national policy measures such as:
  - implementation of road tax changes and impact on car ownership;
  - differential pricing for use of rail and road;
  - internalisation of external transport costs, and
  - climate change policies.

Alternative modelling approaches may be used for other types of projects as described in the JASPERS Transport Models Guidance and JASPERS Rail Freight Guidance. These guides provide detailed descriptions of best international practice relating to demand modelling.

Demand models generally form the key source of input and assumptions for a transport CBA, so their quality and objectivity are an essential prerequisite of a sound transport economic analysis. Demand models provide forecasts of traffic volumes that are a key basis for the assessment of time savings, vehicle operating cost savings and externalities.

In the 2014–2020 programming period, best practice in terms of demand modelling was outlined in Section 3.5 of the 2014 CBA Guide, and this remains valid. However, the points set out below should be considered in the development of a traffic model.

Transport models are both expensive and time-consuming to create. Therefore, at an early project stage, existing models should be reviewed, and pragmatic decisions taken on whether the demand model needs to be updated or replaced. Even when a new demand model is required, existing sources of information (in the form of traffic counts, origin–destination surveys and coded networks of transport supply i.e., networks of roads, railways, inland waterways, and associated links between them) should be used to the maximum extent possible.

The geographic scope of an existing model may not be appropriate for the project under consideration. While it is unlikely that the modelled area of the NTM/NRTM will be too small (except perhaps for major cross-border projects or investment in rail freight facilities), it may well be too large for many projects and/or lack sufficient local detail. The minimum required modelled scope should be the area within which the main expected transport impacts of the project are expected to occur. If the model is too large and lacks sufficient detail in the area of the project, it may need to be cut (taking only the relevant part of the network) and further detailing made in terms of network and zoning.

Transport models require proper calibration and validation. Calibration essentially entails setting the values of the various constants and parameters, while validation establishes the credibility of the model by demonstrating its ability to replicate observed traffic behaviour. Data used for validation should be independent (i.e., they should not have already been used in the first steps of model calibration). If an extracted area of the NTM/NRTM is used for a local project, it will not usually be necessary to recalibrate, but a revalidation must always be undertaken. Statistical tests such as the GEH[12] test should be used as part of a rigorous model acceptability test in the validation process. In validating a model, it is also required to verify that the model reflects accurately the speed observed on the network. This should be undertaken preferably via journey-time surveys, or at minimum via online sources such as Google Maps. Journey-time surveys should ideally be carried out over a period of several days and at different times of the day, to enable an accurate estimate of journey-times and speeds. The selected routes for validating journey times should cover a range of routes within the modelled area to the extent possible. Routes should include those on which traffic will be significantly affected by the proposed intervention. The validation routes should be neither too long (greater than 20km) nor too short (less than 5km).

When a project has a substantial impact on different elements of a door-to-door trip, such as a new railway station, it is advisable that the model and its output into the CBA take into account the perceived cost of each element of the trip. This implies inclusion of and differentiation between access to and from a public transport stop, waiting time and in-vehicle time. Without this, the full benefits of the project will not be measured, which may lead to a low ERR or a distorted option analysis. The full list of weightings of different time elements, as recommended in the EAV, is shown in Table 4.1.

Table 4.1. Recommended weightings of journey time elements

Common perceived time elements	Weighting on in-vehicle unit value of time or fixed penalty	Comment
Door-to-door trip elements		
Walk time	1.5–2	
Wait time (actual time spent waiting for a PT vehicle)	1.5–2	Not to be combined with the PT service headway approach and to be used only for turn-up-and-go services with high frequency (more than four vehicles per hour)
PT service headway (average time interval between services)	0.4–1	Lower weightings are applied to services with lower frequencies (usually longer distance) and can be expressed as a function of service frequency
PT transfer penalties	4–15 minutes fixed penalty	Intrinsic discomfort value after taking into account walking and waiting at interchanges. Lower in high-frequency well-integrated local PT services and higher for longer distance trips
Reliability and congestion		
PT late arrival	2.5–4	Weight applied to lateness / delayed part of travel time
Congested time (in car)	1.5	Applied to time spent in congestion
Travel time standard deviation (car)	0.4–1.2	Applied to the standard deviation of travel time

NB: PT, public transport.

Source: EAV

[12] Refer to the JASPERS guidance reference above for detailed information.

The demand model must be developed for two scenarios:

- a without project case, in which it is assumed that the project under appraisal is not implemented. (This is sometimes referred to as the “do minimum”, “business as usual” or “counterfactual” case. However, the term “without project” abbreviated to WOP is used for consistency.);
- a with project case, abbreviated to WP, which includes the project under appraisal. Apart from data that relates specifically to the project, the WP scenario must be consistent with the WOP scenario in all other respects.

The demand model of the WOP scenario should be developed for a Base Year, for which conditions (traffic, travel time etc.) have been measured. This data is then used for the calibration and validation of the transport model for the base year. The model should also be developed for several forecast years for both the WOP and WP scenarios. Forecast years should include at least the first year of operation of the project and appropriate future years when significant changes in the modelled network may be expected. It is preferable to include the year that corresponds to the final year of the appraisal period, unless it is considered that growth factors can be applied to demand in an earlier year. However, this is less likely to be the case if congestion and/or overcrowding is expected.

For any future years that are modelled, the WOP and WP scenarios should include all other committed infrastructure investment projects that might reasonably be expected to be implemented in the corresponding modelled year and that are located within the sphere of influence of the project under appraisal.

Forecast demand in future years may be influenced by any or all of the following:

- demographic changes;
- socio-economic changes;
- spatial changes relating to housing, commercial activity, industrial activity and logistics;
- elasticity with respect to quality, time and price;
- capacity constraints;
- change of traffic management policies;
- technological changes.

Further details on modelling are to be found in the JASPERS Modelling Guide.

The model outputs should be used for calculating the projects economic benefits (see section 4.7.5).

4.4.2 Option analysis

The project objectives can usually be achieved in more than one way by different project options.

A base case (WOP) is required as the starting point for the generation of any solution options as these will build on it and be benchmarked against it. The WOP scenario describes the base situation against which all investment options will be compared. It includes all necessary maintenance and operation activities required to provide a continued standard of operation without significant deterioration in its technical condition. Thus, even in the WOP scenario, significant investment in periodic maintenance is likely to be incurred. However, it is important not to exaggerate the deterioration of traffic conditions, which could lead to unrealistically favouring investment options.

In defining the project options, the following should be considered:

- The options development process refers to the identification of conceptually different project alternatives. Previous options might also have been generated as part of strategic plans, investigated as part of a feasibility study, or resulted from experience with daily operations. Both previous and new project options would be included in a long list of solution options for the investment need identified. Furthermore, targeted stakeholder consultation should be considered as a possible way of informing the longlist development. This opportunity will need to be assessed on a case-by-case basis, as there will be proposals where such consultation will be critical while it might not be required at all in other situations.

- When defining the options, all the environmental factors, as defined in the EIA Directive, must be considered.
- For a fair comparison between identified options, the cost estimate should be based on the same unit costs and level of aggregation.
- The proposed options should be described in terms of their key parameters (e.g., length, design speed/travel time, carriageway width, cross-section, etc).
- In the 2021-2027 financial perspective, road projects are expected to demonstrate a stronger economic justification in the context of the climate policy. Therefore, when defining project options, adequate design of project capacity versus expected demand is crucial. Excessive capacity on road sections with low traffic levels takes valuable investment resources away from other sections on the network and leads to unjustified operation and maintenance expenditures. In cases where two types of cross-sections might be considered, an incremental analysis comparing costs and benefits could help to determine the optimal selection.
- It is up to the project promoter to establish the number of investment options examined under the CBA. However, the promoter must be able to demonstrate that all reasonable alternative options have been considered adequately and justify the reasons for which the final option was chosen.

The process should normally cover the following key stages (although, depending on the project particulars not all stages may be always required):

a) Identification of a long list of potentially relevant options (e.g., alignment alternatives);

b) Filtering the long list to a shortlist of best/most relevant options based on CEA and/or MCA;

c) Evaluating in more detail and comparing the shortlisted options to determine the preferred one based on CBA/CEA and MCA. For linear infrastructure, the environmental criterion has to be considered in the MCA;

d) Once a project alternative is selected, options for the implementation/refinement of the selected alternative are to be developed.

4.4.3 Preferred option – key features

The project description should include, at least, the elements described below:

- Description of project technical aspects:
  - Description of the main works/investment components, technology adopted, and design standards (e.g., design speed);
  - Key output indicators, defined as the main physical quantities produced (e.g., length and cross-section of road, length of tunnels, length and width of bridges, number of interchanges/stations, etc.).

4.5 Key assumptions

Key assumptions relate to some general parameters that need to be set in advance and are generally common across all transport projects. These are set out in the following paragraphs.

4.5.1 Appraisal period

The appraisal period (sometimes referred to as the “reference period”) should be long enough to cover the time period over which the bulk of the project’s impacts are captured.

The appraisal period covers the period of construction followed by the period of operation. The period of operation may overlap with the period of construction if, for example, there is a phased opening of the project with one or more sections of infrastructure coming into operation before full completion of all sections of the project.

The length of the appraisal period for most projects is expected to be 30 years, in addition to the construction period, but this can be adapted depending on specific project particulars. If the expected economic life of the asset is less than 30 years, the appraisal period can be shortened accordingly.

The economic lifetime should normally be estimated as a weighted average lifetime of the main categories of assets (e.g., structures, pavement, buildings, equipment, etc.). Where the economic life extends beyond the appraisal period, this should be captured in the residual value (see section 4.7.4 below).

According to the EAV, the expenditure incurred before the start of the analysis should be converted using an appropriate inflation rate (e.g., engineering works cost indices provided by INSSE as included in Annex I) and included in the first year of the analysis.

4.5.2 Currency

The economic analysis should be undertaken in EUR and all prices expressed in RON should be converted to EUR using a consistent exchange rate (as set out in Annex I).

4.5.3 Price base

The CBA is carried out in constant prices (in real terms) i.e., excluding the future impact of inflation. Nevertheless, it is necessary to adjust all costs to a common price base.

Costs of investment, maintenance and operation are typically estimated in nominal prices, in local currency, in the year in which the cost estimate is prepared. They will be first converted to constant prices corresponding to those of the price base year by using the appropriate national price indices, and then converted to EUR using the average exchange rate applicable to the price base year.

Unit values for benefits are included in Annex I. These are expressed in prices of the defined price base year. At the time of writing these guidelines, the price base is fixed at 2021, but may be reviewed by the MA and changed to a later year during the course of the programming period. Prior to conducting the CBA, the analyst should download the latest version of RomTAP, the database of parameter values.

4.5.4 Incremental analysis

CBA requires a comparison of the WOP and WP scenarios (incremental analysis). Costs and benefits are assessed by considering the differences between these scenarios, and only the net impact is considered in the analysis (see 4.4.1 and 4.4.2 above). Therefore, the financial and economic indicators are calculated considering only the incremental cash flows.

4.6 Financial analysis

The EAV summarises the legal framework applicable in the financing period 2021-2027 as follows:

- *No provisions are made in the CPR to assess the project's financial performance. Member States are free to set up their methods and criteria to verify that the project is in need of co-financing. For <some> cases, State aid rules <may> apply.*
- *Article 73.2 (d) of the CPR requires verification 'that the beneficiary has the necessary financial resources and mechanisms to cover operation and maintenance costs for operations*

comprising investment in infrastructure or productive investment, so as to ensure their financial sustainability'.

- *According to Article 73.2 (c) of the CPR, the managing authority needs to 'ensure that selected operations present the best relationship between the amount of support, the activities undertaken and the achievement of objectives'. This implies, amongst other considerations, that self-financing and/or the bankability potential of an operation should be taken into account where relevant.*

In the specific context of Romania's transport programme, the following general principles are adopted by the MA:

- For non-revenue generating projects (e.g., any kind of untolled road with no revenue generating from service areas, Danube fairway, etc.) there is no value added in performing either analyses of financial performance or funding gap calculations.
- The same applies for the financial analysis of projects/sectors where revenues are generated but typically do not exceed (or exceed marginally) the operational and maintenance costs (e.g., railway infrastructure, metro). However, a funding gap calculation is typically required for such cases.
- With regard to the financial sustainability:
    - For project promoters (public companies) financed directly from the state-budget (e.g., national road or railway infrastructure companies, Railway Reform Authority, Bucharest Metrorex, etc.) financial sustainability is also considered automatically secured based on a clear and formal commitment from the promoter and the Ministry of Transport to ensure the financing and co-financing of the respective project both during the construction and during the operation period.
    - For other promoters – including private or local companies – financial sustainability should be assessed.
- For projects/sectors covered by state-aid (e.g., ports, local infrastructure such as intermodal terminals), the specific provisions applicable shall be followed, normally including a funding gap calculation.

The table below summarises the guidelines applicable by sector/type of investment:

Table 4.2. Summary of financial analysis requirements

Sector	Investment type	Requierements for financial assessment		
		Funding gap	Financial analysis (FIRR, FNPV)	Financial Sustainability
ROADS	New motorways, expressways, interurban single carriageway roads	Not required, except if tolled or concessioned	Not required	Not required as state budget covered, except if concessioned
	By-passes	Not required.		
	Road rehabilitation, upgrading			
	Road safety			
RAIL	Rail corridor sections	Required	Not required	Not required as state budget covered
	Metropolitan rail	Required	Not required	Required
	ERTMS	Not required		
	Rail safety (e.g., level crossings)	Not required		
	Rail stations	Required	Not required	Not required as state budget covered
	Bridges rehabilitations	Not required unless subject to user charging	Not required	Not required as state budget covered
	Rolling stock	Required	Not required	Required unless owned by the Railway Authority
WATER	Ports infrastructure	Required in conjunction with SA	Not required	Required (including consolidation infra+operator where appropriate)
	Fairway	Not required unless subject to user charging	Not required	Not required as state budget covered
INTERMODAL	IM Terminals (IMT)	Required	Not required	Required
URBAN	Metro	Required	Not required	Required if not covered by state budget

Source: JASPERS

For the less typical cases where a full or partial financial analysis is required, more detailed guidelines are provided in Annex II.

4.7 Economic analysis

The main purpose of the economic analysis is to assess whether the project's benefits exceed its costs and whether it is therefore worthwhile to progress. The analysis is conducted from the point of view of the whole of society, not just the project owners. To capture the range of economic impacts the analysis includes both elements with direct monetary value, such as construction and maintenance costs and vehicle operating cost savings, and elements without direct market value such as time savings, accident reduction and environmental impacts.

In order to allow consistent comparison of costs and benefits across a project, all impacts should be monetised (i.e., attached a monetary value) and then aggregated to determine the net benefits of the project. From this, it can be determined whether the project is desirable and worth implementing, indicated by an economic net present value (ENPV) greater than zero.

4.7.1 Methodology

An economic analysis includes the following steps:

1. Conversion of costs from market to accounting prices.
2. Monetisation of economic benefits.
3. Discounting of estimated future costs and benefits.
4. Calculation of the key economic performance indicators.

The economic analysis converts the costs and benefits of a project into a common unit of account (in this case, EUR) and compares the size of benefits to the size of the costs for individual stakeholder groups (providers, users, and wider society).

Many of the impacts of a project are already expressed in monetary terms, for example investment, maintenance, and operating costs. However, in the economic analysis market prices should be converted into accounting prices using appropriate conversion factors when they do not reflect economic opportunity costs.

For project impacts that do not have a direct market value (for example time savings and local pollution changes) it is necessary to convert the benefits and costs into monetary values using the methods outlined in these guidelines. This allows impacts of varying natures to be combined and compared using a common unit (EUR) as a welfare metric.

There are cases where market price conversions are not available, or very difficult to define reliably and accurately. These include, for example, some environmental impacts such as loss of landscape views and wider economic benefits. Many of these impacts are still important to achieving the project's objective and therefore, while not included explicitly in the quantitative economic analysis, may be incorporated (e.g., in an MCA) in the wider appraisal framework.

Economic analysis does not include transfer payments such as taxes, subsidies, tolls and fares. As the name suggests, transfer payments are payments that are transferred from one body to another, with no actual resources produced or consumed.

Once project impacts have been monetised and discounted, the total benefits can be compared against the total costs.

Simplistically, for a project to be viable, the project benefits should exceed the project costs. More specifically, the present value of the project economic benefits (PVB) should exceed the present value of the project economic costs (PVC). In practice, this is shown by a positive economic net present value (ENPV = PVB-PVC), a benefit-to-cost ratio (BCR = PVB/PVC) greater than one, and an economic internal rate of return (ERR) greater than the discount rate used.

4.7.2 Key parameters

Social discount rate

A project typically incurs costs during the early construction phase and provides benefits (and incurs some operating costs) during the subsequent operation phase. To compare the benefits and costs incurred in different years on a like-for-like basis, it is necessary to 'discount' all costs and benefits to a present value year. The present value considers that costs and benefits incurred in early years are more 'valuable' than the same sized benefit or cost incurred in a more distant year.

A social discount rate of 3% has been set for transport sector projects in Romania, in accordance with the EAV. It is recommended, for ease of understanding, to discount cost and benefits to the same year as the price base.

Conversion factors

Financial cash flows must be converted to economic flows using appropriate factors to convert from financial prices to accounting prices ("shadow prices") which are more effective in conveying social benefits.

The passage from financial prices to accounting (shadow) prices is made in two steps:

- In the first step, fiscal corrections are made directly on the cash flows, involving the removal of direct taxes, indirect taxes, and subsidies.

- In the second step, corrections are made for other factors distorting financial prices from accounting prices. It is assumed for simplification that this includes only corrections to wages (due to imperfections of labour markets) and energy. Weighted conversion factors are calculated to eliminate the remaining distortions on different markets including materials, labour, energy, and others. The categories correspond to those used in the previous EU Major Project Funding Application Form and may need to be adapted as appropriate in the context of the TP procedures.

The conversion factors are based on average estimated percentages of costs of materials, skilled labour, unskilled labour, energy, land acquisition and other costs. The resulting default conversion factors are as follows:

Table 4.3. Conversion factors from financial to economic prices

Cost category		**Conversion factor**
CAPEX	Planning/design fees	0.98
	Land purchase	1.00
	Building and construction	0.90
	Plant and machinery or equipment	1.00
	Contingencies	0.00
	Price adjustment	0.00
	Publicity	0.98
O&M	O&M	0.88

Source: JASPERS

Moving from one price base year to another

The parameter values included in Annex I are all expressed in prices of the defined price base year. Those undertaking CBA should generally not have to change the price base year for these general parameters. However, where alternate parameter values are being proposed (e.g., where better / more appropriate unit values have been identified), the project analyst may need to change the price base year of the new values to that of the defined price base year. Details on the approach to follow for moving the parameter values from one price base year to another are provided in Annex I.

Growth in real values over time

Throughout the appraisal period the unit values of certain costs and benefits (e.g., the value of time) is expected to grow. However, future values should be expressed in real terms (i.e., inflation occurring after the price base year will be ignored).

For many, but not all, parameters it is assumed that growth follows that of real GDP per capita at a specific elasticity. (The specific elasticities to be used are noted below in the paragraphs relating to the respective parameters).

Forecast GDP per capita growth is based on the latest forecast provided by the Economist Intelligence Unit (EIU). Current values are 2.8% per year to 2030 and 2.4% per year thereafter. However, the forecast is updated regularly and the latest values for Romania should be obtained at the time of performing the CBA.

4.7.3 Overview of estimation of costs and benefits

It is necessary to consider the impacts of a project in a consistent manner. Impacts are therefore monetised to allow ease of analysis and combination of impacts across different elements.

Costs typically include:

- investment costs;
- maintenance costs/replacement costs;
- operating costs (for operating new infrastructure/services).

Benefits typically include:

- time savings for users;
- vehicle operating cost changes for users;
- changes in external costs:
    - safety;
    - climate change;
    - local air pollution;
    - noise.

4.7.4 Costs

Investment Costs

The estimate of the investment costs should carefully consider the relevant market conditions including forecasted changes for real prices (e.g., if construction inflation is forecast to be higher than general inflation over the investment period).

