ČESKÉ PRIORITY

Czech Priorities: Guide to Cost-Benefit Analysis

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List of Abbreviations

BCA	Benefit-Cost Analysis (equivalent to CBA)
BCR	Benefits to Costs Ratio (also known as Cost-benefit ratio)
CBA	Cost-Benefit Analysis (equivalent to BCA)
CEA	Cost-effectiveness Analysis
CP	Czech Priorities (the Czech Priorities project)
CZK	Czech Crowns
ČR	Czech Republic
DALY	Disability-Adjusted Life Year
EC	European Commission
ERR	Economic Rate of Return
EU	European Union
EUR	Euro
GE	General Equilibrium
IMF	International Monetary Fund
MCA	Multi Criteria Analysis
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
QALY	Quality-adjusted Life Years
SROI	Social Return on Investment
USD	United States Dollar
VAT	Value Added Tax
VSL	Value of a Statistical Life
WTP	Willingness-To-Pay
YLD	Years Lost Due to Disability
YLL	Years of Life Lost

1. Preface

Present guide to Cost-benefit analysis (CBA)[1] aims to provide researchers with a basic overview of CBA procedure together with practical guidance, principles and rules for evaluations within the Czech Priorities (CP) project. Our approach, which is regarded as the Social CBA, consists of assessing a broad range of possible impacts and includes all stakeholders.

There is an extensive literature dealing with the details of CBA. Therefore, the objective of this document is not to cover all aspects of CBA in detail. Rather, it offers a general framework, providing guidance, and where necessary, rules, specifically for CP projects. Should researchers need more details about any aspect of CBA, they should consult the existing academic literature or one of the many institutional CBA manuals. Reference to the most important sources can be found in the overview of CBA-related literature in Chapter 2 and the recommended reading list in Appendix B. This guide (especially Appendix C) can serve as a checklist for the steps and results that should be implemented and presented in a final report to CP on a project.

The objective of establishing a common approach, rules and assumptions that will be required for all analyses within the Czech Priorities project is ensuring a common standard of the depth, scope and quality of CP appraisals and the comparability of the results of all analyses performed within the CP project.

CP also puts great emphasis on the replicability of results. All the data, formulas, methods, and sources used must be made available in order to enable verification of results and testing the dependence of results on input parameters.

Cost-benefit analysis is one of the most powerful methods for evaluation of the impact of projects. It has great informational value for decision makers. Its main goal is to convert a complex set of impacts into a single monetary value that represents the overall impact of an intervention on the economic, financial, social and environmental welfare of the population.

[1] The term Benefit-cost analysis is preferred in USA.

The challenging task of monetizing impacts that are sometimes very hard to monetize requires an extremely rigorous approach if the results are to be taken seriously and serve as a useful tool for decision makers. This guide provides guidance on how to identify all relevant impacts and stakeholders of an evaluated intervention, how to monetize those impacts, how to evaluate the robustness of the results, and how to deal with uncertainty about individual parameters. In the context of CBA and this guide, the relevant population is divided into three groups:

- The targeted population, which is limited to the parties intended to be affected by an intervention.
- The affected population are those affected by the intervention (they bear costs or receive benefits) whether or not intended.
- Stakeholders is the widest group. They may include people who are not affected by the intervention but care about the results, such as politicians or members of advocacy groups, as well as those who are affected.

These first two categories of stakeholders (the targeted and affected population) are roughly reflected in the division of impacts into those that are direct, which are the intended impacts on the target population, and those that are indirect, which are byproducts of an intervention and may affect a larger population.

In order to achieve comparability despite the varying sizes of different projects, the results of a CBA will be expressed in a Benefits to Costs Ratio (BCR). In addition, the monetary expression of impacts will be complemented by the quantification of those impacts that in the end were too difficult to monetize, and a description of non-quantifiable impacts and the distributional effects of the intervention.

This guide is structured as follows: Chapter 2 provides an overview of the most relevant literature regarding cost benefit analysis and presents alternative approaches to CBA. Chapter 3 outlines the structure of CBA. Chapter 4 emphasizes the need for understanding the underlying problem and precisely defining an intervention. In Chapter 5, we give an extended classification and logical structure for impacts. Chapter 6 is the core of this guide and contains rules and guidance for the process of assigning monetary values to impacts of the intervention. In Chapter 7, we delineate the process of calculating final monetized impacts, as well as for presenting quantified and non-quantified impacts. In the final Chapter 8, we present risk analysis and other robustness checks.

Appendix A: General Assumptions contains the values and links that are to be used by researchers as their primary sources. These include monetary values for health impacts, environmental impacts, the value of time, and macroeconomic and demographic forecasts. A downloadable price converter for convenient transformation of historic prices in Czech Crowns, Euro and dollars to the current rates for the Czech Crown accompanies the appendix. Appendix B provides a bibliography of important resources on the methodology of CBA, with comments thereon, and an extensive list of examples of high-quality CBAs. The procedures and formal requirements that researchers must abide by are described in Appendix C.

2. The Literature of Cost-Benefit Analysis

This chapter presents the key sources in the literature that were used in writing this CBA guide for the Czech Priorities project. We believe that the sources we used are the most relevant works explaining CBA available, although there are a number of other valuable resources. There is a list of recommended literature with short summaries in Appendix B of this document. We use cost-benefit analysis for the CP project because its methodology is well developed and is widely used. However, CBA is not the only available impact assessment method. Alternative approaches are presented in Appendix D.

This guide relies heavily for its theoretical basis on the seminal textbook *Cost-benefit Analysis: Concepts and Practice* by Boardman et al. (2017), which explains all the key theoretical concepts of CBA and a wide variety of valuation methods. It also provides practical examples. A more technical and detailed resource, which emphasizes valuation methods based on stated and revealed preferences, is *Cost–Benefit Analysis (Elements in Public Economics)* by Johansson and Kriström (2018).

There are a number of practical manuals on the implementation of CBA. We used many of them and have adopted their approaches for this CP guide. Those sources are primarily guides used by various influential institutions for evaluation of large investments in social infrastructure. The guides most often cited in this guide include the following publications:

The European Commission's *Guide to Cost Benefit Analysis of Investment Projects* (European Commission, 2014),[2] which serves as an economic appraisal tool for large EU cohesion policy projects for the period 2014-2020, was one of the main sources we used when creating this guide. A second, more general EU source, from which we adopted the classification of intervention impacts and used for other purposes, is *Assessing the Costs and Benefits of Regulation* (Renda, Schrefler, Luchetta, & Zavatta, 2013).

National guides for general appraisals, which cover many areas addressed by this guide, include *The UK Central Government Guidance on Appraisal and Evaluation*, known as *The Green Book*, (HM Treasury, 2018) and its supplementary guides,[3] the widely recognized *Benefit-cost Model* by the Washington State Institute for Public Policy [WSIPP] (2018), and guides issued by the New Zealand Treasury (2015) and New Zealand Transport Agency (2018). All of these guides are binding methodological documents for their respective governments. Their objective is ensuring high-quality economic evaluation of proposed government policies and interventions. The CP project shares that objective. Methodologies used by geographically closer entities, which we took into account when we created this guide, are the *Public Investment Project Assessment Framework* (ÚPVII SR, 2017) and the *Methodology Handbook for CBA* (MDV SR, 2018) used by the *Value for Money* project of the Ministry of Finance of the Slovak Republic

[2] Hereinafter cited as EC (2014).
[3] These guides cover a wide range of topics including risk, optimism bias and local partnerships. Links to all guides are provided in Appendix B.