To this end, it is recommended to ensure that:

1) Information on the unit costs and investment overall cost calculation is presented in sufficient detail to provide confidence in the cost estimate.

2) The cost estimate is based on up-to-date unit prices reflecting the latest market conditions at the time of the estimation.

3) Financial contingencies (or “price adjustment”) are estimated and included i.e., allowance is made for inflation, distinguishing between the “general inflation” (CPI) and “sector specific inflation” (since often construction prices grow faster than consumer prices).

4) Technical contingencies (for unforeseen items) are included – typically 10% but can vary depending on the project particulars (specific risks, stage of design, extent of geotechnical studies, etc.).

The investment costs must include all elements of expenditure required to realise the project, including upfront costs such as planning and design costs. As well, the cost of all the environmental measures, as imposed by the EIA Decisions, must be included in the investment cost.

In summary, investment costs must include any costs relating to each of the following items:

- Planning/design fees, including preparatory studies, designs and tests, approvals and permits, management of the procurement process and any other expenditures prior to the construction period;
- Land purchase costs, including associated administrative costs;
- Building and construction, subdivided into all items listed in Table 4.4 below;
- Plant and machinery or equipment acquired or rented during construction;
- Publicity;
- Supervision during construction;
- Technical assistance;
- Financial (price) contingencies;
- Physical contingencies (maximum 10% of the total investment cost);
- Total excluding VAT;
- VAT;
- Total including VAT.

This list is provisionally based on the items to be included in Table C1 of the former EU Funding Application Form. Costs are to be subdivided into total costs, eligible costs and ineligible costs for each cost category. Restrictions on eligible costs are as outlined in EU Regulation 2021/1060 Chapter III – Eligibility Rules and the applicable national regulation.

The VAT, financial (price) contingencies and physical contingencies are not to be included in the calculations of the economic indicators.

Separately, the investment cost should be presented in terms of annual amounts spread across the implementation period.

Operation and maintenance costs

Operation and maintenance (O&M) costs include the cost of all routine maintenance (summer and winter), periodic maintenance (renewals) and costs of the day-to-day operation of infrastructure.

They do not include the operation and maintenance of road vehicles, railway rolling stock or IWT vessels. Such costs are considered separately as vehicle operating costs (VOCs), train operating costs (TOCs) and vessel operating costs (IWTOCs) under project impacts/benefits.

For roads, O&M costs may include:

- Routine maintenance such as cleaning, patching of potholes, reparation of damage to lighting, signage and crash barriers, snow clearance.
- Periodic maintenance such as road resurfacing.
- Operation of traffic control centres and toll facilities.

For railway infrastructure, O&M costs may include:

- Routine maintenance such as ballast cleaning, reparation of damage to equipment.
- Periodic maintenance such as renewal of catenary.
- Traffic management and control.

Nota bene:

- O&M costs are calculated either in the years in which they occur (preferable) or may be averaged as annual values for each year of operation.
- They must be calculated separately for the WOP and WP scenarios, using the same unit rates for a particular operation, so that the incremental costs (or savings) can be calculated.
- The O&M costs in the WP case should be sufficient to maintain the existing level of service (especially if the historic costs are very low due to spending constraints).
- Similarly, the O&M costs in the WP case should be sufficient to maintain the new infrastructure in a condition adequate to support the level of service offered on project opening.
- In forecasting future operating, maintenance and renewal costs, analysts should consider the impact of increasing usage or patronage if relevant. Where the existing infrastructure is maintained in the WP case, O&M estimates for the existing infrastructure may be reduced to reflect lower forecast demand.
- The proposed unit maintenance costs included in the RomTAP should be considered only for CBA purposes calculation.

4.7.5 Residual value

If the reference period is shorter than the economic life of the project, a residual value of the infrastructure is included in the analysis in the final year of the reference period. If the reference period is equal to the economic life of the project, the residual value is zero.

There are two approaches to the calculation of the residual value:

1) The present value of net economic cash flows generated by the assets during the remaining years of the economic life of the project beyond the end of the reference period (the preferred method).
2) The outstanding value of the assets at the end of the reference period (depreciation method).

In both cases it is necessary to estimate the physical life of the project. The average of the physical life of the different asset categories is calculated, weighted by the value of the investment attributable to each category. The indicative average physical life of each asset category is set out in the table below.

Table 4.4. Average physical life of assets following construction

Mode	Assets	Years
General	Tunnels & bridges	75
	Land	Infinite
Roads	Retaining structures	60
	Earthworks (embankments)	40
	Pavement: concrete	33
	Pavement: asphalt	20
	Drainage (culverts)	40
	Environmental protection measures	25
	Safety measures (signage, guard rails)	15
	Utilities	25
	Installations (mechanical and electrical)	15
	Communication equipment (ITS)	10
Rail	Substructures	60
	Tracks	30
	Technical equipment	20
	Power supply	30
	Environmental installations	30

Source: EIB, JASPERS

For example, if the investment cost of a railway construction project is distributed 50% for substructures, 20% for tracks, and 10% each for technical equipment, power supply and environmental installations, the weighted physical life would be:

$$0.5 \times 60 + 0.2 \times 30 + 0.1 \times 20 + 0.1 \times 30 + 0.1 \times 30 = 44 \text{ years}$$

With a reference period of 30 years, the remaining physical life would be 44 – 30 = 14 years or 31.8% of the total physical life. This is of course an approximation.

The method provides a simple way of estimating the residual value, either by:

- extending the economic cash flow from the last year of the appraisal period over the remaining 14 years (assuming a continuation of a constant value of benefits as estimated in the final year of the appraisal period, and a continuation of the average value of O&M costs during the period of operation) and calculating the NPV over the extended period. If this method is adopted, the resulting residual value is included as a benefit in the final year of the appraisal period; or
- calculating (in this case) 31.8% of the investment cost. If this method is adopted, the resulting residual value is included as a negative cost in the final year of the appraisal period.

4.7.6 Economic benefits

In line with best practices, the benefits that are considered in the economic analysis include time savings, changes in vehicle operating costs and changes in external costs.

This section provides information on the methodology to calculate the benefits. The unit values for the benefits are presented in Annex I.

Time savings

Time savings relate predominantly to reduced journey times attributable to passenger journeys resulting from project implementation.

It is recommended to set the passenger values of time (VoT) at national level based on the "willingness to pay" method, by conducting stated and/or revealed preference surveys. Another method to estimate the value of time is the "cost saving approach" which relates to the costs to employers (salaries and overheads) for trips conducted in the course of work and a percentage of net wages for other trips.

At present, in the absence of these national surveys on passenger VoT, the HEATCO Deliverable 5 derived values will continue to be applied (adjusted to the relevant price base year). In Romania constant average values (equity values) differentiated by trip purpose are to be used across all modes of transport so as not to bias CBA results in favour of a particular transport mode.

Note that work trips relate strictly to journeys carried out during paid working hours or productive working time. They do not include travel to or from work unless this is travel in paid working time to a place that is a non-regular and/or non-fixed location. Regular travel between home and work is classified as commuting and treated separately.

Time savings may also be attributable to the transport of freight depending on sector and project specific conditions.

For road freight vehicles only the time savings for drivers are to be considered, and the same unit cost as the one for passenger work trips will be used in the calculations. It is assumed that occupancy for this category of vehicles will equal one occupant per vehicle.

For rail, both the transport cost component (savings of crew time) and cargo cost component of the journey time are considered, and recommendations from JASPERS Rail Guidance apply.

The values of passenger time to be used are set out in RomTAP by year and trip purpose (see Annex I), expressed in terms of EUR per passenger hour. Information on passenger vehicle occupancy is provided as well. Freight values are also included, expressed in EUR per tonne hour (and apply irrespective of mode). Average loadings for goods vehicles, freight trains and IWT vessels are also provided in RomTAP but can be overridden if more accurate estimates are available.

Future values of passenger time are assumed to grow in real terms in line with GDP/capita with an elasticity of 0.8 applied. Freight values are to be considered constant in real terms over the reference period.

Road vehicle operating costs

Road user vehicle operating costs (VOCs) are split into fuel costs and non-fuel costs. Non-fuel costs include such items as oil, tyres, maintenance, depreciation, and insurance.

The fuel element of VOCs should be calculated based on an estimate of the litres of fuel or kWh of electricity consumed for each journey based on vehicle type, trip length and average speed. The formula for calculating the quantity of petrol and diesel consumed per kilometre is based on work carried out by Ricardo[13] for use in UK WebTAG[14] and takes the form:

$$L = a/v + b + c \cdot v + d \cdot v^2$$

[13] Ricardo (2019) Production of Updated Emission Curves for Use in the NTM and WebTAG https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/942830/Production_of_Updated_Emission_Curves_for_Use_in_the_NTM_and_WebTAG-document.pdf

[14] https://www.gov.uk/guidance/transport-analysis-guidance-tag

where L is fuel consumption in litres per kilometre, v is average journey speed and a, b, c, and d are parameters that take different values depending on the type of vehicle and fuel.

The calculation of electricity consumption of electric cars is based on work by Ricardo-AEA[15] and takes the following polynomial form:

$$K = a \cdot v^4 - b \cdot v^3 + c \cdot v^2 - d \cdot v + e$$

where K is electricity consumption in kWh per kilometre, v is speed and a, b, c, d, and e are parameters with predefined values. Information on the electricity consumption of buses, LGVs and HGVs is sparse. Therefore, default values are proposed for these categories of vehicle until the results of more research are available. The default values are assumed to apply to an average speed and are adjusted according to the polynomial curve used for cars to calculate values at other speeds.

It may be noted that the formulae for both conventionally fuelled vehicles and electric vehicles apply to specific speed ranges. Results may be unreliable beyond these ranges.

The VOC non-fuel element should be calculated based on vehicle type, trip length, type of terrain, type of road and road roughness. Default values are provided based on HDM-VOC for a set of fleet characteristics appropriate for Romania.

Default parameter values for the fuel and non-fuel elements of VOCs are provided in RomTAP (see Annex I). The total VOC for a particular trip is calculated as the product of the length of the trip (km), fuel consumption per kilometre (litres/km and kWh/km) and the cost per unit of fuel (€/litre or €/kWh exclusive of all taxes and duties), plus the product of the trip length and the non-fuel unit cost.

Fuel costs have varied significantly over the years. Uncertainty over future fuel costs coupled with ongoing improvements in fuel efficiency have meant that traditionally road VOCs have been held constant throughout the appraisal period, the rationale being that any increase in cost may be cancelled out by improved efficiency. RomTAP makes provision for two scenarios: the Baseline Scenario continues current trends (VOCs held constant), and an Adapted Scenario which is intended to be consistent with Paris Agreement objectives and assumes annual fuel cost increases alongside improved fuel efficiencies.

Train and IWT vessel operating costs

Train operating costs (TOCs) and inland waterway vessel operating costs (IWTOCs) are the costs of operating and maintaining the railway rolling stock (as opposed to the infrastructure) and the shipping vessels. They include energy consumption, crew costs, maintenance and repairs, general operating costs (administration, office costs and overheads, IT etc).

The change in train kilometres and IWT vessel kilometres which result from the project should be calculated and then monetised using the unit cost rates. Details of how TOCs and IWTOCs are calculated in RomTAP are included in Annex I.

External cost savings

External costs are costs that are not directly or fully accounted for by the groups causing them. Thus, costs that are caused by transport users but incurred (in full or in part) by others are treated as the external costs of transport. They include the costs of accidents, air pollution, noise and greenhouse gas emissions (predominantly CO_2).

[15] Ricardo-AEA (2015) Speed emission/energy curves for ultra-low emission vehicles https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/942831/Speed_emission_energy_curves_for_ultra-low_emission_vehicles-document.pdf

Safety improvements

The accident benefit or disbenefit associated with the project should be calculated, monetised, and input into the CBA. The monetary value attached to the avoidance of an accident is related both to the direct cost associated with the accident (for example the cost of emergency services and hospital treatment etc.) and the indirect economic costs, for example in terms of lost productivity from injury time and a proxy value attributed to the pain, grief and suffering caused by accidents.

In general, the difference in the number of accidents occurring in the WOP and WP networks must be determined.

This is done by calculating the total vehicle kilometres by network type (road type, rail type, waterway type) and applying appropriate accident rates (number of accidents per year per million vehicle kilometres). For rail accidents it may be further disaggregated into accidents related to the number of level crossings.

Casualty rates are then applied to the number of accidents to determine the number of casualties by severity. The severity types are fatal, serious injury, slight injury, and non-injury (material damage only).

The total number of accidents and casualties by severity should be calculated for the WP and WOP scenarios to determine the increase or decrease in accidents associated with the project.

When undertaking detailed project appraisal, local accident data should be used in place of national values where available and considered reliable, in order to derive project specific accident rates. RomTAP provides default national accident rate parameters suitable for strategy appraisal.

Accident rates are assumed to decline over time as infrastructure geometry, vehicle safety features and driver awareness improve. Local historic change in accident experience may be used where available. Alternatively, a default rate of 0.5% per year may be assumed.

For road accidents, monetary values by type of casualty are applied to the accident rates per million vehicle kilometres and casualty rates per accident by type of road in the WOP and WP scenarios. The difference determines the economic benefit. A similar approach is adopted for rail level crossing accidents, where the number of the level crossings is considered in the calculations.

For rail and IWT accidents, due to the lack of reliable data on accident rates for these transport modes, the average unit costs (€/veh.km, €/pax.km and €/tonne.km) presented in the 2019 Handbook on External Costs are considered in the calculations. Thus, the change in vehicle kilometres which result from the project are calculated and then monetised using the unit cost rates.

The monetary values per casualty or per pax.km, tonne.km and vehicle.km are assumed to increase annually in line with GDP/capita with an elasticity of 0.8.

RomTAP includes the annual monetary values per casualty to be used, and presents national road accident rates, road accident costs, rail costs and IWT accident costs by various metrics.

Climate change

Climate change or global warming impacts of transport are mainly caused by emissions of the greenhouse gases (GHGs) carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). These emissions have a range of impacts which may include sea level changes, agricultural impacts, water supply impacts, health impacts, ecosystem and biodiversity impacts and climate/weather impacts.

Emissions should be estimated using emission rates per litre of fuel or kWh of electricity consumed, as calculated for the fuel element in the VOCs. Rates have been derived for Romania based on the EIB Carbon Footprint Methodology, using the electricity grid emission rates for Romania.

GHG emissions are considered a global impact and therefore the value of the change in emissions volume is independent of the location at which the change occurs.

Calculating the monetary costs of changes in emissions should be done in terms of the change in the equivalent tonnes of greenhouse gases released as a result of implementing a project. Both absolute and relative quantities should be calculated and reported, in line with the EIB Carbon Footprint Methodology. For the CBA calculations, the relative quantities are used. The carbon assessment has to be included throughout the project development cycle (e.g., planning stage, option analysis stage, feasibility stage, etc.) with the aim of promoting low-carbon choices and options, in line with Commission Notice "Technical guidance on the climate proofing of infrastructure in the period 2021-2027".

The cost per tonne of carbon to be used is set out in the EAV in €2016, rising from €80 in 2020 to €800 in 2050. Annual costs are set out in RomTAP, adjusted to the price base. RomTAP also includes sample emission costs per road vehicle kilometre for selected years and vehicle speeds, and sample road vehicle emission rates by vehicle type and speed.

<u>*Air pollution*</u>

Local air pollution costs are caused by the emissions of air pollutants with differing impacts including particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides (NOx), sulphur dioxide (SO_2) and non-methane volatile organic compounds (NMVOCs). Impacts include health costs, building/material damages, crop losses and costs of damage to the biodiversity, soil, and water. Health costs (mainly caused by PM, from exhaust emissions or transformation of other pollutants) are by far the most important element.

The scale of the impact will vary depending upon the nature and the location of the project. The main factor that affects the scale of the impact is the population proximity and density near the emission source. Additionally, there are mode specific factors that may be considered:

- Road – the most important factor is the emission standards of the vehicle fleet which depends, in part, upon the age of vehicles. Emissions are then related to the speed of the vehicle, fuel type, road gradient, vehicle load and driving style.
- Rail – the emission level depends upon the train speed, fuel type, share of electrified services, and the sources and location of electricity generating power plants.
- IWT – the main factors are engine type, vessel type, fuel quality, operation mode and the direction of travel (up/down stream).

It is also important to consider the impacts on populations along alternative routes to the project. For example, a new road or rail line may lead to high volumes of traffic, and thus an air pollution increase along the route. However, the net impact may be positive if the new infrastructure is in a rural area and has removed traffic from an urban route.

For detailed project appraisal, the change in tonnes of air pollutants emitted as a result of the project should be calculated taking into consideration the points raised above. TREMOVE is a policy assessment model commissioned by the European Commission to study the effects of different transport and environment policies on the transport sector for all European countries. This model provides emission rates (tonnes per vehicle km) by vehicle type, which can be used, together with vehicle fleet estimates to determine emissions for the WP and WOP scenarios. From these values the change in tonnes of air pollutants emitted can be calculated.

However, this method is complex and requires extensive data relating to fleet composition, which would need to be updated through the appraisal period. Therefore, a simplified approach is recommended and RomTAP provides for two options. The user can either make separate calculations of PM emissions and NOx emissions, or instead base the calculations on an aggregated cost of air pollution per vehicle type as set out in the 2019 Handbook on External Costs. The first approach is preferred, as the PM emissions can be costed separately for exhaust emissions in metropolitan, urban and rural areas, and non-exhaust emissions, and, more importantly it leads to a more accurate estimate which considers in the formula the travel speed. Similarly, NOx emissions can be costed separately for urban and rural environments. The 2019 Handbook values should only be applied in the absence of a road transport model able to produce reliable estimates of e.g., travel speeds. An example of this would be the appraisal of a rail project with a rail only model, but with modal shift calculated using elasticities.

In years beyond the price base, both the average damage costs per pollutant and the aggregated air pollution costs are increased in line with GDP/capita with an elasticity of 0.8 applied.

Noise

If a project changes the volume of traffic on a road or rail line, then there may be an impact upon the population living nearby in terms of increased (or decreased) noise.

Noise can be defined as the unwanted sound or sounds of varying duration, intensity, or other quality that causes physical or psychological harm to humans. In general, two types of negative impacts of transport noise can be distinguished:

- Costs of annoyance: transport noise imposes undesired social disturbances, which result in social and economic costs such as restrictions on the enjoyment of leisure activities, discomfort, or inconvenience.
- Health costs: transport noise can also cause physical health damages. Hearing damage can be caused by noise levels above 85 dB(A), while lower levels (above 60 dB(A) may result in nervous stress reactions, such as change of heartbeat frequency, increase of blood pressure and hormonal changes, increased risk of cardiovascular diseases and reduction in quality of sleep.

The scale of the impact varies depending upon the nature and the location of the project. There are four key factors that determine noise impact:

- Time of day – noise disturbance at night has a greater impact than during the day.
- Population density near the noise source – noise only impacts those who can hear it.
- Existing noise levels – depending upon traffic volume, speed, and vehicle type mix. The higher the existing background noise level, the lower the impact.
- Type of noise – intermittent noise can be more disturbing than constant background noise.

Additionally, there are mode specific factors that should be considered:

- Road – the noise level depends upon the type of vehicle, speed of vehicles, age of the vehicles, proportion of trucks, road surface conditions and gradient.
- Rail – the noise level depends upon the train speed, coach/wagon type, conditions of both track and wheels, type of brake, train length and the presence of noise walls. The most significant impact is from freight train movements at night.

It is also important to consider the impacts along alternative routes to the direct project corridor. For example, a new road or rail line may lead to high volumes of traffic, and thus a noise increase. However, if the new infrastructure is in a rural area and has removed traffic from an urban route the net impact may in fact be positive.

The change in vehicle kilometres which result from the project should be calculated and then monetised using unit cost rates. RomTAP provides annual unit costs (€/veh.km, €/pax.km and €/tonne.km) of the impact of noise by mode, vehicle type and fuel type. If traffic data can be differentiated by urban, sub-urban and rural, adjustment factors are provided to reflect the different nature of traffic and population density in the regions.