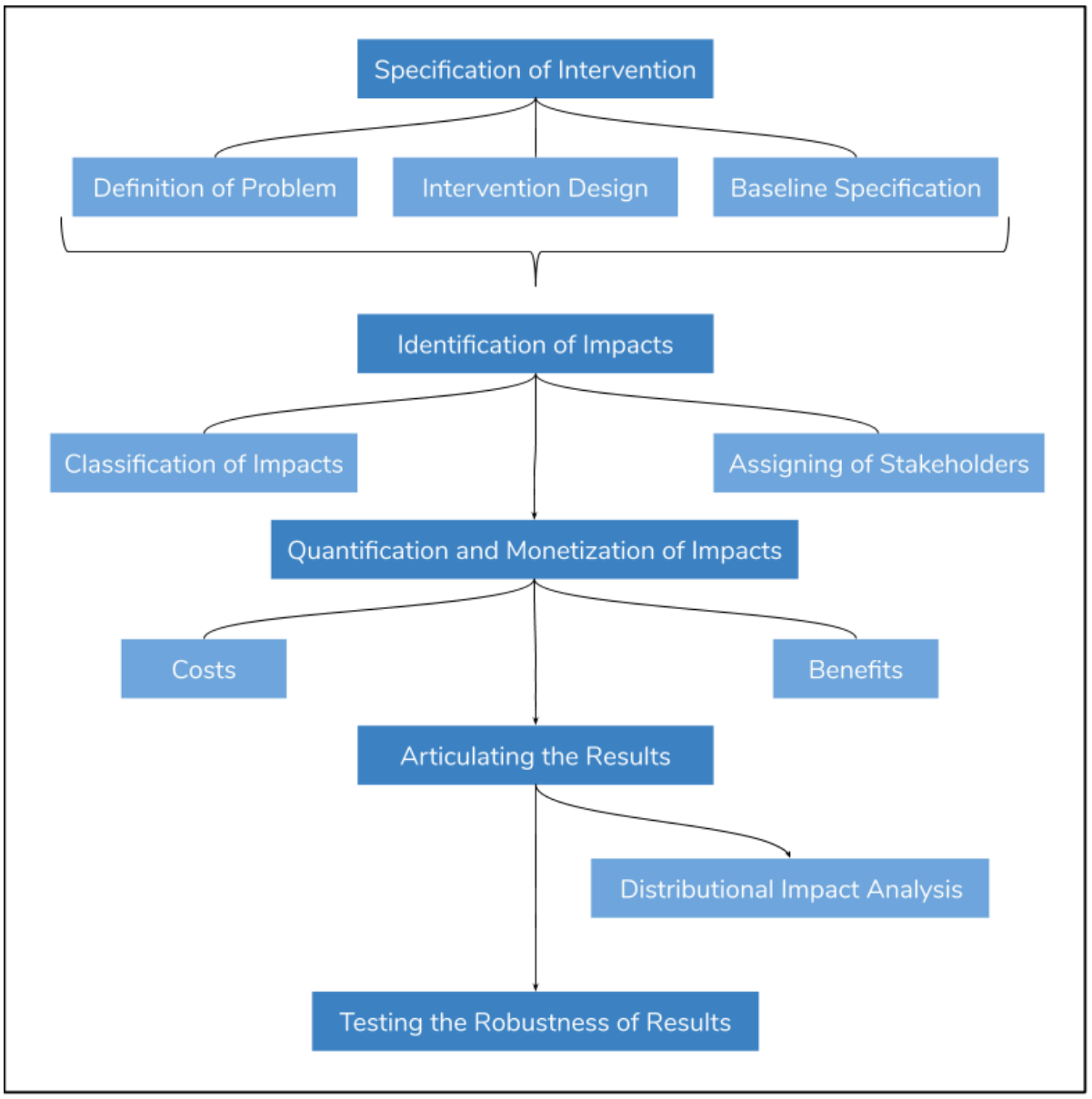
Other guides cover evaluation techniques for just one sector, like guides for transport infrastructure appraisals (for example the New Zealand Transport Agency guidebook (2018)), or the health sector (for example *Methods for the Economic Evaluation of Health Care Programmes* by Drummond, Sculpher, Claxton, Stoddart & Torrance (2015), and *Valuing Health for Regulatory Cost-Effectiveness Analysis* by Institute of Medicine (2006).

In many cases, this CP guide offers only a framework of specific steps for cost-benefit analysis and we strongly encourage researchers to consult as necessary the more detailed and in-depth explanations in the sources referenced in the text and other sector-specific publications.

3. Steps for CBA

The structure of this guide follows the steps for cost-benefit analysis as displayed in the chart below.

Chart 1: The steps of CBA



Source: Czech Priorities

It is useful to think of progress through the individual stages of analysis not as a linear path but rather a circular movement, where one returns to previous steps whenever there is a need to redefine the scope of impacts or stakeholders. Each chapter in the following text addresses one stage of CBA as depicted above.

4. Specification of the Intervention

This chapter presents a framework for defining the problem that is to be solved by the evaluated intervention and the objectives of the intervention. This knowledge is then used for the designing of the intervention. The importance of the baseline scenario is emphasized.

4.1 Definition of the Problem and the Objectives of an Intervention

The starting point of every evaluation is identifying the problem that is meant to be solved by a public intervention. Identification of the problem enables us to define measurable objectives, in order to show the extent that a given intervention contributes to solving the problem.

Every public policy or intervention should be proposed with some declared objectives aimed at solving a particular problem. However, an intervention can have many other impacts (e.g., influencing other stakeholders or other variables) besides its impact on the dependent variables that are associated with its objectives. The analysis should provide an assessment of whether the declared objectives of the intervention are likely to be achieved, but also identify all other potential impacts of the intervention.

In order to investigate the extent to which objectives will be achieved, SMART (Specific, Measurable, Achievable, Realistic, Time-limited) indicators of fulfilment of the objective should be established.

An important part of identifying the problem is a description of the current state of affairs, including potential deficiencies of existing public infrastructure. The description of the current state of affairs should capture the social, political, legal, institutional, historical and economic context of the problem to be solved. This background information should make a clear case for public intervention and offer reasons why the intervention or set of interventions under consideration is the most relevant to the problem. An overview of international experience and lessons learned with regard to similar problems should always be part of this background information.

4.2 Designing the Intervention

The interventions to be analyzed in the CP project will be selected and defined by a panel of economists and Czech Priorities experts.

In some cases, several alternative interventions aimed at solving a particular problem will be analyzed and compared in order to identify the intervention that has the highest value for money expended and to rank the alternatives to it.[4] Alternative interventions should be selected based on existing research and experience, input from sectoral experts,[5] and even public comments.

There are likely to be significant differences among the interventions proposed for evaluation in terms of the level of detail with which they can be described. Some of them may already exist as draft legislation that defines many of their particularities, while others may only be more or less general ideas.

In order to perform CBA, a great level of detail is needed in the definition of the intervention. Researchers, together with a panel of experts and CP economists should fine-tune the intervention (make assumptions about its parameters). The parameters of the intervention should be defined in a way that best achieves its objectives, considering the likelihood of political support, the availability of data and the quality of previous research. All assumptions that are made must be stated clearly and explicitly.

Apart from analyzing a set of alternative interventions, it is sometimes reasonable to analyze several variants of the same intervention. (By alternatives, we mean different measures to achieve the same objectives. By variants, we mean one intervention with different parameters of implementation.[6]) When it appears reasonable to evaluate several variants of the same intervention (because they are not all equally realistic, there are large differences in expected BCR, they lack political support, or for some other reason), researchers are encouraged to consult with a CP economist.

If a previously approved design of an intervention (or one that is close to being approved) exists, it should always be included in the set of interventions to be evaluated. The impact of the approved intervention will be compared to other potential interventions aimed at solving the same problem.

[4] It is worth noting that comparing BCRs of interventions solving a slightly different problem in the same area is a relevant tool for effective use of public money.
[5] Appendix B contains a section on expert elicitation literature, namely O'Hagan, Buck, Daneshkhah, Eiser, et al. (2006).
[6] One example is analysis of potential solutions to the problem of ensuring a certain minimum standard of living for the entire population. A set of alternative solutions might include implementation of a minimum wage or a universal basic income. Variants of the universal basic income alternative would include a basic income in several different amounts.

4.3 The Baseline Scenario

The impacts of evaluated interventions will be compared to a baseline scenario.[7] This step is crucial because we are interested in the impact of the intervention—that is, the difference between a future without the intervention (known as the baseline or sometimes null variant) and the future once the intervention has been implemented.[8] A dynamic baseline is a "dynamic, forward-looking scenario that includes the likely evolution of the policy problem absent the intervention" (Renda et al., 2013, p. 197). In other words, it means continuing business as usual plus foreseeable future developments without the intervention. When choosing between a dynamic baseline and using a static status quo as a baseline,[9] the researcher must consider the inverse relationship between future uncertainty and the precision of information of the results. The baseline scenario should include only the most likely changes in the future, such as implementation of EU legislation that has already been approved.[10] At the national level, it is important to consider whether proposed legislation has secured funding for its aims. Only then should it be added to the mix of the baseline scenario. The baseline must include expected changes in the population and the economic level of development as stated in Appendix A.

Should a situation arise where the expected changes in the environment (legal, institutional, etc.) included in the baseline scenario cause a significant change in the evaluation of the intervention, at least two variants of the baseline scenario (with and without the changes in the environment) must be evaluated and included in the results.

The final design of an intervention or a set of interventions and the baseline scenario or scenarios to which it will be compared must be consulted with a CP economist before starting the analysis itself.

[7] Note that unless the intervention offers a better results than the baseline, it is not to be recommended. Possible market solutions and self-regulation are not to be overlooked.
[8] A situation can occur where the marginal change in costs caused by an intervention cannot be directly assessed. Such a situation requires calculating two cost figures, one of which is the cost of delivering services without any intervention and one of which is the cost of delivering services with the proposed intervention.
[9] Using the status quo as a baseline is rarely acceptable unless the intervention has a very short lifespan.
[10] The website of the EU Directorate General for Communication, found at https://ec.europa.eu/info/departments/communication_en can be very useful.

5. Identification of Impacts

CBA evaluates the impacts of an intervention on all affected members of a society over the longest reasonable time period. Apart from taking into account the financial aspects of an intervention, including its budgetary and overall economic impact, it attempts to monetize as many other impacts of the intervention as possible, including its social, environmental and health impacts. If impacts cannot be monetized, they are evaluated by their quantified impact on indicators of quality of life or described qualitatively.

Researchers need to keep in mind the difference between cause and correlation. The identification of a causal relationship between an intervention and its impact is essential. All the impacts (costs and benefits) of an intervention must be evaluated with respect to the baseline scenario. It is crucial to use the same baseline throughout the analysis.

To capture the full range of impacts of an intervention, as well as to estimate a realistic timeline for its implementation, it is useful to break the intervention down into specific actions and phases.

The costs of the political decision-making process should be ignored in the analysis. This is because the marginal cost of a single additional decision is small and not feasible to measure.

Deadweight loss from taxation is generally ignored in analyses performed by EU countries and the CP project will do the same.[11]

5.1 Sources on the Impacts Identification

When identifying the whole range of possible impacts of an intervention, it is crucial to conduct a proper literature review and make sure that no possible impact is missing from the analysis. The impacts must be analyzed in light of pre-existing knowledge. It is important not only to discover whether there are any cost-benefit analyses already written on the subject that map potential impacts related to the specific field of intervention. Both ex-ante and ex-post evaluations are useful sources. A separate literature review should be done for each impact considered.[12]

[11] In guides from countries like the USA and New Zealand, the costs are increased by as much as 25% (New Zealand Treasury, 2015, p.15) to compensate for the loss of utility caused by the taxes that change consumers behavior from the most preferred one.
[12] While all impacts are to be identified not all deserve the same attention. See Robinson et al. (2019, p.17) for the systematic approach to screening analysis as a tool to select the most relevant impacts to focus on.

Sources for the identification of impacts include:

- Existing CBA literature (many general and sector-specific sources are provided in Appendix B)
- Academic databases of existing impact evaluations (JSTOR, Web of Science, Google Scholar, etc.). See Kugley et al. (2017) for more sources with links sorted by topic (specifically Appendices I & II.).
- Impact assessment studies by the European Commission and other EU or international institutions.
- Research center reports (such as J-Pal, Campbell Collaboration or Cochrane Collaboration, Edu End Foundation, What Works)
- Meetings (roundtables) with professionals in the specific field and stakeholders.[13]
- Meetings with stakeholders.[14]

5.2 Classification of Impacts

The reason for classifying impacts is to minimize the chances of omitting an important impact from the analysis. It increases the clarity of the study and helps to avoid double counting of the same impact. The impacts of interventions can be classified along several dimensions. The primary classification for CP projects will be by sectors, that is, assigning each impact to the area it influences. Such sectors or areas of classification can include:

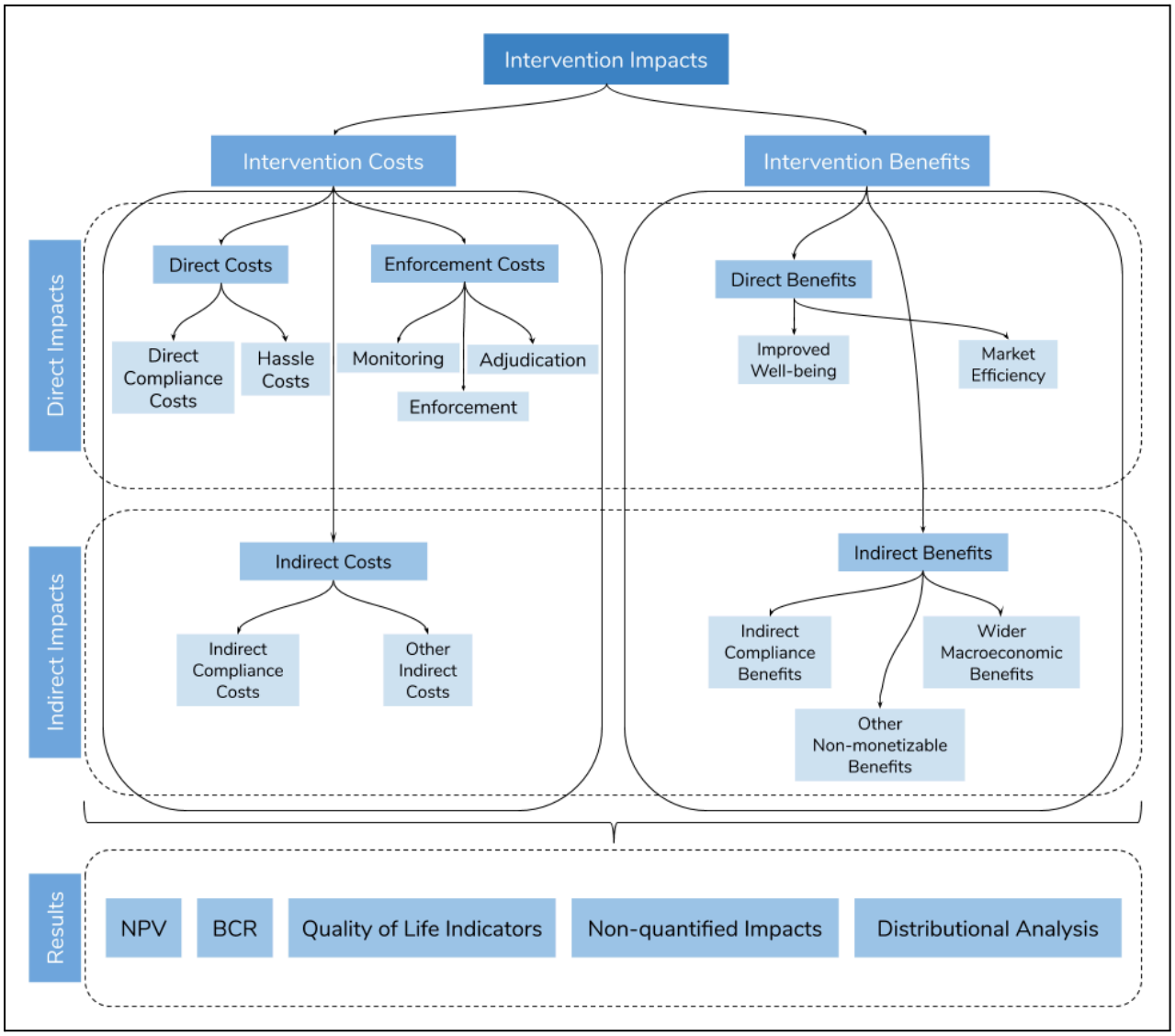
a. Financial revenue and expenditures by the body of government involved (including central, regional and local governmental spending, tax revenues, customs duties, fees for services offered in the intervention)
b. Impacts on the health and wellbeing of the population
c. Impacts on the earnings of the population
d. Impacts on the environment
e. Impacts on the business environment (innovation, infrastructure, startup requirements for new businesses, employment impacts, costs of labor)
f. Impacts on the educational level of the population
g. Impacts on civil society (regeneration of settlements, security, corruption)
h. Inclusion of socially excluded groups of the population and income distribution impacts
i. Impacts on the crime rate
j. Housing
k. Other

This classification by sector will also be used when evaluating impacts on stakeholders. We provide a template with a matrix of impacts classified by sector and the stakeholders they affect.

[13] Czech document from Úřad vlády České republiky (2017, p.35-36) describes the step of the process of communication with stakeholders as they were suggested by OECD.
[14] It is important to include all stakeholders. Repeated meetings are is sometimes necessary for better understanding of the motivation of the stakeholders. It is wise to remember that each stakeholder party is pursuing their own interests and interpret their claims through this optics.

Besides classifying impacts by sector, it is useful to consider other classifications in order to include all possible costs and benefits of an intervention in the analysis. One such classification, used by Renda et al. (2013), is presented below. Researchers should consider whether impacts classified according to these more theoretical dimensions should appear in their analysis.

Chart 2: The Classification of Intervention Impacts (Descriptions of individual costs and benefits follow)



Source: Czech Priorities. The structure was adapted from Renda et al. (2013, p. 21)

5.2.1 Direct Impacts

In the context of CBA, the direct impacts of an intervention are its impacts on the target population and the administrative agencies responsible for implementation and enforcement of the intervention. Direct impacts are divided into direct costs, enforcement costs and direct benefits.

Direct Costs
Within direct costs we distinguish compliance costs and hassle costs borne by the target population.

Compliance costs can be broken down into:

- direct charges - fees, levies or taxes
- substantive compliance costs, (e.g., the costs of a one-time adjustment and adaptation to changes in legal rules, or the recurrent costs of periodic training)
- administrative burdens resulting from administrative activities performed in order to comply with information obligations of the intervention

Hassle costs are a residual category of direct cost. They include costs related to administrative delay, corruption, the opportunity cost of waiting time, and redundancies.

Enforcement costs are the costs incurred by the need to enforce a law or regulation. They are divided into three categories:

- Monitoring costs for collecting information needed to monitor compliance with legislation
- Adjudication (litigation) costs—the cost of legal or alternative dispute resolution mechanisms
- Enforcement—the cost of inspections, adjudicating and enforcing penalties, and handling complaints

Direct Benefits
Direct benefits can be split into those that improve well-being and those that improve market efficiency, including improvements in the allocation of resources.[15]

Improving citizens' well-being means increasing their utility, welfare or life satisfaction and includes:

- Human health
- People's time
- Environmental and ecological benefits, such as reduction of emissions, waste disposal, soil protection, noise reduction and improvement of air and water quality
- Life satisfaction

Improved market efficiency mainly consists of the avoidance or rectification of regulatory and market failures, and cost savings generated by regulation and we discuss them more in Chapter 6.4.

[15] Examples given in this chapter are not a complete list and are often connected. For example, the health effects of air pollution are (usually) an externality; they are monetized by estimating their impact on health.