In years beyond the price base, costs are increased in line with GDP/capita with an elasticity of 0.8 applied.

4.7.7 The Rule of Half (RoH)

The calculation of the value of user benefits follows economic theory of consumer surplus. As such, user benefits may vary depending on whether they are attributable to users of the existing route or infrastructure, users diverting from alternative routes or infrastructure or new users (also referred to as generated or induced traffic) who do not travel in the WOP case. Further benefits may be enjoyed by non-users from reduced external costs.

If benefits are defined as the difference in cost between the WOP and WP cases:

- Existing users are allocated the full value of any benefits they may enjoy in the WP case as compared to the WOP case.
- New users are allocated 50% of the benefits calculated for the existing users.
  - This is because some new users may decide to travel following a very small increase in benefits, while others will require a greater increase. By taking a 50% value of benefits, an average value is attributable to new users that approximates to the economic theory. This is referred to as "the rule of a half" (RoH) and is widely discussed in the literature - the interested reader may refer to the 2014 CBA Guide p89.
- For diverting users:
  - If the economic analysis is based on traffic forecasts from a network based multi-modal traffic model, then the actual costs of the users diverting from one mode to another will be known in both the WOP and WP cases. In this case, they are treated the same way as existing users and the full value of any benefits is included.
  - However, if a more simplified modelling approach is adopted, for example focussing only on the project corridor and/or only on the transport mode of the project, then the WOP costs of traffic diverting from an alternative corridor or alternative mode will not be known and the RoH should be applied (i.e., 50% of the savings enjoyed by the existing users).

Also note that:

- The RoH is only applied to the categories of benefits relating to user behaviour (perceived costs). For example, in the case of roads, this will generally comprise time and fuel costs.
- The RoH is not applied to external costs where an increase in traffic leads to a corresponding increase in costs to third parties. For example, if building a new road results in a certain volume of induced traffic that is truly "new" rather than "diverted", it will result in an increase in GHG emissions of 100% of the emissions caused by the new traffic.

Table 4.5. Application of the Rule of a Half to different categories of user; % of value of benefits applied

Benefit category	**Existing users**	**Diverting users**		**New users**
		WOP costs known	**WOP costs unknown**	
Value of time savings	100%	100%	50%	50%
Road vehicle operating cost savings – fuel component	100%	100%	50%	50%
Road vehicle operating cost savings – non-fuel component	100%	100%	100%	100%
Train operating cost savings	100%	100%	100%	100%
Safety benefits	100%	100%	100%	100%
Environmental benefits (GHG emissions, local air pollution, noise)	100%	100%	100%	100%

Source: JASPERS

4.7.8 Economic indicators

The incremental costs of a project are compared with the incremental benefits over a specified number of years (the "reference" period) to produce three[16] indicators of economic performance. These are:

- The **net present value (NPV)** of the project. Future costs and future benefits are discounted to the price base year according to an annual discount rate. The sum of the discounted future costs and the sum of the future discounted benefits produce the present values (PV) of costs and benefits respectively. The NPV is the PV of the benefits minus the PV of the costs. A project that is economically "viable" will have an NPV greater than zero.
- The **economic internal rate of return (ERR)**. The ERR is the discount rate that would result in an NPV of zero. Thus, a project that is economically "viable" will have an ERR that is greater than the discount rate (3%)[17].
- The **benefit-cost ratio (BCR)**. The BCR is the PV of benefits divided by the PV of costs. The BCR is expressed as a ratio and a project is considered economically viable if the BCR is greater than 1.0.

Note:

- Economic impacts can be positive or negative depending upon the nature of the project being assessed.
- However, in the calculation of the BCR, only investment, replacement and O&M costs are to be included on the costs side, and all impacts listed above on the benefit side, irrespective of their sign.
- In addition, a residual value (RV) may be included as a cost or a benefit, depending on the calculation procedure adopted (see section 4.7.4), i.e., on the benefit side in case the RV is determined as NPV of the remaining lifetime method and respectively on the cost side if determined based on the depreciation method.

The following table shows the calculation in Excel of the ENPV and ERR of a simple investment project with an appraisal period of 32 years, 2 years of construction and 30 years of operation.

Table 4.6. Sample calculations of ENPV and ERR

			Construction		Operation							
		PV	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	...	Year 32
Discount rate	3.0%		0	1	2	3	4	5	6	7	...	31
Discount factor			1.000	0.971	0.943	0.915	0.888	0.863	0.837	0.813	...	0.400
Costs (€m)	PVC	49.27	25	25								
Benefits (€m)	PVB	57.09			3	3	3	3	3	3	...	3
ENPV	PVB-PVC	7.82	-25	-25	3	3	3	3	3	3	...	3
EIRR		4.1%										

The discount rate is 3%. The undiscounted investment costs are €25m in each of years 1 and 2. The undiscounted benefits are €3m in each of years 3 to 32.

The present value of costs is calculated in Excel as:

PVC = SUMPRODUCT(Discount factor array, Costs array)

The present value of benefits is similarly calculated:

PVB = SUMPRODUCT(Discount factor array, Benefits array)

[16] There are other indicators, such as the first year rate of return, but they are less frequently used and are not required to be calculated.
[17] For projects which are financed by International Financial Institutions (e.g., EIB), other rules may apply for the economic analysis, including higher hurdle rates.

The ENPV is calculated as:

$$ENPV = PVB-PVC$$

And the ERR is calculated as:

$$ERR = IRR(ENPV\ array).$$

In this example it can be seen that the ENPV is greater than zero and the ERR is greater than the discount rate. Thus, the project may be considered as good value for money.

4.7.9 Ranking and prioritising projects and options

When comparing options within a single investment proposal, usually the better performing option has both a larger ENPV and a larger ERR/BCR than the option performing less well. There might be, however, some (infrequent) cases in which, owing to the different scales of the options, one has a larger ENPV but a smaller ERR/BCR than the other. In such a case, it is suggested that the ERR/BCR is used because it would (usually) allow the promoter to save resources that could be reused for additional investments.

In ranking alternative projects from a group typically competing under budget constraints, the ENPV is also less relevant (because it is biased towards more expensive projects) and the ERR/BCR is the preferred indicator as well, provided that it can be calculated for all projects.

4.8 Overview of financial and economic outflows and inflows

The economic analysis (and the financial analysis where applicable) considers various outflows (costs) and inflows (benefits in the case of economic analysis, revenues in the case of financial analysis) associated with and generated by a project.

While the characteristics of inputs are consistent between the economic and financial analysis, the treatment of the data can vary. The table below summarises the key inputs to the analysis and whether they are included in the respective analyses.

Table 4.7. Summary of treatment of analysis inputs: included (Y) or not included (N)

	Economic analysis	**Financial analysis**
Investment costs	Y	Y
Operation & maintenance costs	Y	Y
Discount rates	Y (SDR)	Y (FDR)
User charges (fares, tolls)	N (transfer payment)	Y
Travel time savings	Y	N
Vehicle operating cost savings	Y	N
Safety benefits	Y	N
CO_2 emissions	Y	N
Local air pollution	Y	N
Noise	Y	N
Subsidies & taxes	N (transfer payment)	Y
Contingency	N	N
VAT	N	N

Source: JASPERS

4.9 Sensitivity and risk analysis

Project appraisal is a forecasting process and, as such, has inherent uncertainties. These uncertainties come from both data limitations in the existing situation, and uncertainties as to how aspects, such as demand for travel, costs for infrastructure etc., will change over time. These uncertainties in the inputs to the appraisal process lead to uncertainty in the economic and financial appraisal output.

The sensitivity and risk assessment considers these uncertainties and their impact on the outcomes of both the economic and financial appraisal.

4.9.1 Sensitivity analysis

Sensitivity analysis entails a series of tests to establish which input variables have a significant impact on economic and financial appraisal outcomes. The sensitivity analysis considers the impact of changes in input variable value on output value of key performance indicators.

The economic analysis will have been undertaken assuming the most likely values for all the input variables. In the sensitivity analysis, changes +/- are made to the values of each of the key variables in turn. Typical variables tested include:

- Investment and maintenance costs.
- Traffic volumes.
- Unit monetary values of benefit categories.

The impact on the economic indicators of changes to each variable is tested in turn using 1% change of the variable values.

The elasticity between the change in variable value and the change in performance indicator (usually ENPV) is calculated for each variable in order to identify critical variables.

A critical variable is defined as one for which a 1% change in value results in a change of 1% or more in ENPV.

Switching values are then calculated for the critical variables to identify the points at which ENPV becomes zero, providing thus important information on the economic margins for e.g., cost overruns or demand risks.

The closer to the base case values a switching value for a particular variable is, the higher the risk. This risk should be properly assessed, and appropriate mitigation measures should be included as part of the project preparation, implementation, or operation stage.

4.9.2 Scenario analysis

In the sensitivity analysis, variables are tested one by one. Scenario analysis involves combining critical (independent) variables to test extreme optimistic and pessimistic cases. The optimistic and pessimistic scenarios are defined by using the low/high values of the tested variables, within a realistic range. For example, a scenario analysis could test the impact on ENPV of high investment cost combined with low demand.

In the current context of climate mitigation policies aimed at reaching climate neutrality by 2050, actions are being taken to shift more traffic towards low-carbon modes (e.g., rail), in addition to reduction of transport demand. Therefore, a decreased demand is expected for roads. Thus, it is strongly recommended for the analyst to include in the sensitivity analysis a scenario considering very conservative growth rates for road demand (see reference to the EC Sustainable and Smart Mobility

Strategy[18]). This scenario should also include the policy scenario regarding the penetration rates of electric vehicles (see RomTAP - sheet J. Road veh fleet – Adapted scenario.)

Undertaking the scenario analysis allows the analyst to assess the impact of multiple negative events on the project's economic viability. Projects that can withstand multiple negative impacts are likelier to be found economically justified ex-post.

4.9.3 Risk analysis

A probabilistic risk analysis (for example using Monte Carlo analysis) is not generally required, but a qualitative risk analysis must nevertheless be carried out. Detailed guidelines on setting up a qualitative risk analysis are presented in the 2014 CBA Guide. In summary, the analysis should include:

- a list of adverse events to which the project is exposed;
- a risk matrix for each adverse event indicating:
    - the possible causes;
    - the link with the sensitivity analysis (if applicable);
    - the negative effects on the project;
    - the levels of probability of occurrence and severity of impact;
    - the risk level.
- an interpretation of the risk matrix;
- a description of mitigation and/or preventative measures for the main risks, indicating who is responsible for the applicable measures.

The list of adverse events could include (among others):

- demand risks (traffic higher or lower than forecast);
- design risks (site surveys, cost estimates, project design);
- administrative risks (delays obtaining permits, approvals);
- land acquisition risks (higher costs, delays);
- procurement risks (procedural delays);
- construction risks (cost over-runs, geological risks, climate risks, as identified in the Climate Change Vulnerability and Risk Assessment that has been separately prepared for the project, archaeological risks, contractor risks);
- operation risks (inadequate O&M, environmental changes);
- regulatory risks (changes in regulations);
- financial risks (availability of national financing for CAPEX and OPEX, increased financing costs, lower project revenues);
- management risks (weak management capacity of beneficiary);
- political risks (public opposition, policy changes).

For each risk identified, the following should be described:

- the cause (what events could trigger the occurrence of the risks);
- the consequence (what effect will the risk have on costs, benefits, implementation time, funding and financial sustainability);
- the risk owner (who is accountable and will manage it);
- the project stage at which risk occurs;
- the probability of the risk occurring (using the table below);

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0331&from=EN

Table 4.8. Risk probability

	Likelihood	Probability
A	Very unlikely	0-10%
B	Unlikely	>10-33%
C	About as likely as not	>33-66%
D	Likely	>66-90%
E	Very likely	>90-100%

Source: 2014 CBA Guide

- the severity (using the table below);

Table 4.9. Risk severity

	Meaning
I	No relevant effect on social welfare, even without remedial actions.
II	Minor loss of the social welfare generated by the project, minimally affecting the project long run effects. However, remedial, or corrective actions are needed.
III	Moderate: social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem.
IV	Critical: high social welfare loss generated by the project; the occurrence of the risk causes a loss of the primary function(s) of the project. Remedial actions, even large in scope, are not enough to avoid serious damage.
V	Catastrophic: project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialise.

Source: 2014 CBA Guide

- the risk level (the combination of the probability and the severity on a four-level scale: low, moderate, high, very high).

Table 4.10. Risk level

		Severity				
		I	II	III	IV	V
Probability	A	Low	Low	Low	Low	Moderate
	B	Low	Low	Moderate	Moderate	High
	C	Low	Moderate	Moderate	High	High
	D	Low	Moderate	High	Very high	Very high
	E	Moderate	High	Very high	Very high	Very high

Source: 2014 CBA Guide

Prevention and/or mitigation measures should be defined in accordance with the following table:

Table 4.11. Mitigation measures

		Severity				
		I	II	III	IV	V
Probability	A	Prevention or mitigation		Mitigation		
	B					
	C					
	D	Prevention		Prevention and mitigation		
	E					

Source: 2014 CBA Guide

The proposed mitigation measures should be reasonable and realistic and the entities responsible for implementing the mitigation measures should be clearly noted. At the level of the beneficiary, the units responsible for acting should be named. Furthermore, a detailed and realistic implementation plan for the mitigation measures, with their expected completion dates, should be provided, clearly indicating the measures that have already been implemented (if the case). The residual risks should reflect the effect of implementing the mitigation measures.

Finally, the beneficiary has to present a summary of the risk monitoring strategies it has in place to evaluate the correctness of the risk assessment and the appropriateness of the mitigation measures

.

ANNEX I. PARAMETER VALUES FOR THE ECONOMIC ASSESSMENT OF TRANSPORT PROJECTS

AI.1. Database of parameter values

An Excel database of Transport Appraisal Parameter values, RomTAP, has been developed for use in the appraisal of transport projects in Romania. It is included as a separate Excel Annex to these Guidelines. The database consists of information sheets, calculation sheets and tables of parameter values.

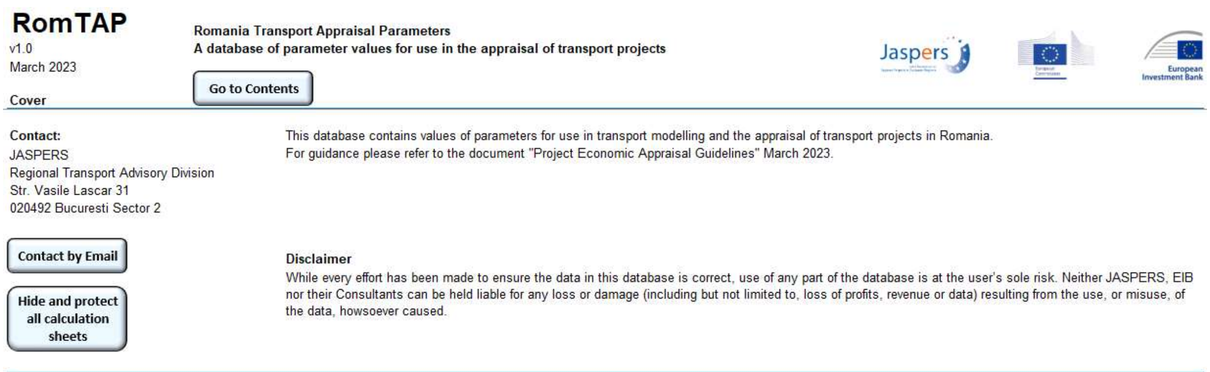
Some general principles of the database are as follows:

- Database worksheets are colour coded according to their category. Information sheets have grey tabs, calculation sheets have red tabs, tables of general parameter values are blue and tables of parameter values that relate to specific benefit categories are green.
- Each page has a header that includes the database name, version number and a link to the Contents page.
- Specific pages can be accessed using links on the Contents page or directly using page tabs.
- Some pages include default values (blue cells) that the user can over-ride (yellow cells).

The following sections describe each of the pages of the database.

AI.2. Cover

A **Cover** page presents information such as the database name, version number, ownership, description, disclaimer and JASPERS/EC/EIB logos. It includes buttons to navigate directly to the Contents page, to contact JASPERS, to unhide or hide all calculation sheets and to unprotect or protect cells.



AI.3. Contents

The **Contents** page is accessible either from a link on the **Cover** page or directly from a page tab. The **Contents** page lists the tab names of the various parameter value pages and includes a table title for each page. Links on the **Contents** page provide access to parameter value tables.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Contents

Category	Parameter group	Worksheet	Table title or page description
Information		**Cover**	Cover page
		Contents	Contents (this page)
		Sources	Details of data sources
		Changelog	Record of version numbers and changes
General	General parameters	**A. General parameters**	General parameters for setting values
		B. Annual Parameters	Annual economic parameters
		C. Conversion factors	Conversion factors from financial costs to economic costs
Infrastructure	O&M costs	**D. O&M**	Operation and maintenance costs by mode
Consumer / producer		**E. Pax trip purpose**	Trip purpose split by passenger mode
		F. Pax veh occupancy	Average number of passengers per vehicle by passenger mode
		G. Freight veh loading	Average load in tonnes per vehicle by freight mode
	Value of time	**H. Pax VoT**	Values of time per person by trip purpose and year

AI.4. Sources

Sources lists the various documents used to compile the database, with live links where available.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Sources

The source of original data is noted on all pages of tables. Details of all sources are shown below.

Abbreviated name	Category	Source name and link (where available)	Notes
CBA Guide	Primary reference	European Commission (2014) Guide to Cost Benefit Analysis of Investment Projects	
EAV	Primary reference	European Commission (2021) Economic Appraisal Vademecum 2021-2027	
Handbook on External Costs	Primary reference	European Commission (2019) Handbook on the External Costs of Transport	
JASPERS Rail Guidance	Primary reference	JASPERS (2017) Guidance on appraising the economic impacts of rail freight measures	
AECOM	Primary reference	AECOM (2014) Guide to Economic and Financial Cost Benefit Analysis and Risk Analysis	
CBR	Primary reference	EIB (2020) Climate Bank Roadmap 2021-2025	
	General	HEATCO (2006) Vol. 5. Proposal for Harmonised Guidelines	
	Annual parameters	Eurostat HICP	

AI.5. Changelog

The **Changelog** is a record of changes made to the RomTAP file with corresponding dates and version numbers.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Changelog

Version	Date	Log
		Air pollution calcs P16: added value for IWT
1.0.21	12/03/2023	Noise calcs D175: modified label
		GHG calcs/GHG: added train and IWT emissions
		Fuel consumption calcs B42:D46: added HGV split
		Fuel consumption calcs rows 106:134: added aggregated calculations
		Fuel costs B165:G172: added aggregated fuel costs of road vehicles for rail projects
		Non-fuel calcs B77:I104: added aggregated calculations
		Non-fuel costs B26:E32: added aggregated non-fuel costs of road vehicles for rail projects
		GHG calcs B590:N618: added aggregated calcualtions
		GHG B553:G560: added aggregated GHG costs of road vehicles for rail projects
1.0	13/03/2023	First release

AI.6. General parameters

Table **A. General parameters** includes the default discount rates, operational period and price base year. In most cases the default values should be used. However, the user can enter alternative values to override defaults where justified. The default financial discount rate (FDR) for projects financed under the 2021-2027 programming period is kept at 4%, the value used for the 2014-2020 programming period. The default social discount rate (SDR) is 3% in accordance with the EAV. The reference period is the period from the start of construction to the end of the operational period. A standard operational period of 30 years should normally be used. The default price base year to which all prices are adjusted is 2021.

RomTAP
v1.0
March 2023
General parameters

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Parameter	Parameter description	Default	Over-ride	Value used
FDR	Financial discount rate	4.00%		4.00%
SDR	Social discount rate (economic discount rate)	3.00%		3.00%
Operational period	Number of years in the operation period	30		30
Price base year	The base year to which all prices are adjusted	2021		2021

Parameter	Source of default values, notes
FDR	CBA Guide
SDR	EAV p13
Operational period	The standard Operational period is set to 30 years.
Reference period	The Reference period is the period from the start of the Construction period to the end of the Operational period.
Price base year	The default year is initially set to 2021, but may be reviewed by the Managing Authority and changed to a later year during the course of the programming period.