5.2.2 Indirect Impacts

Impacts that go beyond the target groups and affect third parties, (e.g. increased safety of the community) are called indirect impacts.

Indirect costs

Indirect compliance costs are usually transmitted through changes in the price, availability, or quality of goods or services produced in the regulated sector. Changes in prices ripple through the rest of the economy, causing prices in other sectors to rise or fall, ultimately affecting the welfare of all involved in the affected markets.

Other indirect costs are mostly case-specific and include substitution effects, transaction costs, and the cost of reduced competition and inefficient allocation of resources.

Indirect Benefits

Indirect compliance benefits can arise from compliance with legal rules that affect third parties, for example by discouraging freeriding or creating a more level playing field for all market players. Wider *macroeconomic benefits* of intervention across sectors, as well as *other unintended benefits,* belong in this category.

5.3 Listing of Stakeholders (Impacted Parties)

The impacts of an intervention will affect different groups of stakeholders in different ways. Specifying which stakeholders will be affected by which impacts is useful for several reasons:

- It increases transparency
- It helps with ex-post facto evaluation of the impacts of proposed legislation on specific stakeholders, as well as analysis of cumulative impacts
- Because the allocation of resources affects overall welfare, a good description of the distributional effects of an intervention is essential from a political point of view
- Different groups of individuals can value the same asset differently.

The process of identifying stakeholders can also lead to uncovering impacts of a policy that were not considered earlier.

However, calculating impacts separately for each discrete group of stakeholders and then aggregating them can easily lead to double counting of costs and benefits. Therefore, one must first identify the overall impacts and only then break them down by affected stakeholders.

The classification of stakeholders should accord with the objectives and impacts of the intervention. Researchers should always check for differences in impact by gender, age and income group. Impacts can also be categorized according to the type of stakeholder, such as public entities, businesses, consumers and NGOs, or by geographic region.[16] The impacts on different stakeholders must be indicated in a table included in the CP Excel Template.

Budgetary impacts will always be part of the outcome of an analysis. Costs and benefits must be allocated to individual public budgets (the state budget, regional budgets, municipalities, public health insurance).

The need for thorough analysis of the distributional impacts of an intervention will be addressed in more detail in Chapter 7.4.

[16] For useful tips on determining distributional effects on different geographical areas and income groups, see *The Green Book*, p. 77-81.

6. Quantification and Monetization of Costs and Benefits

After all impacts of an intervention have been identified, it is necessary to make quantitative estimates of their size. Monetary values must then be assigned to the impacts. All quantifications and calculations of the monetary value of impacts must be described transparently, and be based on reliable sources, data, and formulas for calculations.

Inevitably, there are levels of impacts that cannot be feasibly monetized or even quantified, despite the fact that we aim to monetize all significant impacts. Therefore, all the impacts will be sorted into three categories:

- Monetized costs and benefits
- Costs and benefits that can be quantified but not monetized
- Other impacts that are impossible to quantify

All monetized costs and benefits will be used to calculate the final result, the benefit-to-cost ratio. Impacts that can be quantified but not monetized will be evaluated using the quality of life indicators described in the ČR 2030 (2018) document. The remaining, non-quantifiable impacts will be described qualitatively.

The appropriate approach to quantification and monetization depends on the kind of impact evaluated. The method of quantification can differ from sector to sector. In some cases there are commonly used sector-specific methodological approaches (e.g. for transport, health, and the environment). Reliable expert estimates, experience and data from other countries, projects, and academic research can serve as good sources. Every estimation technique must be properly described and include a discussion of its possible limitations of use in the specific evaluation for the CP project.

In this chapter we offer an overview of some general principles and an approach to the monetization of some of the most common impacts. This chapter is complemented by Appendix A: General Assumptions, which lists assumptions that must be used in evaluations performed for the CP project. Many other sources on valuation are mentioned in Appendix B, with Champ, Boyle & Brown (2017) standing out as a comprehensive guidelines.

6.1 General rules

6.1.1 Data and the Hierarchy of Sources

Researchers should prioritize the use of reliable local and national data sources before turning to data published by EU institutions, the OECD, or other international sources (such as the IMF and World Bank). Researchers must make an effort to find the best available data for each measurement of impact in the specific context of the research question. More recent data is preferred. If a parameter is expected to grow with time, then this must be mentioned and incorporated in the analysis.[17]

In Appendix A, we provide values for some inputs that are likely to be used in many analyses. The aim is to ensure that the same values are used for the main macroeconomic, demographic, and other inputs (such as the value of a life or people's time), and that the results are therefore comparable from project to project.

In situations where researchers must estimate impacts, parameters, or data that are not officially published, it is extremely important to focus on using the best available source as a basis for their estimation. It is not acceptable to rely on “expert opinion” without citing any basis in some data. When using data based on local or otherwise limited experience as a proxy for more general impacts, researchers should strongly consider correcting for optimism bias.

When using estimates taken from other research that have undergone expert review, researchers should always address the context-appropriateness of the estimate used.

6.1.2 Assessment of Data Quality

A good explanation of the appropriateness of the data used, by which we mean all inputs including assumptions and external estimations of impacts or parameters, must be provided. It is important to address all possible limitations of the data transparently. The impact of the limitations on the final results and the risk of possible bias must be addressed in the evaluation.

The overall quality of each CBA input must be assessed by the researchers using the three-level Data Quality Scale below. The scale takes into account the source of the data, how recent the data is, the context of the data and the degree of variability in the estimates of the value of an input that is found in the literature. The scale below serves as a guideline that will help to standardize the classification of data as the CP project understands each category of data quality.

[17] Value of Statistical life is an example of an indicator that can be expected to grow at the pace connected to the growth of GDP per capita.

Data Quality Scale

1. **Well-founded data**
   - *Comes from highly respected sources*
     Typical data in this category is data published by any part of Czech government, and data published in impactful, peer reviewed Czech or foreign journals or other scientific sources that have undergone expert review. Data can also come from well-respected organizations (the EU, the IMF, The World Bank, OECD, the CIA).
   - *Is geographically and contextually appropriate*
     Data should be published specifically for the Czech Republic or be geographically indifferent (such as some medical data and data from multiple studies that have been done in different countries with comparable results).
   - *Data does not show high variability over time or depending on the source*
     Researchers should check the consistency of the values they use by comparing them to other sources.
   - *Data is not outdated*
     The most recent data is preferred but older data can be used if there is a high level of certainty that the underlying conditions have been relatively stable over time.

2. **Data based on research but with a high degree of uncertainty**
   - *Data is published by a respectable source*
     Data should come from academic research, government or supranational institutions. Alternatively, data from well-known non-governmental organization fits this category.
   - *Data comes from a closely comparable context*
     In case the data relates to a non-Czech context, the suitability of using the data for the purposes of CBA in the Czech context must be addressed.
   - *Existing relevant research has mostly consistent findings*
     The evidence adduced about a topic is clear and some level of consistency exists in the findings. Cases where evidence points “both ways” have to be addressed.

3. **Relatively arbitrary data**
   - All other data falls into this category. The data used must still follow strict academic standards and be well-sourced. Expert opinions and data obtained from biased sources must be treated with caution and subjected to the sensitivity analysis (more in Chapter 8.1.1 - Sensitivity analysis).

6.1.3 Prices and Inflation

The effect of inflation on prices is to be removed from the analysis. Because the intervention will be evaluated over a period of time, all prices must be stated in the prices of the base year, that is, the year when the CBA is performed. All older prices must be converted to base year prices using the appropriate deflator from the Czech Statistical Office. A downloadable tool for convenient calculations of prices adjusted for inflation and also for the growth of GDP for the cases where this is needed (such as health effects) is provided here Price converter. Price converter works for prices in Czech crowns, euros and dollars.

Commonly, mistakes occur when accounting for loans, from which the effect of inflation must be removed as well in order to avoid double counting (see chapter 2.8 of EC (2014). The inflation rate to be used is provided in Appendix A.

6.1.4 Sunk Costs

Costs that have already been incurred before the intervention[18] and cannot be recovered must be excluded from the analysis because they should not affect the decision-making process in any way. The decision-making process has to be forward oriented.

6.1.5 Terminal (Residual) Value

Should researchers see fit to end the lifespan of a project while it is still generating costs and/or benefits, a residual value of the project must be determined. Estimation of the residual value of a project can be done using one of two mutually exclusive methods.

1. "By computing the present value of economic benefits, net of economic costs, in the remaining life-years of the project. This approach shall be adopted when the residual value is calculated in the financial analysis with the net present value of future cash flows method" (EC, 2014, p. 64).
2. "By applying an ad hoc conversion factor to its financial price. This is calculated as an average of the cash flows of the single cost components, weighted by the relative share of each component in the total investment. This approach shall be adopted when the depreciation formula has been used in the financial analysis." (Ibid.)

6.1.6 Optimism Bias

Optimism bias means a systemic bias in the predictions and planning where costs (inputs) are likely to be underestimated, but benefits are likely to be overestimated. This is often the case with unrealistically small maintenance costs, key project parameters, capital costs, operating costs, implementation of the intervention and creating the needed infrastructure.