AI.7. Annual parameters

Annual parameters are calculated to convert monetary values to the price base year.

Input data is held on sheet **B. Annual parameters** and includes the following:

- 2010 to 2021 recorded values from INSSE, 2022 to 2026 forecast values from CNSP and 2027 to 2030 JASPERS assumptions of engineering works cost indices used to adjust investment and O&M costs.
- 2010 to 2021 recorded values from CursBNR, 2022 to 2026 forecast values from CNSP and 2027 to 2030 JASPERS assumptions of EUR/RON exchange rates.
- 2010 to 2021 recorded values from Eurostat and 2022 onwards forecast values from EIU of Romanian real GDP/capita growth.
- 2010 to 2021 recorded values from Eurostat, 2022 to 2024 forecast values from ECB and 2025 to 2030 JASPERS assumptions of harmonised indices of consumer prices (HICP) in the euro area.
- 2010 to 2021 recorded values from Eurostat, 2022 to 2026 forecast values from CNSP and 2027 to 2030 JASPERS assumptions of harmonised indices of consumer prices (HICP) in Romania.

Data beyond 2021 may be updated by JASPERS as it becomes available.

RomTAP
v1.0
March 2023
Annual parameters

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

User input (optional)

Engineering cost index, exchange rate, GDP/capita and HICP

Year	Engineering works cost indices	EUR/RON exchange rate	RO real GDP/capita growth	HICP € area	HICP RO
2010	115.600	4.2099			
2011	125.989	4.2379	5.00%	2.70%	5.80%
2012	133.591	4.4560	2.40%	2.50%	3.40%
2013	129.594	4.4190	0.60%	1.40%	3.20%
2014	128.448	4.4446	4.50%	0.40%	1.40%
2015	125.703	4.4450	3.70%	0.20%	-0.40%
2016	127.465	4.4908	3.50%	0.20%	-1.10%
2017	135.342	4.5681	8.80%	1.50%	1.10%
2018	155.338	4.6535	6.60%	1.80%	4.10%
2019	167.731	4.7452	4.30%	1.20%	3.90%
2020	169.338	4.8371	-3.10%	0.30%	2.30%
2021	189.764	4.9204	6.60%	2.60%	5.10%
2022	228.097	4.9300	5.30%	8.40%	13.80%
2023	251.591	4.9400	2.80%	6.30%	10.80%
2024	263.164	5.0000	2.80%	3.40%	5.70%

Various calculations are carried out on the **Annual param calcs** sheet to produce different categories of escalation factors. These include the following:

Investment and O&M costs

- *Moving from a prior year to the price base year*

  Investment costs are typically estimated in nominal prices, in local currency, in the year in which the cost estimate is prepared. To change the price base year for investment costs to the specified base year, the following approach is recommended:

  Step 1: **Exchange rate conversion**. If the values are expressed in EUR, these should be converted to RON (using the average exchange rate applicable to that year).

  Step 2: **Inflation adjustment**. Using the engineering works cost index, the unit value should be updated from the old to new price base year as follows:

  New unit value = old unit value x (index value for updated price base year/index value for old price base year).

  Step 3: **Exchange rate conversion**. The new unit values should be converted to EUR using the average exchange rate applicable to the new price base year.

- *Growth in real values over time (after the price base year)*

  Such process is particularly important when the specific evolution of some costs is significantly different than the general inflation (consumer prices index), meaning that the related costs, in real terms, are evolving over time. To consider the costs increase in real terms after 2021, the following approach is recommended:

  Step 1: **Exchange rate conversion**. If the values are expressed in EUR, these should be converted to RON (using the average exchange rate applicable to the base year).

  Step 2: **Growth in real values**. The cost in RON corresponding to each year after the current base year, converted to the price base year as explained above (Step 1 and 2), should be multiplied by (1+n)/(1+i), where *n* is the percentage change in the engineering works cost for the relevant year after 2021, and *i* is the percentage change in the Romanian consumer price index (HICP RO) over the same period for the relevant year after 2021.This calculation is performed as long as the engineering works cost index percentage change is different to that of the HICP RO.

  Step 3: **Exchange rate conversion**. The new unit values should be converted to EUR using the average exchange rate for the relevant year.

The calculated annual cost escalation factors for investment and O&M costs for the selected price base year using the input data above are presented in Table B1. These are included as an output table as they may be required for use externally to RomTAP.

RomTAP
v1.0
March 2023
Annual parameters

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Table B1. Annual cost escalation factors for investment and O&M costs

	Escalation factor	
Year	to price base	from price base
2010	1.64	0.00
2011	1.51	0.00
2012	1.42	0.00
2013	1.46	0.00
2014	1.48	0.00
2015	1.51	0.00
2016	1.49	0.00
2017	1.40	0.00
2018	1.22	0.00
2019	1.13	0.00
2020	1.12	0.00
2021	1.00	0.00
2022	0.00	1.06
2023	0.00	1.05
2024	0.00	1.04
2025	0.00	1.04
2026	0.00	1.04
2027	0.00	1.04
2028	0.00	1.04
2029	0.00	1.04
2030	0.00	1.04

Notes

Escalation factors are to be applied to investment and O&M costs in RON.

Economic Benefits

There are three categories of parameter values corresponding to the economic benefits in terms of converting the values to a base year and considering the growth in real values over time:

- parameter values dependent on GDP/capita (VoT and externalities, except for GHG emissions).
- parameter values dependent on fuel cost (e.g., VOC for petrol/diesel vehicles).
- CO_2 cost.

Parameter values dependent on GDP/capita (VoT and externalities except for CO_2 cost)

The parameter values for these benefits are typically estimated in nominal prices, in EUR, in the year for which values were calculated (usually 2010). To change the prior price base year to the current base year, the following approach is recommended and is applied internally in RomTAP.

Moving from one price base year to another

The parameter values included in RomTAP are all expressed in prices of the defined price base year. It is not generally necessary to change the price base year for these parameters. However, where alternate parameter values are being proposed (e.g., where better / more appropriate unit values have been identified), the project analyst may need to change the price base year of the new values to that of the defined price base year. In these circumstances the following approach is recommended:

Step 1: **Exchange rate conversion**. If the unit values are expressed in EUR these should be converted to RON (using the average exchange rate applicable to that year).

Step 2: **Inflation adjustment**. Using the appropriate national statistical index (HICP RO), the unit value should be updated from the old to new price base year as follows:

New unit value = old unit value x (index value for updated price base year/index value for old price base year).

Step 3: **Real growth**. The real value of the parameter in question is assumed to grow over time in line with GDP/capita, with an elasticity of 0.8 applied to all such parameters.

Step 4: **Exchange rate conversion**. The new unit values should be converted to EUR using the average exchange rate applicable to the new price base year.

Growth in real values over time

Throughout the appraisal period the unit values are expected to grow in real terms (i.e., inflation occurring after the price base year should be ignored), with an elasticity of 0.8 applied to the GDP/capita growth. The HICP RO values after the base year should not be considered in these calculations.

Parameter values dependent on fuel cost (e.g., VOC for petrol/diesel vehicles)

For this parameter, the values of the fuel element of the VOC are considered for the price base year and two scenarios: the Base scenario and the Adapted scenario, with growth rates defined in RomTAP. For both scenarios the fuel cost values for 2022 will be the average value from the Oil Bulletin, but with inflation (HICP RO for 2022) removed. These values are calculated internally in RomTAP.

For the non-fuel element of VOCs, the costs are converted to RON, inflation-adjusted, then converted back to EUR.

Unit CO_2 cost

EIB shadow cost of carbon in €/tCO2e 2016 prices are to be used. They are converted to the price base year by applying the HICP euro area for inflation adjustment as the values are not specific to Romania. The unit costs for the rest of the reference period are estimated based on linear interpolation of the above defined unit costs. These values are calculated internally in RomTAP.

AI.8. Conversion factors

Sheet **C. Conversion factors** sets out conversion factors from financial to economic prices for various CAPEX and OPEX categories as defined in Table C.1 of the former EU Major Project Funding Application Form. All financial costs should exclude VAT.

Conversion factors are calculated based on the percentage cost of materials, skilled labour, unskilled labour, energy, and other costs of each category, as presented in the Romanian Prices Statistical Bulletin. The conversion factor for each of these categories is shown in the table below.

Conversion factor category

Category	Value
Materials	1.00
Skilled labour	1.00
Unskilled labour	0.53
Energy	0.63
Others	1.00
Land acquisition	1.00

Source: pwc.com; AECOM p36-37, categories defined according to EU major project funding application form, Table C.1.

The conversion factor of 0.53 for unskilled labour is based on the calculation of the Shadow Wage Rate Factor (SWRF). This is derived from the unemployment rate U, income tax rate I, social security rate S and minimum wage W according to the following formula:

$$SWRF = (1 - U) * (1 - (I + S))$$

Shadow Wage Rate Factor (SWRF)

Category	Value
Unemployment rate	5.60%
Income tax rate	6.50%
Social security	37.25%
Minimum wage	€ 466.23
SWRF	53.10%

Source: Eurostat, Romanian National Institute of Statistics

The conversion factor of 0.63 for energy was derived by JASPERS based on European Commission data (Weekly Oil Bulletin 2021), relating the Romanian price for fuel without taxes and duties and the pump price excluding VAT.

The percentage of conversion factor category for each cost category was estimated by JASPERS and is shown in the table below.

Percentage of conversion factor category for each cost category

		Conversion factor category						
Cost category		**Materials**	**Skilled labour**	**Unskilled labour**	**Energy**	**Others**	**Land acquisition**	**Total**
CAPEX	Planning/design fees	16.75%	70.00%	0.00%	5.00%	8.25%	0.00%	100.00%
	Land purchase	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
	Building and construction	47.21%	5.75%	13.41%	10.20%	23.44%	0.00%	100.00%
	Plant and machinery or equipment	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
	Contingencies	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Price adjustment	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Publicity	16.75%	70.00%	0.00%	5.00%	8.25%	0.00%	100.00%
	Supervision during construction	20.10%	50.00%	0.00%	20.00%	9.90%	0.00%	100.00%
	Technical assistance	20.10%	50.00%	0.00%	20.00%	9.90%	0.00%	100.00%
OPEX	O&M	46.82%	5.59%	16.78%	10.20%	20.61%	0.00%	100.00%

Source: JASPERS

The resulting final conversion factors to be applied are shown in the table below:

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Conversion factors

Tables

Table C1. Conversion factors from financial to economic prices

Cost category		Conversion factor
CAPEX	Planning/design fees	0.98
	Land purchase	1.00
	Building and construction	0.90
	Plant and machinery or equipment	1.00
	Contingencies	0.00
	Price adjustment	0.00
	Publicity	0.98
	Supervision during construction	0.93
	Technical assistance	0.93
OPEX	O&M	0.88

AI.9. O&M

Sheet **D. O&M** presents price base year values of operation and maintenance costs for road, rail, IWT and metro.

The values for roads are presented by type of road (based on data obtained from CNAIR Regional Directorate Cluj) and for tunnels (based on work carried out by ARUP), separately by road and lane kilometre for routine maintenance, periodic maintenance, and rehabilitation. Indicative intervention frequency is provided for periodic maintenance and rehabilitation. The tables below show the economic costs that should be used in CBA. (Financial costs are also presented in RomTAP Tables D1 and D2 but are not shown here.)

RomTAP
v1.0
March 2023
O&M

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Table D3. Road maintenance economic costs (€2021/road.km)

	----- Routine maintenance -----			----- Periodic -----		----- Rehabilitation -----	
Road category	**Summer €/km**	**Winter €/km**	**Total €/km**	**€/km**	**Frequency years**	**€/km**	**Frequency years**
2x3 Motorway	30,226	14,482	44,708	281,833	5	3,923,302	20
2x2 Motorway	21,983	10,546	32,529	205,034	5	2,853,326	20
Expressway/ 4-lane road	12,997	8,628	21,625	143,524	5	1,997,311	20
Road (AADT>=3500)	3,268	4,307	7,575	71,762	5	998,655	20
Road (AADT<3500)	3,268	4,307	7,575	71,762	10	998,655	30
Tunnel (twin bore >3km)			382,099				
Tunnel (twin bore 1-3km)			282,285				
Tunnel (twin bore <1km)			200,815				

Table D4. Road maintenance economic costs (€2021/lane.km)

	----- Routine maintenance -----			----- Periodic -----		----- Rehabilitation -----	
Road category	**Summer €/km**	**Winter €/km**	**Total €/km**	**€/km**	**Frequency years**	**€/km**	**Frequency years**
2x3 Motorway	5,038	2,414	7,451	46,972	5	653,884	20
2x2 Motorway	5,496	2,636	8,132	51,258	5	713,332	20
Expressway/ 4-lane road	3,249	2,157	5,406	35,881	5	499,328	20
Road (AADT>=3500)	1,634	2,154	3,788	35,881	5	499,328	20
Road (AADT<3500)	1,634	2,154	3,788	35,881	10	499,328	30
Tunnel (twin bore >3km)			95,525				
Tunnel (twin bore 1-3km)			70,571				
Tunnel (twin bore <1km)			50,204				

The costs of O&M for railways are presented in terms of line km and track km for the overall network and for single track and double track lines, subdivided into electrified and non-electrified lines. They are based on average values in Europe presented by UIC[19], adjusted to account for wage rates in Romania[20]. O&M costs are also included per track km of metro (based on Metrorex Line M2 data) and network km of IWT (based on research by CE Delft[21]).

RomTAP
v1.0
March 2023
O&M

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Table D6. Rail, IWT and metro economic O&M costs (€2021)

Mode	**Category**	**Base unit**	**Component unit**	**Component factor**	**Base unit €1000/km per year**	**Component unit €1000/km per year**
Rail	Network (total)	Line km	Track km	1	53.69	53.69
	Network (non-electrified)	Line km	Track km	1	45.37	45.37
	Network (electrified)	Line km	Track km	1	67.61	67.61
	Single track (total)	Line km	Track km	1	58.52	58.52
	Single track (non-electrified)	Line km	Track km	1	49.46	49.46
	Single track (electrified)	Line km	Track km	1	73.69	73.69
	Double track (total)	Line km	Track km	2	83.01	41.51
	Double track (non-electrified)	Line km	Track km	2	70.15	35.08
	Double track (electrified)	Line km	Track km	2	104.53	52.27
IWT		Network km	Network km	1	7.62	7.62
Metro		Track km	Track km	2	174.52	87.26

O&M costs beyond the price base year should increase in line with the forecast real growth in construction prices.

AI.10. Passenger trip purpose

Passenger trip purposes are presented in sheet **E. Pax trip purpose** in terms of percentages of passengers travelling for work, commuting and other purposes by car, bus, and train. The table is based on aggregated trip purposes presented in the AECOM guide.

[19] UIC (2008) lasting Infrastructure Cost Benchmarking (LICB)
[20] The adjustment is based on the AECOM assumption that 40% of maintenance costs are wage related and that Romanian wages are 20% of average EU wages.
[21] CE Delft (2019) Overview of transport infrastructure expenditures and costs, main report and EXCEL annex.

RomTAP
v1.0
March 2023
Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents
Passenger trip purpose

Tables

Table E1. Passenger trip purpose

	--------- Trip purpose ---------			
Mode	Work	Commuting	Other	Total
Car	13.0%	33.0%	54.0%	100.0%
Bus	6.0%	21.0%	73.0%	100.0%
Train	4.0%	20.0%	76.0%	100.0%

AI.11. Passenger vehicle occupancy

Default average numbers of passengers per passenger vehicle are presented in sheet **F. Pax veh occupancy**. The user can enter over-ride values if more appropriate project specific data is available. Default car occupancy is taken from the AECOM guide. There is little data for bus occupancy, so the value in the table below is proposed until better information becomes available. (It is advised to provide local project specific values, where available, to over-ride this value). Default train and metro occupancies are average observed values.

RomTAP
v1.0
March 2023
Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents
Passenger vehicle occupancy

Tables

Table F1. Number of passengers per vehicle

Mode	Default	Over-ride	Value used
Car	1.79		1.79
Bus	25.00		25.00
Train	80.90		80.90
Metro	360.00		360.00

AI.12. Freight vehicle loading

The default freight vehicle loadings in sheet **G. Freight veh loading** are based on values presented in recent studies. The user can override this data with project specific values.

RomTAP
v1.0
March 2023
Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents
Freight vehicle loading

Tables

Table G1. Number of tonnes per vehicle

Mode	Default	Over-ride	Value used
LGV	1.00		1.00
HGV1	5.00		5.00
HGV2	11.00		11.00
Train	650.00		650.00
IWT vessel	8250.00		8250.00

AI.13. Passenger value of time

Passenger values of time are presented in sheet **H. Pax VoT** by trip purpose and year in terms of price base year € per passenger hour and by vehicle type in terms of price base year € per vehicle hour. The values per vehicle hour are calculated as the product of the number of passengers and the weighted average (across all trip purpose types) value of time per passenger, plus the work value for the drivers of buses. The values are based on those included in the AECOM guide and escalated to the price base year by converting from EUR to RON, increasing in line with Romanian inflation and GDP/capita with an elasticity of 0.8 applied, then converting back to EUR.