Some approaches correct for optimism bias and apply a coefficient to account for the risk of increased costs, lower benefits or the likelihood of complications. The ideal sources of data

[18] In the context of CBA even a cost that have not incurred yet but will before the decision about the intervention will be made can be counted as sunk cost.

for correcting for optimism bias are an organization's own track record of optimism bias and retrospective studies.
An important part of mitigating optimism bias is a thorough check of forthcoming legislative changes, especially at the EU level. Such a check should be done when defining the baseline scenario. The risk of increased costs should be discussed in detail in the risk assessment part of the analysis.

Correction for optimism bias is not ordinarily used in the European context, however. Researchers can include it in their analysis if they feel that there is a strong reason to do so based on past experience. This is particularly the case when predictive (ex-ante) analysis is undertaken. For details see The Green Book (p. 91) or The Green Book's supplementary guidance on optimism bias. A slightly different but transparent and useful approach is presented in HM Treasury (2014, p. 33).

6.1.7 Market Price Distortions and Shadow Prices

If market prices are distorted,[19] researchers should use shadow prices, which reflect the opportunity costs of goods and services. International prices are often used as a means of correcting for local market distortions. Researchers must decide for themselves whether or not a market is distorted, but their decision must be backed by evidence. When a finding of market distortion is backed up by factors such as price controls, the prices used in the analysis must be adjusted.

A practical approach to converting prices in a distorted market is used by the EC (2014, p. 56). If there is no distortion in the market, market prices should be used. The sources of market distortion include:

- non-efficient markets (due to subsidies, monopolies, etc.)
- mandated tariffs for utilities that do not reflect opportunity costs of inputs
- prices that include government exactions (duties, taxes, etc.)
- cases where market prices are not available (e.g. some environmental impacts such as noise reduction)

There are three ways to determine shadow prices for use in the analysis:

- Fiscal corrections
- Conversion from market to shadow prices
- Evaluation of non-market impacts and correction for externalities

Fiscal Corrections
"Taxes and subsidies are transfer payments that do not represent real economic costs or benefits for society." (EC, 2014, p. 55) General rules to correct for fiscal matters are:

- Prices of inputs and outputs must be considered net of VAT
- Prices of inputs should be considered net of direct and indirect taxes

[19] The CBA literature does not offer a precise definition of a distorted market, rather it identifies sources of market failure that cause market distortion. Classically, these are externalities, misuse of market power, and issues of access to information). See Chapter 6.4 and Romijn & Renes (2013, Chapter 3.3) for more detail.

- Prices used as a proxy for the value of outputs should be considered net of any transfers to public entities. However, in practice, such prices will usually be replaced by an estimate of willingness-to-pay.

Conversion from market to shadow prices
For tradable goods prices at the border are used to eliminate the effects of a distorted market. Which border to use depends on the context and the specific good. It can be the national or the EU border. Prices at the border can be found in data from national and international statistical offices or customs authorities (EC, 2014, p. 56, 236).

For non-tradable goods

- Ad hoc assumptions about the extent of distortion of price should be used for "major" items (for example land prices, cost of civil works, etc.). These assumptions should reflect long-term marginal costs
- Labor costs that are believed to be distorted should be accounted for by a shadow wage that corrects for a significant disparity between the nominal wage and opportunity costs. See Annex IV of EC (2013).

The value of project outputs for which market prices are non-existent or distorted should be measured by marginal willingness-to-pay (WTP) for a given good or service. More on WTP in Chapter 6.3. Some of these prices provided in Appendix A.

6.1.8 Transfers

In CBA, transfer payments such as government user fees and taxes should not affect the resulting net benefits, because what one party loses is precisely offset by what the other gains. At the same time, the distributional analysis including the budgetary impact of an intervention, is an important part of the results of each CP analysis. For that reason, transfer payments that would otherwise be excluded from the analysis should be entered twice, once with as a positive number and once as a negative to cancel themselves out in terms of NPV.

The decision whether or not to keep costs and benefits, which can be considered transfer payments, in the calculations also depends on the nature of the research question and the distributional effects that we are interested in. Generally we would choose to exclude transfer payments from the calculation of the overall benefit-to-cost ratio but include it in any distributional effects considerations.

6.2 Direct Costs

In the context of CBA, the direct impacts of an intervention are its impacts on the target population and that part of government administration responsible for implementing the intervention. The monetizing of costs is usually much more straightforward than the monetizing of benefits and is much more case specific, for details see EC (2014).

The researcher should focus on big, important direct costs. Being precise and realistic about direct costs is much more important than spending time on more speculative indirect impacts of an intervention. If the compliance rate is an important determinant of a cost (or benefit) it must be taken into account (this is especially important for collected taxes).

6.3 Direct Benefits: Valuing the Changes in Well-being

We provide binding values for some of the most common benefits in Appendix A. For others we offer an overview of the methodological approach that should be used for valuation of benefits. Direct benefits are usually split into improved well-being and improved market efficiency. The latter is likely to include improvements in the allocation of resources.

The most common approach to valuation of well-being is to replace actual financial revenues in the form of fees or prices paid by the persons receiving a benefit and replace it with an approximation of their willingness-to-pay (WTP) for the benefits of an intervention. The reason is that WTP offers a better estimate of the social value of a good or service than actual observed payments because (EC, 2014, p. 60):

- In sectors that are not exposed to market competition, fees paid by users may not reflect the full social value of their use of a particular good or service (e.g., publicly provided goods such as healthcare
- The use of a good or service may generate a social benefit for which there is no market or price at all (e.g., time savings or increased safety of new transport services).

WTP can be estimated in several ways that are described below. A useful table of benefit assessment methods showing their impacts, strengths and weaknesses can be found in Renda et al. (2013, p. 185). More on WTP can be found in Annex VI of EC (2014), and Boardman et al. (2017). Comprehensive source of practically used methods is Champ, Boyle & Brown (2017).

6.3.1 Revealed Preferences

WTP is based on observation of what individuals are actually paying to achieve a given outcome. Methods for determining WTP include:

- *Travel cost method*
  Sometimes referred to as recreation demand models. The value of a given monument or landmark can be approximated by looking at how much stakeholders are willing to spend to get to it and see it. See Renda et al. (2013, p. 93-98).

- *Hedonic models*
  Hedonic models determine the contribution of certain characteristics of a good to its price and therefore the value of each individual characteristic. Hedonic pricing is frequently used in the labor market and in real estate markets, for example to determine the value of noise reduction or good travel accessibility. See Renda et al. (2013, p. 98-107).

- *Averting behavior models*
  Calculation of costs avoided by users when consuming the same good from alternative sources of production or the price consumers are willing to pay in order to avoid a certain risk. This is the standard approach for safety (relying on the price of insurance) and the environment. When using averting behavior models it is important to keep in mind that many types of averting behavior not only reduce the damage that an intervention is meant to address, but also provide benefits. This has to be accounted for, otherwise the cost of the intervention would be artificially high.

- *Cost-of-Illness methods*
  The benefit of staying healthy is determined by the sum of direct and indirect costs associated with illness. Expenditures associated with diagnosis, treatment, rehabilitation, and accommodation are direct costs. The value of lost income and leisure time due to illness is a direct cost. The value of people's time is provided in Appendix A.

6.3.2 Stated Preferences

Stated preferences are determined by surveys that ask individuals directly how much they would be willing to pay to achieve a given positive outcome or to avoid a negative outcome. It is a valid, but less universal and reliable method.[20] Its shortcomings include underestimating long-term effects, and the limitations imposed by bounded rationality and rational ignorance. Only readily available data will be used for the purposes of Czech Priorities, so no own surveys or any other active method of acquiring raw data will be used by the researchers. For more details see Renda et al. (2013, p. 186). For thorough guidelines see Bateman et al. (2002) or Johnston et al. (2017).

- *Contingent valuation*
  Individuals directly state their WTP for a future benefit. For the principles of conducting surveys (such as the need for a pilot study), examples, and an overall evaluation of this approach, see Renda et al. (2013, p. 118-125). For detailed guidance see Alberini & Kahn (2006).
- *Choice modelling and conjoint analysis*
  "Respondents are asked to choose a good based on preferences for the types and levels of attributes associated with the good. The amount of WTP can be estimated indirectly from the prices of attributes of the good being valued." (Renda et al., 2013, p. 126).

6.3.3 Benefit Transfer Method

Estimates of the value of benefits based on the results of previously completed studies in another location or context can be used when the assumptions, conditions, and methods used in the studies are relevant to our specific needs.

6.3.4 Life Satisfaction Approach

This is a valuation technique that attempts to overcome some of the traditional challenges of the stated preference and revealed preference models. The underlying idea is that the use of market-based approaches does not guarantee a good approximation of the underlying utility perceived by individuals before and after the intervention. The need to measure "utility" has led to the development of models that look at people's life satisfaction as reported in surveys. See Renda et al. (2013, p. 146) for list of existing surveys.

6.3.5 Value of Human Health and Life

Health effects are a very important issue in CBA and often account for most of the costs and benefits. Interventions can affect human health directly or through the environment in a number of ways. They can save lives by reducing the risk of mortality (premature death), improving the health of those living with diseases (morbidity benefit), reducing tension and stress, or improving mental health.

[20] It's less useful for outcomes that cannot easily be given a market value, and for population groups that do not have the ability to pay (e.g.research into willingness to pay for counselling to address feelings of insecurity will be inappropriate for homeless people or those living in poverty).