Growth beyond the price base is calculated in line with forecast growth in GDP/capita with an elasticity of 0.8 applied.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Passenger VoT

Tables

Table H1. Passenger value of time by trip purpose and year (€2021)

	€/pax.hour			€/veh.hour	
Year	**Work**	**Commuting**	**Other**	**Car**	**Bus**
2021	16.11	6.56	5.49	12.93	143.18
2022	16.79	6.83	5.73	13.48	149.25
2023	17.17	6.99	5.85	13.78	152.60
2024	17.55	7.14	5.99	14.09	156.01
2025	17.95	7.30	6.12	14.41	159.51
2026	18.35	7.47	6.26	14.73	163.08

AI.14. Freight value of time

The recommended unit values for freight value of time savings are presented on sheet **I. Freight VoT**. Table I1 presents the values for road freight, which are values per hour of driver time taken from the work VoT on sheet **H. Pax VoT**.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Freight VoT

Tables

Table I1. Road freight value of time by year (€2021/vehicle hour)

Year	LGV	HGV1	HGV2
2021	16.11	16.11	16.11
2022	16.79	16.79	16.79
2023	17.17	17.17	17.17
2024	17.55	17.55	17.55
2025	17.95	17.95	17.95
2026	18.35	18.35	18.35
2027	18.76	18.76	18.76
2028	19.18	19.18	19.18

Table I2 presents freight values for rail and IWT modes. The values quoted in this table are based on research undertaken in France but are considered appropriate given the small differences in market value between countries for typical rail freight and given the broad range of value categories. They are held constant over time beyond the price base year.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Freight VoT

Table I2. Rail freight values of time by commodity type (€2021/tonne hour)

Commodity	Value of time (€/tonne.hour)
Freight with low added value (< €6,000/tonne), e.g. bulk, aggregates	0.00
Ordinary freight (€6,000 - €35,000/tonne)	0.23
Freight with high added value (> €35,000/tonne), e.g. parcels, refridgerated produce, combined traffic, RORO traffic	0.69

AI.15. Road vehicle fleet

The composition of the road vehicle fleet is presented in the sheet **J. Road veh fleet** by year from 2016 to 2070 for two scenarios: Baseline (following current trends, based on a study by Deloitte[22] and assuming a ban on newly produced internal combustion vehicles after 2045) and Adapted (based on the Paris Agreement). The table shows the forecast percentage of cars, buses, LGVs and HGVs

[22] https://viitorultransportului.ro/wp-content/uploads/2022/07/Concordia_Future-of-mobility_-Final-presentation-vf_RO-new.pdf

subdivided by type of fuel (petrol, diesel and electricity) in the Baseline scenario. A similar table shows the forecast fleet structure in the Adapted scenario.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Road vehicle fleet

Tables

Table J1. Road vehicle fleet composition: Baseline Scenario (current trend)

	Car (petrol)	Car (diesel)	Car (electric)	Bus (diesel)	Bus (electric)	LGV (petrol)	LGV (diesel)	LGV (electric)	HGV (diesel)	HGV (electric)
2016	61.3%	38.7%	0.0%	100.0%	0.0%	19.0%	81.0%	0.0%	100.0%	0.0%
2017	58.0%	42.0%	0.0%	100.0%	0.0%	17.4%	82.6%	0.0%	100.0%	0.0%
2018	55.2%	44.8%	0.0%	100.0%	0.0%	15.8%	84.2%	0.0%	100.0%	0.0%
2019	53.2%	46.8%	0.0%	100.0%	0.0%	14.5%	85.5%	0.0%	100.0%	0.0%
2020	51.6%	48.4%	0.0%	100.0%	0.0%	13.2%	86.8%	0.0%	100.0%	0.0%
2021	50.2%	49.7%	0.1%	100.0%	0.0%	12.4%	87.6%	0.0%	100.0%	0.0%
2022	50.2%	49.7%	0.1%	100.0%	0.0%	12.4%	87.5%	0.1%	100.0%	0.0%
2023	49.7%	49.2%	1.2%	100.0%	0.0%	12.3%	86.9%	0.8%	100.0%	0.0%
2024	49.1%	48.6%	2.2%	100.0%	0.0%	12.2%	86.4%	1.4%	100.0%	0.0%
2025	48.6%	48.1%	3.3%	100.0%	0.0%	12.1%	85.8%	2.1%	100.0%	0.0%
2026	48.1%	47.6%	4.4%	100.0%	0.0%	12.1%	85.2%	2.7%	100.0%	0.0%
2027	47.5%	47.1%	5.4%	100.0%	0.0%	12.0%	84.7%	3.4%	100.0%	0.0%
2028	47.0%	46.5%	6.5%	100.0%	0.0%	11.9%	84.1%	4.0%	100.0%	0.0%

AI.16. Fuel costs

Costs per unit of fuel (price base € resource costs) are presented in sheet **K. Fuel costs** for the years 2010 to 2022 (actual values) and 2023 to 2070 (forecast values), for both the Baseline and Adapted scenarios. The observed costs of petrol and diesel are average annual values exclusive of tax for Romania extracted from the Weekly Oil Bulletin[23]. The observed cost for electric vehicles is based on Eurostat[24] household electricity prices for Romania, with an assumption that electric vehicles are charged 80% at private locations and 20% at public locations, where a markup of €0.10/kWh is incurred. The user can over-ride both these assumptions.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Fuel costs

User input (optional)

EV assumptions

	Default	Over-ride	Value used
Household charging %	80%		80%
Public markup (€/kWh)	0.10		0.10

Source: base assumption

Baseline forecast prices assume short term fluctuations consistent with research carried out by Deloitte[25] and are held constant from 2026. Adapted scenario forecast prices follow the same profile to 2025. Thereafter, petrol prices are forecast to increase by 2.2% annually, diesel prices by 2.3% annually, while electricity prices are held constant.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Fuel costs

Tables

Table K1. Fuel cost growth per year beyond observed data

	Baseline scenario			Adapted scenario		
Year	Petrol	Diesel	Electricity	Petrol	Diesel	Electricity
2023	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
2024	-10.00%	-10.00%	-10.00%	-10.00%	-10.00%	-10.00%
2025	-10.00%	-10.00%	-10.00%	-10.00%	-10.00%	-10.00%
2026	0.00%	0.00%	0.00%	2.20%	2.30%	0.00%

[23] https://energy.ec.europa.eu/data-and-analysis/weekly-oil-bulletin_en
[24] https://ec.europa.eu/eurostat/databrowser/view/NRG_PC_204__custom_807721/default/table?lang=en
[25] https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/energy-resources/ca-en-energy-resources-industrials-o-g-price-forecast-report-Q2-fy23-aoda.pdf

Table K2. Baseline road vehicle fuel costs, resource cost average per year €2021

			---------- Electricity ----------		
	Petrol	**Diesel**	**(household)**	**(public)**	**(inc. public)**
Year	**€/litre**	**€/litre**	**€/kWh**	**€/kWh**	**€/kWh**
2010	0.523	0.552	0.085	0.185	0.105
2011	0.629	0.693	0.084	0.184	0.104
2012	0.681	0.760	0.077	0.177	0.097
2013	0.663	0.728	0.089	0.189	0.109
2014	0.641	0.694	0.091	0.191	0.111
2015	0.511	0.538	0.093	0.193	0.113
2016	0.453	0.468	0.090	0.190	0.110
2017	0.501	0.526	0.091	0.191	0.111
2018	0.573	0.628	0.098	0.198	0.118
2019	0.543	0.608	0.100	0.200	0.120
2020	0.434	0.475	0.104	0.204	0.124
2021	0.604	0.621	0.114	0.214	0.134
2022	0.911	0.996	0.196	0.296	0.216
2023	1.048	1.145	0.225	0.325	0.245
2024	0.943	1.030	0.203	0.303	0.223
2025	0.849	0.927	0.183	0.283	0.203

AI.17. Fuel consumption

Sheet **L. Fuel consumption** presents the formulae and parameter values to be used to calculate the fuel consumption per kilometre for road vehicles. The formulae depend on speed and the user must therefore apply them according to modelled average link speeds. Sample calculations are presented for cars, buses, LGVs and HGVs by fuel type, sample speeds, sample years and alternative scenarios (Baseline and Adapted). Values are provided for all sample speeds. However, the calculations may present unreliable results for speeds greater than the maximum speeds specified in Table L1.

The formulae are based on WebTAG and the original data relates to UK fleet composition in 2015, but assumed representative of Romanian fleet composition in 2021. Note that HGVs are split into two categories – HGV1 (2 and 3-axle rigid vehicles) and HGV2 (4-axle rigid vehicles and all articulated vehicles). HGV1 corresponds to the UK WebTAG category OGV1, and HGV2 corresponds to the UK WebTAG category OGV2. The default split to be used is 34.8% HGV1 and 65.2% HGV2, based on proportions observed in the Romanian National Traffic Model. Note also that until more data becomes available, values for electric buses, electric LGVs and electric HGVs are adjusted from a speed of 80km/h to other speeds following a similar profile to that of electric cars.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Fuel consumption calculations (hidden)

Source data

Base data relates to the year: 2021

Road vehicle fuel consumption: petrol and diesel fuelled vehicles (base data for year 2021)

								---- Sample calculations ---- L = a/v + b + c.v + d.v2		
Vehicle category	**a**	**b**	**c**	**d**	**Min speed km/h**	**Av speed km/h**	**Max speed km/h**	**Min speed l/km**	**Av speed l/km**	**Max speed l/km**
Car (petrol)	0.451947	0.096046	-0.001094	0.000007	10	100	130	0.13	0.06	0.08
Car (diesel)	0.481913	0.069094	-0.000665	0.000005	10	100	130	0.11	0.06	0.07
Bus (diesel)	3.360187	0.295249	-0.003209	0.000024	12	80	85	0.54	0.23	0.23
LGV (petrol)	0.344348	0.193090	-0.003031	0.000020	12	90	120	0.19	0.08	0.11
LGV (diesel)	0.463485	0.113278	-0.001634	0.000014	12	90	110	0.13	0.08	0.11
HGV1 (diesel)	2.696285	0.143057	-0.001034	0.000011	12	80	85	0.36	0.17	0.17
HGV2 (diesel)	5.665597	0.294224	-0.001949	0.000012	12	80	85	0.74	0.28	0.28

Source: WebTag Table A1.3.8, based on research carried out by Ricardo-AEA (2019)
Note: data relates to UK fleet composition 2015, but is assumed representative of RO 2021. The minimum and maximum speeds delimit the range over which the curves are valid.
HGV1 (diesel 2 and 3-axle rigid vehicles) corresponds to the UK WebTAG category OGV1. HGV2 (diesel 4-axle rigid vehicles and all articulated vehicles) corresponds to the UK WebTAG category OGV2.

									---- Sample calculations ---- K = a.v4 - b.v3 + c.v2 - d.v + e		
Vehicle category	**a**	**b**	**c**	**d**	**e**	**Min speed km/h**	**Av speed km/h**	**Max speed km/h**	**Min speed kWh/km**	**Av speed kWh/km**	**Max speed kWh/km**
Car (electric	7.21215E-09	-2.58685E-06	3.39096E-04	-1.60095E-02	4.15855E-01	10	100	130	0.29	0.34	0.44
Bus (electric)					1.180	12	80	85		1.18	
LGV (electric)					0.259	12	80	120		0.26	
HGV (electric)					1.860	12	80	85		1.86	

Source:
Car - Ricardo-AEA (2015) Speed emission/energy curves for ultra-low emission vehicles, as reported by EIB
Bus, LGV - WebTAG Table A1.3.8
HGV - omev.se

Table L2. Fuel efficiency improvement per year from 2021

Scenario	Petrol	Diesel	Electric
Baseline	0.00%	0.00%	0.00%
Adapted	1.25%	1.30%	1.40%

Sample tables

Table L3. Road vehicle fuel consumption with fuel efficiency improvement applied

Scenario: Baseline — Select a scenario from the drop-down list and, if required, enter a custom speed and custom year.
Custom speed: 75
Custom year: 2025

				Speed (km/h)						
Year	**Vehicle category**		**Unit**	**20**	**40**	**60**	**80**	**100**	**120**	**75**
2021	Car	petrol	l/km	0.100	0.075	0.064	0.061	0.064	0.073	0.061
	Car	diesel	l/km	0.082	0.063	0.056	0.055	0.060	0.069	0.055
	Car	electric	kWh/km	0.212	0.171	0.211	0.276	0.340	0.403	0.259
	Bus	diesel	l/km	0.408	0.289	0.243	0.231	0.243	0.277	0.232
	Bus	electric	kWh/km	1.341	1.083	1.335	1.750	2.155	2.554	1.643
	LGV	petrol	l/km	0.158	0.112	0.087	0.080	0.089	0.114	0.080
	LGV	diesel	l/km	0.109	0.082	0.073	0.077	0.093	0.120	0.075
	LGV	electric	kWh/km	0.383	0.309	0.381	0.500	0.616	0.730	0.470
	HGV1	diesel	l/km	0.262	0.187	0.167	0.166	0.180	0.204	0.165
	HGV2	diesel	l/km	0.543	0.376	0.314	0.283	0.272	0.275	0.289
	HGV	electric	kWh/km	1.426	1.151	1.419	1.860	2.291	2.714	1.747
2025	Car	petrol	l/km	0.100	0.075	0.064	0.061	0.064	0.073	0.061
	Car	diesel	l/km	0.082	0.063	0.056	0.055	0.060	0.069	0.055
	Car	electric	kWh/km	0.212	0.171	0.211	0.276	0.340	0.403	0.259
	Bus	diesel	l/km	0.408	0.289	0.243	0.231	0.243	0.277	0.232
	Bus	electric	kWh/km	1.341	1.083	1.335	1.750	2.155	2.554	1.643
	LGV	petrol	l/km	0.158	0.112	0.087	0.080	0.089	0.114	0.080
	LGV	diesel	l/km	0.109	0.082	0.073	0.077	0.093	0.120	0.075
	LGV	electric	kWh/km	0.383	0.309	0.381	0.500	0.616	0.730	0.470
	HGV1	diesel	l/km	0.262	0.187	0.167	0.166	0.180	0.204	0.165
	HGV2	diesel	l/km	0.543	0.376	0.314	0.283	0.272	0.275	0.289
	HGV	electric	kWh/km	1.426	1.151	1.419	1.860	2.291	2.714	1.747

Note: the default HGV split is HGV1 34.8%, HGV2 65.2%, based on data from the National Transport Model.
Values are provided for all sample speeds. Note however that the calculations may be unreliable for speeds greater than the maximum speeds specified in Table L1 above.
Until more data becomes available, values for electric buses, LGVs and HGVs are adjusted from a speed of 80km/h to other speeds following a similar profile as for cars.

Table L4. Road vehicle fuel cost with cost growth and fuel efficiency improvement applied

Scenario: Baseline

Year	Vehicle category		Fuel unit	Fuel unit cost €	Unit	Speed (km/h) 20	40	60	80	100	120	75
2021	Car	petrol	l	0.604	€/km	0.060	0.045	0.039	0.037	0.038	0.044	0.037
	Car	diesel	l	0.621	€/km	0.051	0.039	0.035	0.034	0.037	0.043	0.034
	Car	electric	kWh	0.134	€/km	0.028	0.023	0.028	0.037	0.046	0.054	0.035
	Bus	diesel	l	0.621	€/km	0.254	0.179	0.151	0.144	0.151	0.172	0.144
	Bus	electric	kWh	0.134	€/km	0.121	0.098	0.121	0.158	0.195	0.231	0.149
	LGV	petrol	l	0.604	€/km	0.095	0.068	0.053	0.048	0.054	0.069	0.049
	LGV	diesel	l	0.621	€/km	0.068	0.051	0.045	0.048	0.058	0.075	0.046
	LGV	electric	kWh	0.134	€/km	0.027	0.021	0.026	0.035	0.043	0.051	0.033
	HGV1	diesel	l	0.621	€/km	0.162	0.116	0.103	0.103	0.111	0.127	0.102
	HGV2	diesel	l	0.621	€/km	0.337	0.234	0.195	0.176	0.169	0.171	0.179
	HGV	electric	kWh	0.134	€/km	0.191	0.154	0.190	0.249	0.307	0.364	0.234
2030	Car	petrol	l	0.849	€/km	0.085	0.064	0.054	0.051	0.054	0.062	0.052
	Car	diesel	l	0.927	€/km	0.076	0.058	0.052	0.051	0.055	0.064	0.051
	Car	electric	kWh	0.173	€/km	0.037	0.030	0.037	0.048	0.059	0.070	0.045
	Bus	diesel	l	0.927	€/km	0.379	0.268	0.226	0.214	0.226	0.257	0.215
	Bus	electric	kWh	0.173	€/km	0.157	0.127	0.156	0.205	0.252	0.299	0.192
	LGV	petrol	l	0.849	€/km	0.134	0.095	0.074	0.068	0.076	0.097	0.068
	LGV	diesel	l	0.927	€/km	0.101	0.076	0.067	0.071	0.086	0.112	0.069
	LGV	electric	kWh	0.173	€/km	0.034	0.028	0.034	0.045	0.055	0.066	0.042
	HGV1	diesel	l	0.927	€/km	0.243	0.174	0.155	0.154	0.167	0.189	0.153
	HGV2	diesel	l	0.927	€/km	0.504	0.349	0.291	0.263	0.252	0.255	0.268
	HGV	electric	kWh	0.173	€/km	0.247	0.200	0.246	0.323	0.397	0.471	0.303

Note: the default HGV split is HGV1 34.8%, HGV2 65.2%, based on data from the National Transport Model.
Values are provided for all sample speeds. Note however that the calculations may be unreliable for speeds greater than the maximum speeds specified in Table L1 above.
Until more data becomes available, values for electric buses, LGVs and HGVs are adjusted from a speed of 80km/h to other speeds following a similar profile as for cars.

Aggregated fuel costs of road vehicles are included in a separate table for use in the assessment of rail and other non-road projects. The costs are shown in terms of €/pax.km and €/tonne.km for the Baseline and Adapted scenarios for the price base year and a custom year. These costs should be added to the aggregated non-fuel costs of road vehicles to get total road vehicle VOCs.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Fuel consumption and sample costs

Table L5. Aggregated fuel costs of road vehicles

		Baseline 2021	Baseline 2030	Adapted 2021	Adapted 2030
Car	€/pax.km	0.020	0.020	0.028	0.027
Bus	€/pax.km	0.006	0.006	0.009	0.009
LGV	€/ton.km	0.047	0.047	0.068	0.063
HGV	€/ton.km	0.018	0.018	0.027	0.026

AI.18. Non-fuel costs

Non-fuel VOCs for road vehicles have been calculated using HDM-VOC for a standard set of vehicle fleet characteristics adjusted to Romanian conditions. RomTAP can generate adjustment factors if modifications to the original data are required. JASPERS are available to assist with this process.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Non-fuel road VOCs

Input data

Fleet data

		Units	LVs: Car ICE	LVs: Car electric	LVs: LGV ICE	LVs: LGV electric	HVs: Bus diesel	HVs: HGV1 diesel	HVs: HGV2 diesel
Economic Unit Costs	New Vehicle Cost	€/vehicle	18,000.00	25,000.00	31,000.00	45,000.00	80,000.00	60,000.00	100,000.00
	Lubricant Cost	€/litre	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	New Tyre Cost	€/tyre	80.00	80.00	80.00	80.00	120.00	120.00	300.00
	Maintenance Labor Cost	€/hour	25.00	25.00	30.00	30.00	30.00	30.00	35.00
	Crew cost	€/hour	-	-	-	-	-	-	-
	Interest Rate	%	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Utilization and Loading	Kilometers Driven per Year	km	12,000.00	12,000.00	40,000.00	40,000.00	60,000.00	50,000.00	150,000.00
	Hours Driven per Year	hours	550.00	550.00	1,100.00	1,100.00	950.00	1,200.00	2,125.00
	Service Life	years	12.00	12.00	10.00	10.00	12.00	10.00	10.00
	Gross vehicle weight	tons	1.80	1.80	3.50	3.50	7.20	7.50	40.00

Source: JASPERS

The non-fuel VOCs are presented in price base € by type of vehicle, type of terrain (flat, hilly, mountainous), type of road (interurban dual carriageway, interurban single carriageway, urban) and road roughness (IRI 2, 6, 10) in sheet **M. Non-fuel costs**.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Non-fuel road VOCs

Tables

Table M1. Consolidated road vehicle non-fuel costs 2021 (€/veh.km)

Terrain	Type of road	IRI	Car ICE	Car electric	LGV ICE	LGV electric	Bus diesel	HGV1 diesel	HGV2 diesel
Flat	Interurban Dual	2	0.210	0.266	0.240	0.308	0.450	0.547	1.043
Flat	Interurban Dual	6	0.233	0.293	0.283	0.365	0.583	0.660	1.259
Flat	Interurban Dual	10	0.266	0.335	0.346	0.450	0.728	0.795	1.478
Flat	Interurban Single	2	0.211	0.267	0.240	0.308	0.451	0.547	1.042
Flat	Interurban Single	6	0.233	0.294	0.284	0.365	0.584	0.660	1.259
Flat	Interurban Single	10	0.266	0.335	0.346	0.450	0.728	0.795	1.478
Flat	Urban	2	0.214	0.272	0.243	0.311	0.453	0.549	1.042
Flat	Urban	6	0.236	0.299	0.286	0.368	0.586	0.662	1.259
Flat	Urban	10	0.268	0.338	0.347	0.452	0.730	0.796	1.479
Hilly	Interurban Dual	2	0.211	0.267	0.241	0.308	0.451	0.548	1.052
Hilly	Interurban Dual	6	0.233	0.294	0.284	0.366	0.584	0.661	1.271
Hilly	Interurban Dual	10	0.266	0.336	0.346	0.450	0.729	0.796	1.492
Hilly	Interurban Single	2	0.211	0.267	0.241	0.309	0.452	0.548	1.052
Hilly	Interurban Single	6	0.234	0.295	0.284	0.366	0.585	0.661	1.271
Hilly	Interurban Single	10	0.266	0.336	0.346	0.451	0.729	0.796	1.492
Hilly	Urban	2	0.214	0.272	0.244	0.312	0.455	0.550	1.055
Hilly	Urban	6	0.236	0.299	0.287	0.369	0.587	0.663	1.273
Hilly	Urban	10	0.268	0.338	0.348	0.452	0.731	0.797	1.493
Mountainous	Interurban Dual	2	0.212	0.269	0.243	0.311	0.456	0.552	1.104
Mountainous	Interurban Dual	6	0.235	0.296	0.287	0.369	0.589	0.665	1.328
Mountainous	Interurban Dual	10	0.268	0.337	0.349	0.453	0.734	0.800	1.551
Mountainous	Interurban Single	2	0.213	0.269	0.244	0.312	0.457	0.552	1.104
Mountainous	Interurban Single	6	0.235	0.296	0.287	0.369	0.590	0.665	1.328
Mountainous	Interurban Single	10	0.268	0.337	0.349	0.453	0.734	0.800	1.551
Mountainous	Urban	2	0.215	0.273	0.246	0.314	0.459	0.554	1.107
Mountainous	Urban	6	0.238	0.300	0.289	0.372	0.592	0.667	1.330
Mountainous	Urban	10	0.269	0.339	0.350	0.455	0.735	0.801	1.551

The values are held constant beyond the price base.

Aggregated non-fuel costs of road vehicles are included in a separate table for use in the assessment of rail and other non-road projects. The costs are shown in terms of €/pax.km and €/tonne.km for the price base year and a custom year that can be specified on sheet **L. Fuel consumption**. These costs should be added to the aggregated fuel costs of road vehicles to give total road vehicle VOCs.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Non-fuel road VOCs

Table M2. Aggregated non-fuel costs of road vehicles

		2021	2030
Car	€/pax.km	0.133	0.136
Bus	€/pax.km	0.024	0.024
LGV	€/ton.km	0.292	0.296
HGV	€/ton.km	0.123	0.123

AI.19. TOCs

Train operating costs are calculated separately for passenger trains and freight trains in sheet **N. TOCs**. For passenger trains, costs per train kilometre are based on AECOM 2010 data, subdivided by type of train and energy, and adjusted to the price base year by applying the Romanian inflation rate. Freight train costs are based on JASPERS Rail Guidance, subdivided into hourly and kilometric cost components by type of train. The hourly cost component is adjusted to the price base by applying the Romanian inflation rate and the kilometric cost is adjusted according to energy market prices.

Passenger train operating costs are presented in RomTAP by train kilometre and passenger kilometre and either metric may be used. The costs remain constant beyond the price base year.

RomTAP
v1.0
March 2023
Train operating costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Table N1. Economic passenger TOCs: total TOC/train.km (€2021)

	Diesel trains						Electric trains					
	Locomotive hauled			New multiple unit		Old mult. unit	Locomotive hauled			New multiple unit		Old mult. unit
Year	Inter-city	Inter-regional	Regional	Long distance	Regional	All	Inter-city	Inter-regional	Regional	Long distance	Regional	All
2021	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2022	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2023	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2024	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2025	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2026	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2027	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45
2028	15.62	13.51	8.71	7.75	7.28	6.16	11.63	10.03	7.11	7.04	6.45	6.45

RomTAP
v1.0
March 2023
Train operating costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Table N2. Economic passenger TOCs: total TOC/passenger.km (€2021)

	Diesel trains						Electric trains					
	Locomotive hauled			New multiple unit		Old mult. unit	Locomotive hauled			New multiple unit		Old mult. unit
Year	Inter-city	Inter-regional	Regional	Long distance	Regional	All	Inter-city	Inter-regional	Regional	Long distance	Regional	All
2021	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2022	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2023	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2024	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2025	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2026	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2027	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080
2028	0.193	0.167	0.108	0.096	0.090	0.076	0.144	0.124	0.088	0.087	0.080	0.080

No operating costs are currently available for metro trains. For appraisal of metro projects, the operator should provide the applicable TOC data.

Freight train operating costs are presented for trains and tonnes by time and distance metrics and both metrics are to be used together i.e., the total TOC is the hourly cost plus the kilometric cost either per train or per tonne. The hourly costs remain constant beyond the price base year while the kilometric costs are adjusted in line with the Baseline and Adapted scenarios.

Table N3. Economic freight TOCs: total TOC/train.hour and train.km (€2021)
NB. These are NOT mutually exclusive. Use the cost per hour PLUS the cost per kilometre.

	€2021/train.hour						€2021/train.km			
	Block train		Wagonload train		Container train		Baseline		Adapted	
Year	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel
2021	392.17	419.70	435.14	476.97	361.85	391.01	3.54	5.07	3.54	5.07
2022	392.17	419.70	435.14	476.97	361.85	391.01	5.82	9.25	5.82	9.25
2023	392.17	419.70	435.14	476.97	361.85	391.01	6.69	10.64	6.69	10.64
2024	392.17	419.70	435.14	476.97	361.85	391.01	6.02	9.58	6.02	9.58
2025	392.17	419.70	435.14	476.97	361.85	391.01	5.42	8.62	5.42	8.62
2026	392.17	419.70	435.14	476.97	361.85	391.01	5.42	8.62	5.42	8.82
2027	392.17	419.70	435.14	476.97	361.85	391.01	5.42	8.62	5.42	9.02
2028	392.17	419.70	435.14	476.97	361.85	391.01	5.42	8.62	5.42	9.23

Table N4. Economic freight TOCs: total TOC/tonne.hour and tonne.km (€2021)
NB. These are NOT mutually exclusive. Use the cost per hour PLUS the cost per kilometre.

	€2021/tonne.hour						€2021/tonne.km			
	Block train		Wagonload train		Container train		Baseline		Adapted	
Year	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel
2021	0.603	0.646	0.669	0.734	0.557	0.602	0.005	0.008	0.005	0.008
2022	0.603	0.646	0.669	0.734	0.557	0.602	0.009	0.014	0.009	0.014
2023	0.603	0.646	0.669	0.734	0.557	0.602	0.010	0.016	0.010	0.016
2024	0.603	0.646	0.669	0.734	0.557	0.602	0.009	0.015	0.009	0.015
2025	0.603	0.646	0.669	0.734	0.557	0.602	0.008	0.013	0.008	0.013
2026	0.603	0.646	0.669	0.734	0.557	0.602	0.008	0.013	0.008	0.014
2027	0.603	0.646	0.669	0.734	0.557	0.602	0.008	0.013	0.008	0.014
2028	0.603	0.646	0.669	0.734	0.557	0.602	0.008	0.013	0.008	0.014

AI.20. IWTOCs

Inland waterway vessel operating costs are tabulated in sheet **O. IWTOCs** by year in price base € in terms of €/km, €/hour, €/tonne.km and €/tonne.hour for the Baseline and Adapted scenarios. The values are based on work carried out by Jacobs[26] and Panteia[27].

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

IWT vessel operating costs

Tables

Table O1. Baseline IWT vessel operating costs, resource cost average per year €2021

Year	€/km	€/hour	€/tonne.km	€/tonne.hr
2021	83.763	430.163	0.010	0.052
2022	98.023	503.396	0.012	0.061
2023	102.755	527.696	0.012	0.064
2024	99.127	509.066	0.012	0.062
2025	95.862	492.299	0.012	0.060
2026	95.862	492.299	0.012	0.060
2027	95.862	492.299	0.012	0.060
2028	95.862	492.299	0.012	0.060

Original data is subdivided into crew costs, fuel costs and other costs, escalated to the price base as follows:

- Crew cost: converted to RON, escalated in line with Romanian inflation and GDP/capita with an elasticity of 1.0, then converted back to EUR.
- Fuel cost: escalated in line with market prices.
- Other costs: converted to RON, escalated in line with Romanian inflation, then converted back to EUR.

Crew costs and other costs are held constant from the price base year while fuel costs are escalated according to the Baseline and Adapted scenarios.

AI.21. Road accidents

Accident costs are tabulated in sheet **P. Road accidents** by year, type of casualty and for material damage. The values are based on the 2019 Handbook on External Costs data for Romania, rebased to the price base year. In years beyond the price base, costs are increased in line with GDP/capita with an elasticity of 0.8 applied.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Road accident costs

Tables

Table P1. Cost per casualty by year with elasticity to GDP/capita applied (€2021)

Year	Fatality	Serious injury	Slight injury	Damage only
2021	3,137,396	436,105	33,650	6,275
2022	3,270,422	454,596	35,077	6,541
2023	3,343,679	464,779	35,863	6,687
2024	3,418,578	475,190	36,666	6,837
2025	3,495,154	485,835	37,488	6,990
2026	3,573,445	496,717	38,327	7,147
2027	3,653,490	507,844	39,186	7,307
2028	3,735,329	519,219	40,064	7,471

A second table presents road accident rates in terms of the number of damages only accidents per million vehicle kilometres and injury accidents per million vehicle kilometres by type of road (motorway, national rural, national urban, regional rural, regional urban and local). The number of fatalities, serious injuries and slight injuries is also tabulated. The rates are based on data from 2007 – 2011 reported in the AECOM Guide and should be updated once suitable data is available. Accident rates are assumed

[26] JACOBS (2020) Improvement of Navigation Conditions on the Romanian-Bulgarian Common Sector of the Danube
[27] Panteia (2020) Cost figures for freight transport

to decline by a default rate of 0.5% per year, as infrastructure geometry, vehicle safety features and driver awareness improve.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Road accident costs

Table P2. Accident rates by type of road

	Motorway					DN Rural						
Year	Damage only accidents per mln.veh.km	Injury accidents per mln.veh.km	Fatalities per accident	Serious injuries per accident	Slight injuries per accident	Damage only accidents per mln.veh.km	Injury accidents per mln.veh.km	Fatalities per accident	Serious injuries per accident	Slight injuries per accident	Damage only accidents per mln.veh.km	Injury accidents per mln.veh.km
2021	1.5300	0.0406	0.1495	0.3551	1.0000	2.2700	0.1325	0.1726	0.4841	1.1296	10.7300	0.7306
2022	1.5224	0.0404	0.1495	0.3551	1.0000	2.2587	0.1318	0.1726	0.4841	1.1296	10.6764	0.7269
2023	1.5147	0.0402	0.1495	0.3551	1.0000	2.2474	0.1312	0.1726	0.4841	1.1296	10.6230	0.7233
2024	1.5072	0.0400	0.1495	0.3551	1.0000	2.2361	0.1305	0.1726	0.4841	1.1296	10.5699	0.7197
2025	1.4996	0.0398	0.1495	0.3551	1.0000	2.2249	0.1299	0.1726	0.4841	1.1296	10.5170	0.7161
2026	1.4921	0.0396	0.1495	0.3551	1.0000	2.2138	0.1292	0.1726	0.4841	1.1296	10.4644	0.7125
2027	1.4847	0.0394	0.1495	0.3551	1.0000	2.2027	0.1286	0.1726	0.4841	1.1296	10.4121	0.7090
2028	1.4772	0.0392	0.1495	0.3551	1.0000	2.1917	0.1279	0.1726	0.4841	1.1296	10.3600	0.7054

A further table presents the costs of road accidents per injury accident and per million vehicle kilometres by type of road, again with annual reduction factors applied.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Road accident costs

Table P3. Cost of road accidents, €2021 per injury accident and per million vehicle kilometres

	Motorway			DN Rural			DN Urban			DJ Rural		
Year	Cost of road injury accident	Cost of road injury acc. / mln.veh.km	Cost of all road accs. / mln.veh.km	Cost of road injury accident	Cost of road injury acc. / mln.veh.km	Cost of all road accs. / mln.veh.km	Cost of road injury accident	Cost of road injury acc. / mln.veh.km	Cost of all road accs. / mln.veh.km	Cost of road injury accident	Cost of road injury acc. / mln.veh.km	Cost of all road accs. / mln.veh.km
2021	663,827	26,951	34,427	796,919	105,592	105,592	635,802	464,517	464,517	658,173	193,766	193,766
2022	691,973	27,954	35,392	830,709	109,519	109,519	662,760	481,792	481,792	686,080	200,972	200,972
2023	707,473	28,437	35,838	849,317	111,412	111,412	677,606	490,121	490,121	701,448	204,446	204,446
2024	723,321	28,929	36,293	868,341	113,338	113,338	692,784	498,594	498,594	717,160	207,981	207,981
2025	739,523	29,429	36,756	887,792	115,297	115,297	708,303	507,214	507,214	733,225	211,576	211,576
2026	756,089	29,937	37,228	907,679	117,291	117,291	724,169	515,982	515,982	749,649	215,234	215,234
2027	773,025	30,455	37,709	928,011	119,318	119,318	740,390	524,903	524,903	766,441	218,955	218,955
2028	790,341	30,981	38,199	948,798	121,381	121,381	756,975	533,977	533,977	783,609	222,740	222,740

A final table presents road accident costs per passenger kilometre and tonne kilometre by year. This table is based solely on data in the Handbook on External Costs and may not, therefore, be fully consistent with the previous tables. These values should only be applied in the absence of a road transport model able to produce reliable estimates of e.g., vehicle kilometres. An example of this would be the appraisal of a rail project with a rail only model, but with modal shift calculated using elasticities.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Road accident costs

Table P4. Road accident costs per passenger kilometre and tonne kilometre, €2021

	----- €/pax.km -----		----- €/tonne.km -----	
Year	Car	Bus	LGV	HGV
2021	0.096	0.018	0.586	0.009
2022	0.100	0.019	0.610	0.009
2023	0.103	0.019	0.624	0.010
2024	0.105	0.020	0.638	0.010
2025	0.107	0.020	0.652	0.010
2026	0.110	0.020	0.667	0.010
2027	0.112	0.021	0.682	0.010
2028	0.115	0.021	0.697	0.011

AI.22. Rail & IWT accidents

Rail and IWT accident costs are presented in sheet **Q. Rail & IWT accidents**. They are expressed in terms of cost per train kilometre, passenger kilometre, tonne kilometre and per level crossing for rail, and per vessel kilometre and tonne kilometre for IWT vessels. The table is based on values presented in the 2019 Handbook on External Costs and, for level crossings, AECOM data.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Rail & IWT accident costs

Tables

Table Q1. Cost per rail and IWT accident in Romania, €2021

	Rail					IWT	
	Passenger train		Freight train		Level crossing		
Year	€/train.km	€/pax.km	€/train.km	€/tonne.km	€/crossing	€/vessel.km	€/tonne.km
2021	0.5000	0.00618	0.3270	0.00050	21,644	0.8117	0.00060
2022	0.5212	0.00644	0.3408	0.00052	22,562	0.8461	0.00063
2023	0.5329	0.00659	0.3485	0.00054	23,067	0.8651	0.00064
2024	0.5448	0.00673	0.3563	0.00055	23,584	0.8845	0.00066
2025	0.5570	0.00689	0.3643	0.00056	24,112	0.9043	0.00067
2026	0.5695	0.00704	0.3724	0.00057	24,653	0.9245	0.00069
2027	0.5823	0.00720	0.3808	0.00059	25,205	0.9453	0.00070
2028	0.5953	0.00736	0.3893	0.00060	25,769	0.9664	0.00072

AI.23. Noise

Noise costs based on the 2019 Handbook on External Costs are presented in sheet **R. Noise** by passenger kilometre, tonne kilometre and vehicle kilometre by type of vehicle (car, bus, LGV, HGV, train and IWT) and fuel (petrol, diesel and electricity) by year. In years beyond the price base, costs are increased in line with GDP/capita with an elasticity of 0.8 applied. The Handbook does not provide data for electric road vehicles. An assumption is made that they are 50% quieter than conventionally fuelled road vehicles.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Noise costs

Tables

Table R1. Noise costs per passenger kilometre and tonne kilometre, €2021

	€/pax.km							€/tonne.km					
Year	Car (petrol)	Car (diesel)	Car (electric)	Bus (diesel)	Bus (electric)	Train (electric)	Train (diesel)	LGV (petrol)	LGV (diesel)	LGV (electric)	HGV1 (diesel)	HGV2 (diesel)	HGV
2021	0.006773	0.007554	0.003582	0.003055	0.001528	0.010233	0.017750	0.021086	0.021086	0.010543	0.015755	0.005395	0
2022	0.007061	0.007874	0.003734	0.003185	0.001592	0.010667	0.018503	0.021980	0.021980	0.010990	0.016423	0.005624	0
2023	0.007219	0.008051	0.003817	0.003256	0.001628	0.010906	0.018917	0.022473	0.022473	0.011236	0.016791	0.005750	0
2024	0.007380	0.008231	0.003903	0.003329	0.001665	0.011150	0.019341	0.022976	0.022976	0.011488	0.017167	0.005879	0
2025	0.007546	0.008415	0.003990	0.003404	0.001702	0.011400	0.019774	0.023491	0.023491	0.011745	0.017551	0.006010	0
2026	0.007715	0.008604	0.004080	0.003480	0.001740	0.011655	0.020217	0.024017	0.024017	0.012008	0.017945	0.006145	0
2027	0.007888	0.008796	0.004171	0.003558	0.001779	0.011916	0.020670	0.024555	0.024555	0.012277	0.018347	0.006283	0

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Noise costs

Table R2. Noise costs per vehicle kilometre, €2021

	€/veh.km												
Year	Car (petrol)	Car (diesel)	Car (electric)	Bus (diesel)	Bus (electric)	Train (electric)	Train (diesel)	LGV (petrol)	LGV (diesel)	LGV (electric)	HGV1 (diesel)	HGV2 (diesel)	HGV
2021	0.012124	0.013521	0.006411	0.061109	0.030554	0.827830	1.436001	0.021086	0.021086	0.010543	0.078775	0.059346	0.
2022	0.012638	0.014095	0.006683	0.063700	0.031850	0.862930	1.496888	0.021980	0.021980	0.010990	0.082115	0.061862	0.
2023	0.012921	0.014410	0.006833	0.065127	0.032563	0.882260	1.530418	0.022473	0.022473	0.011236	0.083954	0.063248	0.
2024	0.013211	0.014733	0.006986	0.066585	0.033293	0.902022	1.564699	0.022976	0.022976	0.011488	0.085835	0.064665	0.
2025	0.013507	0.015063	0.007143	0.068077	0.034038	0.922228	1.599749	0.023491	0.023491	0.011745	0.087757	0.066113	0.
2026	0.013809	0.015401	0.007302	0.069602	0.034801	0.942885	1.635583	0.024017	0.024017	0.012008	0.089723	0.067594	0.
2027	0.014119	0.015746	0.007466	0.071161	0.035580	0.964006	1.672220	0.024555	0.024555	0.012277	0.091733	0.069108	0.

If a more detailed breakdown of costs is required, consolidated adjustment factors can be applied. These facilitate the conversion of the costs per vehicle kilometre to be adjusted to noise generated during the day and during the night in urban (average population density of 1,500 inhabitants per square kilometre), suburban (average population density of 300 inhabitants per square kilometre) and rural (average population density of less than 150 inhabitants per square kilometre) locations. The adjustment factors are based on the relative values presented in the AECOM Guide. They are applied by multiplying the per vehicle kilometre cost by the corresponding adjustment factor.

RomTAP
v1.0
March 2023
Noise costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Table R3. Consolidated adjustment factors

Vehicle type	Time of day	Location Urban	Suburban	Rural
Car	Day	3.76	0.59	0.07
	Night	6.85	1.07	0.12
Bus	Day	3.76	0.59	0.07
	Night	6.85	1.07	0.12
LGV	Day	3.76	0.59	0.07
	Night	6.85	1.07	0.12
HGV	Day	3.76	0.59	0.07
	Night	6.85	1.07	0.12
Pax train	Day	2.48	1.80	0.26
	Night	4.52	3.27	0.47
Freight train	Day	2.60	1.69	0.24
	Night	4.73	3.07	0.44

AI.24. GHG emissions

Greenhouse gas (GHG) emission costs are calculated in sheet **S. GHG** as costs per litre and kWh of fuel and energy consumed for Baseline and Adapted scenarios. Emission rates in terms of kg/litre and kg/kWh of CO_2 equivalent are based on the EIB Carbon Footprint Methodology.

RomTAP
v1.0
March 2023
GHG costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Tables

Table S1. Emission rates 2021

	----- Diesel -----		----- Electricity -----		
Petrol kg/litre	Road kg/litre	Rail kg/litre	Road kg/kWh	Rail/IWT kg/kWh	Metro kg/kWh
2.300	2.700	2.700	0.310	0.295	0.301

Source: EIB Carbon Footprint Methodology, Table A1.1 default emission factors, Table A1.3 grid emissions

Annual electricity grid emission factors are presented on the basis that such emissions will be zero by the year 2050.