The value of a life is measured in terms of the value of a statistical life (VSL). There are three main preference-based approaches for determining the VSL:

- **Hedonic wage** (wage-risk) methods, which derive the value of a life from the risk premium in the wages accepted by workers performing jobs that including some elevated level of risk
- **Averting behavior models** use data about purchases of goods that can lower mortality risk by increasing safety
- **Stated preference studies** use survey techniques to capture or infer individuals' WTP to avoid major risks.

All analyses in the CP project should use the value of a statistical life or the value of a major or minor injury provided in Appendix A. The value of a statistical life must be adjusted for both inflation and real GDP growth, because the VSL increases over time with GDP.[21] If the affected population is a specific known group rather than an average of the population, adjustments for age and life expectancy must be made in accordance with the sources listed at the end of this section. Special cases of health risks and prevention measures also deserve specific treatment, for example, for evaluation of the benefit of avoiding suffering or dying from cancer see Alberini & Ščasný (2018). Wage-risk studies are known to produce higher VSLs (Kluve & Schaffner, 2008). This is an expected result of the underlying logic used in such studies for valuation of a life.

To take into account the quality of the years lived by a subject, researchers use the concept of Quality Adjusted Life Years (QALY). QALY are calculated by multiplying the utility value associated with a given state of health (0 for being dead, 1 for perfect health) by the years lived in that condition.

See the practical guides to valuation of health (Robinson et al., 2019); Renda et al. (2013, p. 131-141) for more information about valuing health; and *The Green Book* (p. 70-73) for detailed information about life and health topics including Quality Adjusted Life Years (QALY). Czech sources include Winkler, Bejdová, Csémy, & Weissová (2015) covering all sorts of cost (depression, suicide, loss of productivity or employment, etc.).[22]

6.3.6 Value of Time

The value of time is based on the average price of labor in a national economy and is different for work time, commuting time and leisure time. The values are provided in Appendix A. More detailed data on the value of time spent in transport compiled by Máca, Braun Kohlová, Melichar (2011) can also be used.

[21] By using the same pace we assume that income elasticity is 1.0. For more detailed approach to income elasticity see Robinson et al. (2019). See appendix A: General Assumptions for the expected GDP growth sources.

[22] Literature focused more on the CEA includes Methods for the Economic Evaluation of Health Care Programmes by authors Drummond,, Sculpher, Claxton, Stoddart, & Torrance (2015) and Valuing Health for Regulatory Cost-Effectiveness Analysis by Institute of Medicine (2006). Influential study is Drummond (1992).

6.3.7 Unemployment

Changes in expected unemployment must be treated on a case by case basis and the opportunity costs of labor must be considered. If an intervention creates a job position, it does not guarantee that a person who would otherwise be unemployed will occupy it. If the intervention specifically targets job creation, researchers need to understand its broader effects in order to assess its impact in a cost-benefit framework. Changes in short-term unemployment or the cost of frictional unemployment must be included in the analysis. For more on the topic see New Zealand Treasury (2015).

6.4 Direct Benefits: Assessing Improved Market Efficiency

Improved market efficiency as a result of the intervention mainly consists of correcting regulatory or market failures and cost savings generated by the implementation of regulations. Inefficiently functioning markets generate a deadweight loss, which is the amount of lost social surplus caused by diminished output. Improving market efficiency thus means reducing deadweight loss.

An overview of market failures addressed by the European Commission (2014) and *The Green Book* is provided below. It is worth noting that depending on the situation these can appear both on the benefits or costs side of the CBA.

- Externalities (positive or negative)
- Insufficient supply of public goods
- Absent or weak competition (including abuse of market or monopoly power)
- Absent or incomplete markets
- Information failures, such as lack of access to information for decision makers (including consumers and public authorities)
- Moral hazard (individuals or businesses changing their behavior and taking risks because they are protected from negative consequences that will be someone else's burden)

Other channels by which an intervention can increase market efficiency include stimulating innovation and technological progress, promoting the production of certain goods, improving the information available to market players, and removing barriers to cross-border operations and entry of new players to the market.

Harmonization of legislation and removing international trade barriers can lead to increased economies of scale.

The change in deadweight loss is calculated as the change in the social surplus. To be able to monetize the social surplus, researchers need to be able to estimate the shape of the demand and supply curves.

If there is no reliable estimate of the elasticity of supply and demand for a good or service in question can be found in the existing literature, use the values for the most similar of the eight categories of goods and services provided for the Czech Republic in Janský (2014). If these categories are not appropriate, use an educated guess, give reasons for the choice (such as the known supply and demand curves of a similar good or service), and compare its elasticity with the ones in Janský (2014). If the guess seems too arbitrary, assume instead a linear demand function. This practice is known as the "Rule of a Half" and is acceptable for small changes in prices.[23]

6.5 Indirect Impacts and Externalities

Impacts that go beyond the target groups of intervention and affect third parties, are called indirect impacts. An externality is a cost or benefit that affects third parties without monetary compensation. A typical example of externalities are environmental impacts.

6.5.1 Value of Environmental Impacts and Externalities

Environmental impacts can be the intended objectives of an intervention, but they can also be unintentional externalities. Environmental benefits listed by Renda et al. (2013) include:

- Reduction in emissions of pollutants.
- Waste disposal and recycling.
- Soil protection.
- Noise reduction.[24]
- Air quality.
- Water quality and availability.
- Promotion of the use of renewable resources.

Monetary values for the most common environmental impacts, such as damage caused by different air pollutants and the impact on the climate of CO_2 emissions are included in Appendix A.

For guidelines about other non-market valuation methods for environmental issues, such as valuation through understanding environmental and natural capital, effects on air quality, noise, waste, recreation, effects on amenity value, the landscape, valuation of water quality and water resources, food risks, land evaluation, and biodiversity, see *The Green Book* (p. 61-68). Another highly respected sources are more general Freeman III, Herriges & Kling (2014) and Johnston, Rolfe, Rosenberger & Brouwer (2015) that focuses on benefit transfer method of environmental and resource values.

[23] This issue and many other aspects of the stated-preference and revealed-preference valuation methods are covered in Johansson, P., & Kriström, B. (2018). Winkler (2015) points out that use of the Rule of a Half was endorsed by the United Nations in 2003. His study also proves that the Rule is valid for models of travel demand that are subject to multiple constraints. An introduction to the Rule can be found in Williams (1976).
[24] See Urban & Máca (2013) for more about noise annoyance.

6.5.2 Macroeconomic Impacts: Partial or General Equilibrium Analysis

When we only consider the impact of an intervention on a single market, we use the partial equilibrium approach. When an intervention has complex impacts on supply, demand and prices in the whole economy and many interacting markets, we use the general equilibrium approach.[25]

Whether to adopt a partial equilibrium or a general equilibrium (GE) approach should be determined by answering the following two questions (Renda et al., 2013, p. 165):

- Is the intervention likely to affect several markets and present significant cascading and cumulative effects?
- Is the intervention likely to generate significant impacts on the economy?

Significant impact here means that the intervention is likely to affect prices and outputs in sectors other than the one targeted or immediately affected (Commonwealth of Australia, 2006, p. 45). This does not include change in expected long term economic growth, because GE models are not typically designed for changes in trends. If the answer to both questions is yes, researchers should opt for a GE approach.

This is especially important if the main goal of an intervention is macroeconomic benefit. In that case, the use of a GE model is preferable because it allows for simulation of long-term impacts on the economy and all the variables that will be included in the equations. The same holds true for large-scale environmental interventions.

Unless the above-mentioned conditions for use of GE analysis have been met, the researcher should opt for a partial equilibrium analysis. The EC gives similar advice (2014, p. 64) for cases in which the focus is on direct, microeconomic impacts. Including indirect, macroeconomic impacts is not recommended because it increases the risk of double counting of impacts already captured in shadow prices and monetized externalities.

If inclusion of macroeconomic impact is required, and if it is done proportionately and appropriately, the researcher may use “ready-made multipliers” to assess how sector-specific benefits translate into macroeconomic benefit. However, the use of multipliers is very controversial. If multipliers are used, the scientific evidence supporting them has to be carefully scrutinized and fully described in the analysis.

[25] See Ščasný, Píša, Pollitt & Chewpreecha (2009) as an example of the use of GE.

7. Articulating the Results

This chapter aims to provide guidelines for transforming all research, and all monetized and non-monetized impacts evaluated, into transparent, accessible results with a clear message and strong added value. The standard CBA produces a single benefit-to-cost ratio that helps decision makers to assess whether an intervention is socially desirable and to compare it to other possible interventions. Non-monetized impacts and impacts on specific groups of shareholders should be examined and discussed in a distributional analysis and if needed, in a generational accounting.

7.1 Monetized Impacts

7.1.1 Locating Impacts Along the Lifespan of the Intervention

The evaluations of interventions within the CP project are expected to cover the longest reasonable time period, while at the same time stating the results for a time period of 10 and 40 years.[26] Individual impacts must be located along the lifespan of the intervention.[27] Values for each year must be discounted to their base year values.