RomTAP
v1.0
March 2023
GHG costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Table S2. Annual grid emission reduction factors (2050 grid emissions = 0)

Year	Reduction factor
2021	1.0000
2022	0.9655
2023	0.9310
2024	0.8966
2025	0.8621
2026	0.8276
2027	0.7931
2028	0.7586

Fuel efficiency is assumed to remain constant in the Baseline scenario but to improve annually in the Adapted scenario.

RomTAP
v1.0
March 2023
GHG costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Table S3. Fuel efficiency improvement per year

Scenario	Petrol	Diesel	Electric
Baseline	0.00%	0.00%	0.00%
Adapted	1.25%	1.30%	1.40%

Source: modelling assumption

The cost per tonne of carbon (equivalent) emitted is adjusted from the 2016 data presented in the EAV to the price base year in line with euro area inflation.

RomTAP
v1.0
March 2023
Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents
GHG costs

Table S4. Carbon cost €/tonne

Year	2016 €/tonne	2021 €/tonne
2020	80	86.1
2021	97	104.4
2022	114	122.7
2023	131	141.0
2024	148	159.3
2025	165	177.6
2026	182	195.8
2027	199	214.1
2028	216	232.4

A table of emission rates presents GHG emissions by fuel type for the two scenarios, adjusted by the assumed annual fuel efficiency improvement.

RomTAP
v1.0
March 2023
Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents
GHG costs

Table S5. GHG emission rates

	Baseline					Adapted				
		Diesel		Electricity			Diesel		Electricity	
Year	Petrol kg/litre	Road kg/litre	Rail kg/litre	Road kg/kWh	Rail kg/kWh	Petrol kg/litre	Road kg/litre	Rail kg/litre	Road kg/kWh	Rail kg/kWh
2021	2.300	2.700	2.700	0.310	0.295	2.300	2.700	2.700	0.310	0.295
2022	2.300	2.700	2.700	0.299	0.285	2.271	2.665	2.665	0.295	0.281
2023	2.300	2.700	2.700	0.289	0.275	2.243	2.630	2.630	0.281	0.267
2024	2.300	2.700	2.700	0.278	0.264	2.215	2.596	2.596	0.266	0.254
2025	2.300	2.700	2.700	0.267	0.254	2.187	2.562	2.562	0.253	0.240
2026	2.300	2.700	2.700	0.257	0.244	2.160	2.529	2.529	0.239	0.228
2027	2.300	2.700	2.700	0.246	0.234	2.133	2.496	2.496	0.226	0.215
2028	2.300	2.700	2.700	0.235	0.224	2.106	2.464	2.464	0.213	0.203

The cost per tonne is applied to the emission rates to produce a table of annual costs by fuel type for the two scenarios.

RomTAP
v1.0
March 2023
Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents
GHG costs

Table S6. GHG emission costs €2021

	Baseline					Adapted				
		Diesel		Electricity			Diesel		Electricity	
Year	Petrol €/litre	Road €/litre	Rail €/litre	Road €/kWh	Rail €/kWh	Petrol €/litre	Road €/litre	Rail €/litre	Road €/kWh	Rail €/kWh
2021	0.240	0.282	0.282	0.032	0.031	0.240	0.282	0.282	0.032	0.031
2022	0.282	0.331	0.331	0.037	0.035	0.279	0.327	0.327	0.036	0.034
2023	0.324	0.381	0.381	0.041	0.039	0.316	0.371	0.371	0.040	0.038
2024	0.366	0.430	0.430	0.044	0.042	0.353	0.413	0.413	0.042	0.040
2025	0.408	0.479	0.479	0.047	0.045	0.388	0.455	0.455	0.045	0.043
2026	0.450	0.529	0.529	0.050	0.048	0.423	0.495	0.495	0.047	0.045
2027	0.493	0.578	0.578	0.053	0.050	0.457	0.535	0.535	0.048	0.046
2028	0.535	0.628	0.628	0.055	0.052	0.490	0.573	0.573	0.050	0.047

Sample road vehicle GHG emission costs per vehicle kilometre at various speeds are tabulated for the Baseline and Adapted scenarios. Values are provided for all sample speeds. Note however that the calculations may be unreliable for speeds greater than the maximum speeds specified in Table L1.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

GHG costs

Table S7. Sample road vehicle GHG emission costs per veh.km, €2021 Baseline scenario
(Year and custom speed are selected on page L. Fuel consumption)

				Speed (km/h)						
Year	Vehicle category		Unit	20	40	60	80	100	120	75
2021	Car	petrol	€/veh.km	0.024	0.018	0.015	0.015	0.015	0.017	0.015
	Car	diesel	€/veh.km	0.023	0.018	0.016	0.016	0.017	0.019	0.016
	Car	electric	€/veh.km	0.007	0.006	0.007	0.009	0.011	0.013	0.008
	Bus	diesel	€/veh.km	0.115	0.081	0.069	0.065	0.069	0.078	0.065
	Bus	electric	€/veh.km	0.029	0.024	0.029	0.038	0.047	0.056	0.036
	LGV	petrol	€/veh.km	0.038	0.027	0.021	0.019	0.021	0.027	0.019
	LGV	diesel	€/veh.km	0.031	0.023	0.021	0.022	0.026	0.034	0.021
	LGV	electric	€/veh.km	0.006	0.005	0.006	0.008	0.010	0.012	0.008
	HGV1	diesel	€/veh.km	0.074	0.053	0.047	0.047	0.051	0.058	0.046
	HGV2	diesel	€/veh.km	0.153	0.106	0.088	0.080	0.077	0.077	0.081
	HGV	electric	€/veh.km	0.046	0.037	0.046	0.060	0.074	0.088	0.057
2030	Car	petrol	€/veh.km	0.062	0.047	0.040	0.037	0.039	0.045	0.038
	Car	diesel	€/veh.km	0.060	0.046	0.041	0.040	0.043	0.050	0.040
	Car	electric	€/veh.km	0.012	0.010	0.012	0.016	0.020	0.023	0.015
	Bus	diesel	€/veh.km	0.297	0.210	0.177	0.168	0.177	0.201	0.168

Similar tables present sample road vehicle GHG emission rates per vehicle kilometre for the Baseline and Adapted scenarios.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

GHG costs

Table S9. Sample road vehicle GHG emission rates, g/veh.km, Baseline scenario
(Year and custom speed are selected on page L. Fuel consumption)

				Speed (km/h)						
Year	Vehicle category		Unit	20	40	60	80	100	120	75
2021	Car	petrol	g/veh.km	229	173	147	139	146	168	140
	Car	diesel	g/veh.km	221	170	151	150	162	186	149
	Car	electric	g/veh.km	66	53	65	86	105	125	80
	Bus	diesel	g/veh.km	1103	779	657	624	657	748	626
	Bus	electric	g/veh.km	280	226	279	366	451	534	344
	LGV	petrol	g/veh.km	362	257	201	184	205	262	185
	LGV	diesel	g/veh.km	295	220	196	208	251	325	202
	LGV	electric	g/veh.km	62	50	61	80	99	117	75
	HGV1	diesel	g/veh.km	707	505	450	449	485	551	445
	HGV2	diesel	g/veh.km	1467	1016	846	765	735	742	780
	HGV	electric	g/veh.km	442	357	440	577	710	841	541
2030	Car	petrol	g/veh.km	229	173	147	139	146	168	140
	Car	diesel	g/veh.km	221	170	151	150	162	186	149
	Car	electric	g/veh.km	45	37	45	59	73	86	55
	Bus	diesel	g/veh.km	1103	779	657	624	657	748	626

GHG emissions from trains are tabulated in terms of kgCO2/train.km, kgCO2/pax.km and kgCO2/tonne.km for the Baseline and Adapted scenarios.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

GHG costs

Table S11. Rail GHG emission rates

	kg/train.km								kg/pax.km or kg			
	Baseline				Adapted				Baseline			
	Pasenger trains		Freight trains		Pasenger trains		Freight trains		Pasenger trains		Freight trains	
Year	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel
2021	3.06	7.24	4.90	13.23	3.06	7.24	4.90	13.23	0.038	0.090	0.008	0.020
2022	2.96	7.24	4.73	13.23	2.92	7.15	4.66	13.06	0.037	0.090	0.007	0.020
2023	2.85	7.24	4.56	13.23	2.77	7.05	4.43	12.89	0.035	0.090	0.007	0.020
2024	2.75	7.24	4.39	13.23	2.63	6.96	4.21	12.72	0.034	0.090	0.007	0.020
2025	2.64	7.24	4.22	13.23	2.50	6.87	3.99	12.56	0.033	0.090	0.006	0.020
2026	2.54	7.24	4.05	13.23	2.36	6.78	3.78	12.39	0.031	0.090	0.006	0.020
2027	2.43	7.24	3.89	13.23	2.23	6.70	3.57	12.23	0.030	0.090	0.006	0.020
2028	2.32	7.24	3.72	13.23	2.11	6.61	3.37	12.07	0.029	0.090	0.006	0.020

A similar table presents GHG emissions from trains in terms of € per train.km, € per pax.km and € per tonne.km.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

GHG costs

Table S12. Rail GHG emission costs (€2021)

	€/train.km								€/pax.km or €/tc			
	Baseline				Adapted				Baseline			
	Pasenger trains		Freight trains		Pasenger trains		Freight trains		Pasenger trains		Freight trains	
Year	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel
2021	0.32	0.76	0.51	1.38	0.32	0.76	0.51	1.38	0.004	0.009	0.001	0.002
2022	0.36	0.89	0.58	1.62	0.36	0.88	0.57	1.60	0.004	0.011	0.001	0.002
2023	0.40	1.02	0.64	1.87	0.39	0.99	0.63	1.82	0.005	0.013	0.001	0.003
2024	0.44	1.15	0.70	2.11	0.42	1.11	0.67	2.03	0.005	0.014	0.001	0.003
2025	0.47	1.29	0.75	2.35	0.44	1.22	0.71	2.23	0.006	0.016	0.001	0.004
2026	0.50	1.42	0.79	2.59	0.46	1.33	0.74	2.43	0.006	0.018	0.001	0.004
2027	0.52	1.55	0.83	2.83	0.48	1.43	0.76	2.62	0.006	0.019	0.001	0.004
2028	0.54	1.68	0.86	3.08	0.49	1.54	0.78	2.81	0.007	0.021	0.001	0.005

GHG emission rates and costs for IWT vessels are tabulated in terms of kg and € per ship.km and kg and € per tonne.km for the Baseline and Adapted scenarios.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

GHG costs

Table S13. IWT GHG emission rates (kg/ship.km and kg/tonne.km) and costs (€2021)

	GHG emission rates				GHG emission costs			
	Baseline		Adapted		Baseline		Adapted	
Year	kg/ship.km	kg/tonne.km	kg/ship.km	kg/tonne.km	€/ship.km	€/tonne.km	€/ship.km	€/tonne.km
2021	128.41	0.016	128.41	0.016	13.40	0.002	13.40	0.002
2022	128.41	0.016	126.74	0.015	15.75	0.002	15.55	0.002
2023	128.41	0.016	125.09	0.015	18.10	0.002	17.63	0.002
2024	128.41	0.016	123.47	0.015	20.45	0.002	19.66	0.002
2025	128.41	0.016	121.86	0.015	22.80	0.003	21.64	0.003
2026	128.41	0.016	120.28	0.015	25.15	0.003	23.56	0.003
2027	128.41	0.016	118.72	0.014	27.50	0.003	25.42	0.003
2028	128.41	0.016	117.17	0.014	29.85	0.004	27.23	0.003

A final table presents aggregated GHG costs of road vehicles for use in the assessment of rail and other non-road projects. The costs are shown in terms of €/pax.km and €/ton.km for the price base year and a custom year that can be specified on sheet **L. Fuel consumption**.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

GHG costs

Table S14. Aggregated GHG costs of road vehicles

		Baseline		Adapted	
		2021	2030	2021	2030
Car	€/pax.km	0.010	0.024	0.010	0.018
Bus	€/pax.km	0.004	0.010	0.004	0.008
LGV	€/tonne.km	0.026	0.064	0.026	0.045
HGV	€/tonne.km	0.010	0.025	0.010	0.019

AI.25. Air pollution

An assessment can use either combined local Air Pollution tables or separate PM and NOx tables, but should not use both.

Local air pollution costs in sheet **T. Air pollution** based on the 2019 Handbook on External Costs are presented by passenger kilometre, tonne kilometre and vehicle kilometre by type of vehicle (car, bus, LGV, HGV, train and IWT) and fuel (petrol, diesel and electricity) by year. In years beyond the price base, costs are increased in line with GDP/capita with an elasticity of 0.8 applied. The Handbook does not provide data directly for electric road vehicles but includes data from COPERT that enables an estimate to be made. The 2016 cost of air pollution created by electric cars is about 16.7% that of conventionally fuelled cars, while that of electric LGVs is about 7.8%.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Air pollution costs

Tables

Table T1. Total air pollution costs per passenger kilometre and tonne kilometre, €2021

	€/pax.km							€/tonne.km				
Year	Car (petrol)	Car (diesel)	Car (electric)	Bus (diesel)	Bus (electric)	Train (electric)	Train (diesel)	LGV (petrol)	LGV (diesel)	LGV (electric)	HGV1 (diesel)	HGV2 (diesel)
2021	0.006062	0.010864	0.000706	0.010531	0.000000	0.000106	0.004782	0.078336	0.070428	0.001734	0.010493	0.010493
2022	0.006319	0.011325	0.000736	0.010977	0.000000	0.000111	0.004985	0.081658	0.073414	0.001807	0.010938	0.010938
2023	0.006460	0.011579	0.000753	0.011223	0.000000	0.000113	0.005096	0.083487	0.075058	0.001848	0.011183	0.011183
2024	0.006605	0.011838	0.000770	0.011474	0.000000	0.000116	0.005210	0.085357	0.076740	0.001889	0.011434	0.011434
2025	0.006753	0.012103	0.000787	0.011731	0.000000	0.000118	0.005327	0.087269	0.078459	0.001931	0.011690	0.011690
2026	0.006904	0.012374	0.000804	0.011994	0.000000	0.000121	0.005446	0.089224	0.080216	0.001975	0.011952	0.011952
2027	0.007059	0.012652	0.000823	0.012263	0.000000	0.000124	0.005568	0.091222	0.082013	0.002019	0.012219	0.012219
2028	0.007217	0.012935	0.000841	0.012538	0.000000	0.000127	0.005693	0.093266	0.083850	0.002064	0.012493	0.012493

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

Air pollution costs

Table T2. Total air pollution costs per vehicle kilometre, €2021

	€/veh.km											
Year	Car (petrol)	Car (diesel)	Car (electric)	Bus (diesel)	Bus (electric)	Train (electric)	Train (diesel)	LGV (petrol)	LGV (diesel)	LGV (electric)	HGV1 (diesel)	HGV2 (diesel)
2021	0.010850	0.019447	0.001264	0.210612	0.000000	0.008602	0.386847	0.078336	0.070428	0.001734	0.052467	0.115427
2022	0.011310	0.020272	0.001318	0.219542	0.000000	0.008967	0.403249	0.081658	0.073414	0.001807	0.054691	0.120321
2023	0.011564	0.020726	0.001347	0.224460	0.000000	0.009168	0.412282	0.083487	0.075058	0.001848	0.055916	0.123016
2024	0.011823	0.021190	0.001378	0.229488	0.000000	0.009373	0.421517	0.085357	0.076740	0.001889	0.057169	0.125772
2025	0.012087	0.021665	0.001408	0.234628	0.000000	0.009583	0.430959	0.087269	0.078459	0.001931	0.058450	0.128589
2026	0.012358	0.022150	0.001440	0.239884	0.000000	0.009798	0.440612	0.089224	0.080216	0.001975	0.059759	0.131469
2027	0.012635	0.022647	0.001472	0.245257	0.000000	0.010017	0.450482	0.091222	0.082013	0.002019	0.061097	0.134414
2028	0.012918	0.023154	0.001505	0.250751	0.000000	0.010242	0.460573	0.093266	0.083850	0.002064	0.062466	0.137425

AI.26. PM

An assessment can use either combined local Air Pollution tables or separate PM and NOx tables but should not use both.

PM emissions include both exhaust and non-exhaust PM_{10} emissions. PM_{10} particle mass includes both fine (below 2.5 μm) and course (between 2.5 and 10 μm) fractions of airborne particulate matter.

The formulae for the calculation of exhaust PM emissions are presented in sheet **U. PM** in terms of grams per kilometre by vehicle category for selected years, based on WebTAG. The formulae depend on speed and the user must therefore apply them according to modelled average link speeds. The tables present an indication of the valid speed ranges to which the formulae apply and sample calculations for minimum, user selected average and maximum speeds.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

PM costs

Tables

U1. Exhaust PM emissions parameter values (g/km)

												----- Sample calculations ----- $L = (a + bv + cv^2 + dv^3 + ev^4 + fv^5 + gv^6) / v$		
Vehicle category	Year	a	b	c	d	e	f	g	Min speed km/h	Av speed km/h	Max speed km/h	Min speed g/km	Av speed g/km	Max speed g/km
Car (petrol)	2021	3.49805E-03	7.77435E-04	9.61460E-06	-4.39934E-07	9.00841E-09	-9.01603E-11	3.51205E-13	10	100	130	0.00119	0.00088	0.00170
	2026	2.37907E-03	6.22316E-04	5.75809E-06	-3.38664E-07	6.56547E-09	-6.29354E-11	2.48291E-13	10	100	130	0.00089	0.00059	0.00133
	2031	1.87287E-03	7.30685E-04	4.20501E-06	-3.16769E-07	5.84546E-09	-5.34376E-11	2.11583E-13	10	100	130	0.00093	0.00062	0.00137
	2036	1.46718E-03	7.81656E-04	3.15823E-06	-2.89409E-07	5.15983E-09	-4.54318E-11	1.79833E-13	10	100	130	0.00094	0.00063	0.00135
	2041	1.38804E-03	7.90451E-04	2.98054E-06	-2.84695E-07	5.04002E-09	-4.40038E-11	1.74032E-13	10	100	130	0.00094	0.00064	0.00134
Car (diesel)	2021	1.20402E-02	1.60286E-02	-2.36830E-04	2.22606E-06	-7.84992E-09	4.19675E-11	-9.09955E-14	10	100	130	0.01508	0.01016	0.01432
	2026	1.52400E-02	6.62689E-03	-1.19539E-04	1.61873E-06	-1.32114E-08	7.21654E-11	-1.58695E-13	10	100	130	0.00710	0.00343	0.00425
	2031	1.61263E-02	3.60336E-03	-8.81562E-05	1.54086E-06	-1.55993E-08	8.57796E-11	-1.89442E-13	10	100	130	0.00447	0.00144	0.00150

Values for intermediate years may be interpolated, while values for years beyond 2041 should be held constant.

A separate table presents non-exhaust PM emissions from tyre wear and brake wear by vehicle category and type of road.

RomTAP
v1.0
March 2023
PM costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

U2. Non-exhaust PM emissions (g/km)

Vehicle category	Urban: Tyre wear	Urban: Brake wear	Urban: Total	Rural: Tyre wear	Rural: Brake wear	Rural: Total	Motorway: Tyre wear	Motorway: Brake wear	Motorway: Total
Car	0.00874	0.01168	0.02042	0.00680	0.00553	0.01233	0.00579	0.00136	0.00715
Bus	0.02118	0.05360	0.07478	0.01739	0.02714	0.04453	0.01398	0.00844	0.02242
LGV	0.01380	0.01822	0.03202	0.01074	0.00862	0.01936	0.00915	0.00212	0.01127
HGV1	0.02074	0.05100	0.07174	0.01739	0.02714	0.04453	0.01398	0.00844	0.02242
HGV2	0.04707	0.05100	0.09807	0.03824	0.02714	0.06538	0.03149	0.00844	0.03993

A final table presents the costs that are to be applied per tonne of PM exhaust emissions in metropolitan, urban and rural areas, and PM non-exhaust emissions. It is noted that the metropolitan area applies to cities larger than 0.5 million inhabitants These costs are extracted from the 2019 Handbook on External Costs data annex for Romania, adjusted to the price base. In years beyond the price base, costs are increased in line with GDP/capita with an elasticity of 0.8 applied.

RomTAP
v1.0
March 2023
PM costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

U3. PM costs per tonne, €2021

Year	PM exhaust: Metropolitan	PM exhaust: Urban	PM exhaust: Rural	PM non-exhaust
2021	349,308	113,011	53,937	20,676
2022	364,118	117,803	56,224	21,553
2023	372,275	120,442	57,484	22,035
2024	380,613	123,140	58,771	22,529
2025	389,139	125,898	60,088	23,034
2026	397,856	128,718	61,434	23,550
2027	406,768	131,601	62,810	24,077
2028	415,879	134,549	64,217	24,616

AI.27. NOx

An assessment can use either combined local Air Pollution tables or separate PM and NOx tables but should not use both.

The formulae for the calculation of NOx emissions are presented in the **V. NOx** sheet in terms of grams per kilometre by vehicle category for selected years, based on WebTAG. The formulae depend on speed and the user must therefore apply them according to modelled average link speeds. The tables present an indication of the valid speed ranges to which the formulae apply and sample calculations for minimum, user selected average and maximum speeds.

RomTAP
v1.0
March 2023
NOx costs

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects
Go to Contents

Tables

V1. NOx emissions parameter values (g/km)

Sample calculations: $L = (a + bv + cv^2 + dv^3 + ev^4 + fv^5 + gv^6) / v$

Vehicle category	Year	a	b	c	d	e	f	g	Min speed km/h	Av speed km/h	Max speed km/h	Sample calculations: Min speed g/km	Sample calculations: Av speed g/km	Sample calculations: Max speed g/km
Car (petrol)	2021	-2.75193E-02	1.33465E-01	-1.22195E-03	-1.06496E-05	4.74778E-07	-4.36986E-09	1.40097E-11	10	100	130	0.11786	0.08239	0.10960
	2026	1.44527E-02	9.30617E-02	-1.22404E-03	1.02637E-05	2.53074E-09	-4.06549E-10	1.71088E-12	10	100	130	0.08329	0.05242	0.06047
	2031	1.90129E-02	8.71269E-02	-1.27847E-03	1.71942E-05	-1.28595E-07	5.94541E-10	-1.16260E-12	10	100	130	0.07784	0.05064	0.05577
	2036	1.65523E-02	8.80483E-02	-1.30898E-03	1.81086E-05	-1.42748E-07	6.92865E-10	-1.42287E-12	10	100	130	0.07829	0.05071	0.05549
	2041	1.58203E-02	8.83983E-02	-1.31651E-03	1.81986E-05	-1.43564E-07	6.97134E-10	-1.43228E-12	10	100	130	0.07850	0.05072	0.05545
Car (diesel)	2021	1.84399E+00	9.33174E-01	-1.40679E-02	9.53669E-05	4.88229E-07	-8.14384E-09	3.94983E-11	10	100	130	0.98684	0.56732	0.94345
	2026	1.44917E+00	7.23815E-01	-1.06833E-02	7.47048E-05	2.44334E-07	-4.94166E-09	2.60799E-11	10	100	130	0.76957	0.42799	0.70238
	2031	1.05910E+00	4.80768E-01	-6.91526E-03	4.86027E-05	1.55917E-07	-3.39185E-09	1.83340E-11	10	100	130	0.52251	0.28593	0.46585

Values for intermediate years may be interpolated, while values for years beyond 2041 should be held constant.

A second table presents the costs that are to be applied per tonne of NOx emission in urban and rural areas. These costs are extracted from the 2019 Handbook on External Costs data annex for Romania, adjusted to the price base. In years beyond the price base, costs are increased in line with GDP/capita with an elasticity of 0.8 applied.

RomTAP
v1.0
March 2023

Romania Transport Appraisal Parameters
A database of parameter values for use in the appraisal of transport projects

Go to Contents

NOx costs

V2. NOx costs per tonne, €2021

	---------- NOx ----------	
Year	**Urban**	**Rural**
2021	24,914	14,383
2022	25,970	14,993
2023	26,552	15,329
2024	27,147	15,672
2025	27,755	16,023
2026	28,376	16,382
2027	29,012	16,749
2028	29,662	17,124

ANNEX II. FINANCIAL ANALYSIS

The aim of financial analysis is to assess whether the proposed project needs co-financing from EU funds. If so, the analysis then determines the co-financing contribution and checks whether the EU support is appropriate, whether the proposed project investment option is financially sustainable during the construction and operation phases, and/or whether there are adequate commitments to ensure its sustainability.

In practice, it means that the financial analysis should answer the following questions:

- What is the project financial profitability?
- What will be the EU contribution?
- How will the project be financed?
- What is the national capital profitability?
- Will the project be financially sustainable?

Taking into consideration the above, the following sequence of steps is recommended:

- Setting assumptions for the analysis;
- Determination of all cash flows for each year of analysis (calculation of project financial inflows and outflows);
- Calculation of financial indicators for the entire investment (C) (net present value – FNPV(C) and profitability or rate of return – FRR (C));
- Calculation of co-financing contribution from EU funds;
- Calculation of financial indicators for the national capital (K) (net present value – FNPV(K) and profitability or rate of return – FRR(K)). For most projects (C) and (K) calculations are not required (see Table 4.2);
- Verification of the project financial sustainability.

AII.1. Assumptions and parameters

The following assumptions and parameters will be considered and presented in the financial analysis:

- The financial analysis will be carried out using the Discounted Cash Flow (DCF) method. An appropriate Financial Discount Rate (FDR) is adopted to calculate the present value of the future cash flows. The financial discount rate reflects the opportunity cost of capital. For the 2021-2027 programming period, the same FDR considered for the 2014-2020 programming period, respectively 4%, is to be used for transport sector projects in Romania.
- Only cash inflows and outflows are considered in the analysis. Depreciation, reserves, price and technical contingencies, and other accounting items which do not correspond to actual flows are disregarded.
- As a general rule, the financial analysis should be carried out from the point of view of the infrastructure owner. If, in the provision of a general interest service, the owner and operator are not the same entity, a consolidated financial analysis, which excludes the cash flows between the owner and the operator, should be carried out to assess the actual profitability of the investment.
- The financial analysis will be carried out considering the same appraisal period as the one in the economic analysis (see section 4.5.1 for details), and it should be clearly indicated.
- The financial analysis will be carried out in constant prices considering the same price base year as the one in the economic analysis (see section 4.5.3 for details), and it should be clearly indicated.
- The analysis should be carried out net of VAT, both on purchase (cost) and sales (revenues), if it is recoverable by the project promoter. If it is not the case, the VAT should be included.

- Direct taxes (on capital, income or other) are to be considered only for the financial sustainability verification and not for the calculation of the financial profitability, which is calculated before such tax deductions.
- All other input data and assumptions for the analysis must be coherent with the economic analysis data and transport forecasts (in particular, traffic forecast).

The structure of the financial analysis and the elements to be included are presented in the figure and table below, sourced directly from the 2014 CBA Guide:

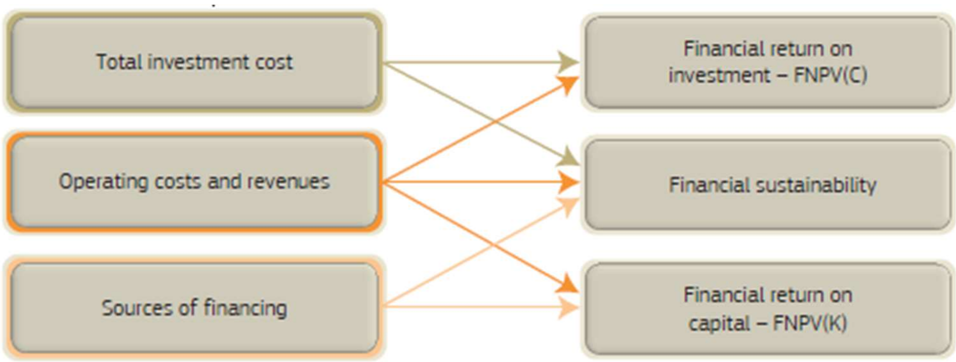


Figure AII.1. Structure of the financial analysis

Source: 2014 CBA Guide

Table AII.1. Elements to be included in the financial analysis

	FNPV(C)	SUSTAINABILITY	FNPV(K)
Investment costs			
Start-up and technical costs	-	-	
Land	-	-	
Buildings	-	-	
Equipment	-	-	
Machinery	-	-	
Replacement costs	-	-	-*
Residual value	+		+
Operating costs			
Personnel	-	-	-
Energy	-	-	-
General expenditure	-	-	-
Intermediate services	-	-	-
Raw materials	-	-	-
Other outflows			
Loan repayments		-	-
Interests		-	-
Taxes		-	
Inflows			
Revenues	+	+	+
Operating subsidies		+	
Sources of financing			
Union assistance		+	
Public contribution		+	-**
Private equity		+	-
Private loan		+	

* *Only if they are self-financed by the project revenues. Otherwise, if new sources of financing (either equity or debt) are needed to sustain them, these sources must be displayed within the outflows at the time they are disbursed.*
** *Operating subsidies shall not be accounted in order to avoid double counting with the operating costs outflow.*

Source: 2014 CBA Guide

AII.2. Financial cash flows

The financial analysis considers the financial flows of the project during construction and during operation. Financial flows should be determined for the WOP and WP scenarios for the purpose of further calculation of incremental flows used in the calculation of financial indicators and specification of the amount of the financial contribution from EU funds.

The cash flows to be included in the financial analysis are:

- Investment costs
- Operation and maintenance costs
- Revenues
- Residual value
- Source of financing.

The elements which constitute the investment and O&M costs are the same as the ones considered in the economic analysis (see sections 4.7.3 and 4.7.4), only that financial flows will be considered. The residual value can be calculated using either the net present value of the cash flows over the remaining lifetime of the project beyond the end of the reference period, or the depreciation method (see section 4.7.4).

Project revenues

The project revenues are defined as the '*cash in-flows directly paid by users for the goods or services provided by the operation, such as charges borne directly by users for the use of infrastructure, sale or rent of land or buildings, or payments for services*'.

Project revenues should include all revenues from all sources such as:

- Road tolls;
- Concessionaire payments, for example for the operation of road service areas;
- Rail track access charges;
- Ticket fares e.g., for public transport modes, where applicable.

Transfers or subsidies (e.g., transfers from state or regional budgets) and other financial income must not be considered revenues and included in the financial analysis as they are not directly attributable to the project operations. However, they should be included in the sustainability analysis.

Sources of financing

The main sources of financing in the EU co-financed context can be:

- Union assistance;
- national public contribution (including, always, the counterpart funding from the OP plus additional grants or capital subsidies at central, regional or local government level, if any);
- project promoter's contribution (loans or equity), if any;
- private contribution (e.g., under a PPP, (equity and loans)), if any.

AII.3. Project financial profitability

Generally, the calculation of the financial indicators on entire investment and national capital is not required (see Table 4.2). However, in case there is a specific need for these indicators to be calculated on a particular project, the instructions below apply.

This point of the analysis involves calculation of financial indicators for the project, based on which the profitability assessment is performed. Two basic groups of indicators are distinguished:

- Profitability indicators for the entire investment (project costs) – the so-called (C) indicators.
- Profitability indicators for the national capital – (K) indicators.

Financial indicators are calculated in the same way as economic indicators but using the financial cash flows. They include:

- Net present value (FNPV) which is the sum of the discounted financial flows of the project.
- Internal rate of return (FRR), defined as the discount rate that results in an FNPV equal to zero.

Details on the elements to be included in the calculations of the financial indicators for both the entire investment (C) and national capital (K) are provided in Table AII.1 above.

Firstly, a consolidated analysis should be carried out to calculate the overall investment profitability. For a project to require contribution from EU Funds, the FNPV (C) should be negative and the FRR(C) should be lower than the financial discount rate used in the analysis. If a project has high financial profitability (e.g., the FRR(C) is significantly higher than the FDR), the investor can implement the project without EU support. Generally, transport projects are non net-revenue generating projects and therefore the FRR(C) will be negative.

Sample calculations of the profitability indicators for the entire investment are presented in the table below, sourced directly from the 2014 CBA Guide.

Table AII.2. Sample calculations of FNPV (C) and FRR (C)

	Years							
	1	2	3	4	5-9	10	11-29	30
Total revenues				11,598	...	12,011	...	12,222
Residual value								4,265
Total inflows	**0**	**0**	**0**	**11,598**	**...**	**12,011**	**...**	**16,487**
Total operating costs				5,561	...	5,662	...	5,713
Initial Investment	8,465	75,176	42,890					
Replacement costs						11,890	9,760	
Total outflows	**8,465**	**75,176**	**42,890**	**5,561**	**...**	**17,552**	**...**	**5,713**
Net cash flow	**-8,465**	**-75,176**	**-42,890**	**6,037**	**...**	**-5,540**	**...**	**10,774**
FNPV(C)				**- 34.284**				
FRR(C)				**1.4%**				

A financial discount rate of 4 % has been applied to calculate this value.

Source: 2014 CBA Guide

Secondly, to check that any profit generated by EU support is not unduly high, the return on capital is calculated as well.

Sample calculations of the profitability indicators for the national capital are presented in the table below, sourced directly from the 2014 CBA Guide.

Table AII.3. Sample calculations of FNPV (K) and FRR (K)

	Years							
	1	2	3	4	5-9	10	11-29	30
Total revenues				11,598	...	12,011	...	12,222
Residual value								4,265
Total inflows	**0**	**0**	**0**	**11,598**	**...**	**12,011**	**...**	**16,487**
Public contribution	3,148	27,956	15,950					
Private equity	1,085	9,632	5,495					
Loan repayment (including interest)					1,789	1,789	1,789	
Total operating & replacement costs				5,561	...	17,552	...	5,713
Total outflows	**4,233**	**37,588**	**21,445**	**5,561**	**...**	**19,341**	**...**	**5,713**
Net cash flow	**-4,233**	**-37,588**	**-21,445**	**6,037**	**...**	**-7,329**	**...**	**10,774**
FNPV(K)	**11,198**							
FRR(K)	**5.4 %**							

The loan is here an outflow and is only included when reimbursed. In this example, it is assumed to be paid back in ten constant payments starting in year 5.

In this example, replacement costs are self-financed with the project revenues. Accordingly, they are treated as operating costs.

Source: 2014 CBA Guide

AII.4. Funding gap calculation

The funding gap is to be calculated in the same manner as for the 2014-2020 programming period. The steps are shown in the table below. We note that the majority of transport projects are non net-revenue generating projects, and therefore for subsectors which are not revenue generating (e.g., untolled roads), the funding gap calculation is not required and is set to 100%. All transport projects that are revenue generating require a funding gap calculation.

Table AII.4. Funding gap calculation

	Main elements and parameters	**Value**	
1	Reference period (years)		
2	Financial discount rate (%)[(1)]		
	Main elements and parameters	**Value Not discounted**	**Value Discounted (Net Present Value)**
3	Total investment cost excluding contingencies		
4	Residual value		
5	Revenues		
6	Operating and replacement costs		
	Pro-rata application of discounted net revenue[(2)]		
7	Net revenue = revenues – operating and replacement costs + residual value = (5) – (6) + (4)		
8	Total investment cost – net revenue = (3) – (7)		
9	Pro-rata application of discounted net revenue (%) = (8) / (3)		

* Where VAT is recoverable, the costs and revenues should be based on figures excluding VAT.
[(1)] Preferably in real terms.
[(2)] This does not apply: 1) for projects subject to the rules on State aids in the meaning of Article 107 of the Treaty (see point G1); and 2) if the sum of the present values of operating and replacement costs are higher than the present value of revenues the project is not considered as revenue generating, in which case items 7 and 8 can be ignored and pro-rata application of discounted net revenue should be set at 100%.

Source: Table E.1.2 Main elements and parameter used in the CBA for the financial Analysis; Annex II. Commission Implementing Regulation (EU) 2015/207

AII.5. Financial sustainability of the project

The project is financially sustainable if there are sufficient funds to cover the expenses during the construction stage and the operation stage. The aim of the financial sustainability check is to demonstrate that the project beneficiary will be able to bear all financial expenditures required to maintain the operational services throughout the reference period. All costs need to be included, such as routine O&M costs and rehabilitation costs.

A project beneficiary must prove or show clear commitment that it has sufficient financial resources that will consistently match disbursements in the years to come to ensure an adequate level of service of the infrastructure. Revenues must be sufficient to cover O&M expenditures or supplemented with operational subsidies. Cumulated undiscounted net cash flows must be non-negative for all years of the reference period. In the case of non-revenue generating projects, it must be indicated how costs will be covered with a clear commitment of the beneficiary/operator to provide adequate funding from other sources to ensure the sustainability of the project.

Details on the elements to be included in the financial sustainability analysis are provided in table AII.1 above.

Sample calculations performed for the financial sustainability analysis are presented in the table below, sourced directly from the 2014 CBA Guide.

Table AII.5. Sample calculations for the financial sustainability analysis

	Years							
	1	2	3	4	5-9	10	11-29	30
Sources of financing	8,465	75,176	42,890					
Total revenues				11,598	...	12,011	...	12,222
Total inflows	**8,465**	**75,176**	**42,890**	**11,598**	...	**12,011**	...	**12,222**
Initial investment	8,465	75,176	42,890					
Replacement costs						11,890	9,760	
Loan repayment (including interest)					1,789	1,789	1,789	
Total operating costs				5,561	...	5,662	...	5,713
Taxes				604	...	-733	...	651
Total outflows	**8,465**	**75,176**	**42,890**	**5,561**	...	19,341		**5,713**
Net cash flow	**0**	**0**	**0**	**6,037**	...	**-7,329**	...	**6,509**
Cumulated net cash flow	**0**	**0**	**0**	**6,037**	...	**20,726**	...	**133,835**

The cumulated cash flow should be zero (or positive) during the construction phase

Financial sustainability is verified if the cumulated net cash flow row is greater than zero for all the years considered.

Source: 2014 CBA Guide

ANNEX III. PROJECT COMPLETION REPORT

The MA requires that a Project Completion Report (PCR) is undertaken for selected projects. The PCR should be a brief document (ca. 10 pages) and be completed about 1 year after the opening of the project.

The main aims of the Project Completion Report are:

(i) to understand whether the basis on which the project was approved proved correct;
(ii) to check whether the expected benefits materialised; and
(iii) to see what lessons, if any, may be drawn which may be applicable to other projects under development.

The PCR should contain the following sections:

(i) **Project concept.** This should review the development of the project concept, what was the need for the project, what objectives were set for it, whether it was included in relevant transport programmes/masterplans or operational programmes. It should conclude whether the project was correctly established and whether the project objectives were clearly stated.

(ii) **Project development.** The PCR should critically review the project development stages, commenting on the appropriateness of e.g., demand analysis, options analysis, financial analysis, economic analysis, risk analysis, selected design.

(iii) **Project Implementation.** The PCR should discuss whether: the management of the project during implementation was of good quality; the required periodic monitoring reports were timely and of good quality; any issues relating to quality of completed works were noted; the project outturn costs met the costs outlined at design stage; and whether there were any slippages to schedule. The PCR should discuss changes to the project during implementation; the extent to which such changes affected time or budget; whether variations to contract could have been anticipated in advance; whether active value for money management was evident during construction phase. The PCR may also discuss whether there were any design changes during implementation, whether all contractual obligations were met and whether there were any contractual claims made / outstanding.

(iv) **Post-opening performance**. This section of the PCR should review whether the listed project objectives were met, whether forecast traffic volumes were achieved (if not detailing what went wrong and any lessons to be learnt for appraisal of similar projects going forward). The section may also comment on whether there have been any safety issues in early operational stage (and if so, what is being done to correct them), and detail any actions needed to ensure that forecasted benefits materialise.