Outcomes such as better educated children entering the labor market are generational ones. However, it is clear that the nature of intervention has to be taken into account. At least a 40-year time horizon is used for CBAs that focus on infrastructure or other physical investments. For predictive and evaluative models of new ways of delivering public services that focus more on revenue than on capital expenditures and have a limited duration, a shorter modelling period is more appropriate with periods as short as one year being acceptable. The length of a lifespan is to be consulted with a CP economist.

7.1.2 Application of the Social Discount Rate

Evaluations of CP projects must use the discount rate provided in Appendix A. That discount rate must be subjected to sensitivity analysis. The results of sensitivity analysis must be presented using the high and low discount rates also provided in Appendix A. Discounting of future values is done solely to adjust for social time preference and is not the same as adjusting for inflation.

The discount rate to be applied to future values is based on an estimate of the long-term social rate of time preference (Florio & Sirtori, 2013), which "reflects the social view on how future benefits and costs should be valued against present ones" (EC, 2014, p. 301). For more information on the calculation and theoretical background of social discount rates, see Chapter 10 in Boardman et al. (2017), Annex II in EC (2014) or *The Green Book* (p. 101-106).

[26] Template for calculations that is accessible to researchers provides these results automatically.
[27] And possibly beyond the lifespan of the intervention as is the case with education and other

Once costs and benefits are quantified along the lifespan of the intervention, calculating their net present value is straightforward. The Template provided in Appendix E includes formulas for discounting individual costs and benefits in each category of impacts to their present values.

7.1.3 Benefits to Costs Ratio (Cost-benefit Ratio)

In order to show the final overall impact of an intervention, the results of CBA will be expressed in two ways,[28] as:

- A Net Present Value (NPV), that is, the difference between the total monetized costs and the total monetized benefits of a CP project, discounted to today's value
- A Benefits to Costs Ratio[29] (BCR), which is the ratio of total benefits over total costs.

Stating a Benefits to Costs Ratio (BCR) enables comparisons with the results of evaluations of other interventions. The higher the BCR, the more socially beneficial the project is. In theory, projects with a BCR lower than one should not be implemented because they are consuming too many resources and producing too little value for society in return.

Nevertheless, there may be some special cases. Sometimes not all relevant benefits of an intervention are monetizable (such as cultural interventions or preserving a historical monument). Therefore, the benefit of such projects to society does not correspond to their BCR. Interventions with a strong social focus, or that work with client groups who require intensive (and therefore expensive) support, are unlikely to generate a positive fiscal (as opposed to social) rate of return on investment. There could still be a strong justification for investing in terms of non-monetizable moral or strategic considerations.

7.2 Non-monetized but Still Quantifiable Impacts

There may be some impacts of an evaluated intervention that cannot be monetized, but for which a quantified expression of their value is still possible. Researchers should quantify any such impacts that are substantial, either as regards the declared objectives of the intervention or the real impacts. These impacts should be quantified according to the Quality of Life Indicators outlined in ČR 2030 (2018) and the evaluation should include an explanation for the use of those indicators and how they are calculated.

[28] Another option, the Internal Rate of Return (IRR), is not typically used in CP projects. This is primarily because interventions with non-normal annual net benefit patterns (i.e., when net benefits change sign more than once) result in multiple IRRs, which is considered undesirable.
[29] The terms "Benefits to Costs Ratio," "Cost-benefit Ratio," and "Benefit-cost Ratio" all refer to the same concept: the total benefits divided by the total costs. The term "Cost-benefit Ratio" is most commonly used in European contexts but can be misleading as it lists costs first. In the United States, "Benefit-Cost Ratio" is more prevalent, aligning with the general terminology where Cost-Benefit Analysis is often referred to as Benefit-Cost Analysis.

7.3 Non-quantifiable Impacts

Impacts that are too difficult to quantify and monetize, or for which quantifying and monetizing are unreasonable,[30] must be presented in the form of a qualitative description and, if appropriate, using a scorecard analysis. Scorecard analysis expresses the intensity of an impact on a scale of zero to five. More on the use of scorecard analysis is found in Renda et al. (2013, p. 195-196).

7.4 Distributional and Cumulative Impacts

The **distributional impacts** of the intervention on groups of stakeholders must be described in a table that assigns individual impacts to specific stakeholders. This is best done at the stage of identification of impacts and stakeholders.

When appropriate, researchers should include a quantification of the distributional impacts on relevant stakeholders. The quantification of distributional impacts should be part of the analysis when:[31]

- It is possible to assign quantified impacts to groups of stakeholders
- The distributional impacts are of significant size or they are the direct objectives of an evaluated intervention
- It is possible to avoid the risk of double counting

It is always necessary to quantify the impact of an evaluated intervention on public finances separately. A budgetary impact analysis must always be a part of the final report, indicating the different impacts of an intervention on different public budgets (state, regional, municipal, and public health insurance). See HM Treasury (2014, p. 36-37) for tips on cashability and budgetary impacts.

The effect of **cumulative impacts**, such as imposing yet another time-consuming administrative duty on small businesses, should not be ignored if such impacts threaten to cumulate to a level where they can have a significant effect. This is especially important in sectors with small profit margins where the size of competitors varies significantly, such as agriculture.

7.5 Generational Accounting

The standard CBA for CP projects does not require generational accounting. However, where the design of an intervention suggests that the accrual of costs and benefits will be significantly uneven over an extended period of time, it should be considered.

[30] Examples are the dynamic effects of increased competition or feelings of distress in a population that have not been quantified in any way. The fact that the size of the affected population is known does not change the classification to that of a quantifiable impact.
[31] Johansson & Kriström (2018) connect the theory of distributional effects with practice very well.

8. Testing the Robustness of Results

It is critical to provide an honest assessment of any uncertainty regarding estimates of future revenues and costs, the limitations of data sources used, and potential risks. This chapter outlines how to assess uncertainty and risk[32] that affects the results presented and how to increase the reliability of results by checking them for common mistakes.

8.1 Quantitative Risk Assessment

For the purposes of CP projects, quantitative risk assessment requires a sensitivity analysis, which among other things should identify the critical variables that need to be subjected to probabilistic risk analysis.

8.1.1. Sensitivity Analysis

Sensitivity analysis involves testing how the results respond to changes in the values of one or more variables at the same time. It enables the researcher to identify the variables with the largest impact on the results. An important assumption of sensitivity analysis is that the tested variables are independent and can be disaggregated. Interlinked, interdependent variables might result in double counting and biased results.

A complete **one-variable-at-a-time sensitivity analysis** for all variables must be performed and the results reported. All variables must be individually tested for the effect that a one percent change in their value has on the final NPV of the intervention. A discussion or explanation of the variables that show a very high and/or surprising impact on NPV must be provided.

Furthermore, an analysis of **critical variables** must be completed. Critical variables require special attention when the model proves to be sensitive to changes in them, and at the same time their value inputs have limited reliability. This analysis must be performed in the following three steps:

1. **Assign a data quality score**
   Every variable will be assigned a data quality score using the Data Quality Scale from Chapter 6.1.2 Assessment of Data Quality
2. **Identify critical variables**
   There are two criteria by which a variable is identified as critical:
   a. The impact of a one percent change in the variable generates a greater than one percent change in the NPV of an intervention.
   b. The variable scored low on data quality.

[32] Parts of risk analysis presented in this chapter would be called uncertainty analysis in the USA. In more technical literature the distinction is that risk is a situation where there is a set of possible outcomes from the project, and the probability of each outcome is known. Uncertainty is the situation where there is a set of possible outcomes, but the probability of each one is not known.

The following table shows how these two criteria are used to determine whether or not we must consider a specific input to be critical and subject it to further analysis.[33]

	Quality of estimate/data			
Impact on NPV		Well founded, good precision	Based on research but higher degree of uncertainty	Relatively arbitrary
	High (> 1%)	Not critical	Critical	Critical
	Low (< 1%)	Not critical	Not critical	Depends on context

Determine low and high values and their impact
The range of realistic values, from low to high (or, for example, from the most optimistic to the most pessimistic) must be determined for the critical variables by the researcher. The best general guidance for setting the high and low values is to use an "educated guess" as to the standard deviation from the mean, based on the assumed underlying distribution.
A NPV must be computed based on the low and high values of all critical variables.

Critical variables and their impact on a project's NPV must be reported along with a discussion of their appropriateness, relevance, and any possible substitutes for them. Also, researchers are encouraged to construct scenarios for several combinations of critical variables.

Additionally, **switching points** must be individually computed for all critical variables. Switching points are the values of variables which result in a BCR of one. This determines where the project ceases (or begins) to be beneficial in monetary terms. If the switching point lies between the low and high values used in the sensitivity analysis, this must be explicitly stated.

[33] For an example of the two criteria appearing together, making sensitivity analysis justified, see Kertesi and Kezdi (2006). They estimated an employment discrimination factor in order to account for discrimination against Roma in the labor market. Their estimate was based on some existing research but its value was uncertain. At the same time, it had a strong impact on the final results of the evaluation. For that reason, the employment discrimination factor was one of the inputs the authors subjected to sensitivity analysis.

A Template for sensitivity analysis is attached in Appendix E. This template automates most of the work required for sensitivity analysis. Assessing the quality of the variables, assigning them low and high values, and the discussion of the results are the only parts of sensitivity analysis left up to researchers. The assumptions will also be routinely validated during the peer review process.

8.1.2 Probabilistic Risk Analysis

Probabilistic risk analysis presents a probabilistic distribution for every critical variable around the best estimate and recalculates the expected results according to this probabilistic distribution. More on probabilistic risk analysis can be found in EC (2014, p. 71-73).

The probability distribution of each critical variable that is needed for probabilistic risk analysis has to be obtained from the literature. The Computational Monte Carlo method is recommended to obtain the best results. If a case similar enough to the project or intervention at hand cannot be found and reliably used for probability distribution data, a simple triangular form can still be used to present the results. See EC (2014, Annex VII).

8.2 Qualitative Risk Assessment

The elements of a qualitative risk analysis, as outlined in EC (2014, p. 69), are:

- a list of adverse events that may endanger the outcomes of the intervention
- a risk matrix for each such adverse event indicating:
    - the things that may possibly cause it to occur;
    - the link with the sensitivity analysis, where applicable
    - the negative effects the event will generate on the project;
    - the probability of occurrence and the severity of impact;
    - the level of the risk (see the table below)
- an interpretation of the risk matrix including an assessment of the acceptable level or levels of risk
- A description of mitigation and/or prevention measures for the high level risks.

Events and factors carrying risk will be assigned a risk level according to the probability they will occur and the severity of their impact in the following way:

Probability of occurrence	Very unlikely	Unlikely	As likely as not	Likely	Very likely
Severity of impact					
No relevant effect on welfare	Low	Low	Low	Low	Moderate
Minor loss of welfare	Low	Low	Moderate	Moderate	High
Moderate loss of welfare	Low	Moderate	Moderate	High	Very high
Critical - large welfare loss	Low	Moderate	High	Very high	Very high
Catastrophic - project failure	Moderate	High	Very high	Very high	Very high

For more detail on the elements of risk analysis, probability of occurrence and severity of impact and preparing a risk matrix, see EC (2014, p. 69-71).

8.3 Checking for Typical Mistakes in Cost-Benefit Analysis

Double counting

When checking for double counting, keep in mind the following:

- Do not add a single factor multiple times, see Romijn & Renes (2013, p. 64) for an example.
- Do not add estimates resulting from different techniques applied to the same impact.
- Check for errors in computing both costs and benefits (e.g., adding monetized direct compliance costs, but failing to take into account that those costs may at least in part be passed on end consumers. In that case, adding indirect costs to end consumers is double counting)

Confusing the baseline with the status quo

The baseline is a dynamic, forward-looking, most likely scenario. All impacts in CBA are measured in relation to the baseline scenario. Status quo means no changes at all (see Chapter 4.2).

Spurious accuracy

If a monetization of impact is based on a reasonable but not very well-founded estimate, this should be properly addressed in discussion, together with the degree to which the results are dependent on this estimate.

8.4 Conclusion Stating the Overall Evaluation of the Robustness of the Results

The research report must include a section with conclusions about the reliability and robustness of the findings, including the quality of the data used. The focus should be on the main limitations of the data and methodologies used and their possible impact on the validity and robustness of the final result.

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Appendix A: General Assumptions

A downloadable current version of the Appendix is available here: *General Assumptions*.

To ensure comparability of results, all researchers will use the parameters and projections provided by Czech Priorities in the CP document, *General Assumptions*. For values not stated in *General Assumptions*, researchers may use other appropriate and reliable sources (see Chapter 6.1.1).

The general assumptions include discount rates, health valuation indicators and main macroeconomic and demographic indicators, with forecasts. Links to quality of life indicators, environmental valuations and many other values are also provided.

Every cost or benefit used in CBA for CP must be converted into base year CZK prices. A downloadable Price converter using the GDP deflator and exchange rates from the Czech Statistical Office is provided for that purpose.

Appendix B: Recommended Literature Overview

A literature overview with links, categorization and brief summary is provided here.

HM Treasury (2018): *The Green Book: Appraisal and Evaluation of Policies and Projects Methodology*, 132p. (here)

- HM Treasury (UK) guidance on how to appraise and evaluate policies, projects and programmes
- For selected issues, see *The Green Book* supplementary guidance collection (here) with detailed guides on the following topics:
    - Assessing the competition: effects of subsidies
    - Completing competition assessments in impact assessments
    - Economic valuation with stated preference techniques
    - Intergenerational wealth transfers and social discounting
    - Accounting for environmental impacts in policy appraisal
    - Multi-criteria analysis: a manual
    - Optimism Bias
    - Policy appraisal and health
    - Procedures for dealing with optimism bias in transport
    - Regeneration, renewal and regional development
    - The economic and social costs of crime
    - The Orange Book (risk)
    - Valuation of energy use and greenhouse gas emissions for appraisal
    - Value for money and the valuation of public sector assets
    - Valuing impacts on air quality
    - Valuing Infrastructure spending
- Guide for CBA in local partnerships (HM Treasury, 2014), originally developed by New Economy, local authorities and other public sector agencies across Greater Manchester, is another high quality supplementary guide to Green book.

A Selected Cost-Benefit Analysis Bibliography

- The leading authors in the field and the authors of Boardman, Greenberg, Vining & Weimer (2017) prepared this list of key studies sorted into 27 categories, such as Air Pollution, Crime and Drug Abuse, Water, and many others in 2011. See https://lecture.ecc.u-tokyo.ac.jp/~zkanemoto/CBA_Bibliography.pdf

Kugley et al. (2017). Searching for studies: a guide to information retrieval for Campbell systematic reviews.

- A publication by the Campbell Collaboration with extensive lists of sorted studies for impact identification in Appendices I. & II. See https://onlinelibrary.wiley.com/doi/full/10.4073/cmg.2016.1

Center for Evaluation of Value and Risk in Health at Tufts Medical Center (n.d). [Web page] http://www.cearegistry.org/

- Has a comprehensive database of cost per QALY studies.

Environmental Valuation Reference Inventory (n.d). [Web page] https://www.evri.ca/en

- A searchable storehouse of empirical studies, including those concerning the Czech Republic, on the economic value of environmental assets and human health effects.

Copenhagen Consensus Center. (n.d.). *Economist Handbook*. Retrieved from https://www.copenhagenconsensus.com/sites/default/files/economist_handbook.pdf

- Very accessible and brief guide on how to perform a CBA study, written for use in Bangladesh.

High impact and quality evaluation guidelines from USA:

- Office of the Assistant Secretary for Planning and Evaluation U.S. Department of Health and Human Services (2016). Guidelines for Regulatory Impact Analysis. Retrieved from https://aspe.hhs.gov/system/files/pdf/242926/HHS_RIAGuidance.pdf
- United States Environmental Protection Agency (2010). Guidelines for Preparing Economic Analyses. Retrieved from https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses

OECD - Valuing Mortality Impacts [Web page]. Retrieved from http://www.oecd.org/environment/tools-evaluation/valuingmortalityimpacts.htm

- Many important links including an Excel file with data from all studies measuring VSL and other mortality impacts in all countries of the world, including five studies from the Czech Republic

Office of Information and Regulatory Affairs. (n.d.). Reports to Congress [Web page]. Retrieved from https://www.whitehouse.gov/omb/information-regulatory-affairs/reports/

- Contains a detailed overview of legislation enacted in every year, clearly stating whether or not costs and benefits were assessed and the results of assessment.

Washington State Institute for Public Policy. (2018). Benefit-Cost Model. Retrieved from http://www.wsipp.wa.gov/BenefitCost

- A very long list of high-quality CBAs sorted into following categories: Juvenile Justice, Adult Criminal Justice, Child Welfare, Pre-Kindergarten, Elementary, Secondary and Higher Education, Children's and Adult Mental Health, Health Care, Substance Use Disorders, Public Health & Prevention, Workforce Development.

WHO (n.d.). Metrics: Disability-Adjusted Life Year (DALY) [Web page]. Retrieved from https://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/

- Short and practical explanation of DALY, YLL, YLD and their construction.

Robinson et al. (2019). Reference Case Guidelines for Benefit-Cost Analysis in Global Health and Development (February 2019 review draft). Retrieved from https://sites.sph.harvard.edu/bcaguidelines/guidelines/

- Highly useful guide to valuation of health by the leading authority in the field. Down-to-earth practical approach to dealing with basic issues of evaluating health.

Expert elicitation and uncertainty literature:

- Morgan, M.G. & Henrion. M. (1990). Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis. Cambridge, UK: Cambridge University Press.
- O'Hagan, A., Buck, C.E., Daneshkhah, A., Eiser, J., Garthwaite, P., Jenkinson, D., Oakley, J., Rakow. T. (2006). Uncertain Judgements: Eliciting Experts' Probabilities. Chichester, England: John Wiley & Sons Ltd.
- U.S. Environmental Protection Agency. 2011. Expert Elicitation Task Force White Paper.

Appendix C: Process and Formal Requirements

In order to achieve the highest possible degree of comparability of the analyses conducted under the Czech Priorities project, all researchers will be bound by the rules set forth in this guide and will use a common set of assumptions and common methodology. The analyses must include full sheets with data, calculations, links and formulas in order to make the results reproducible.

A blueprint with a unified visual style and structure will be provided to researchers to assist them in their work and to improve the comfort of readers of multiple studies performed in the CP project.

An Excel template is provided for calculations, discounting, sensitivity analysis and distributional analysis (see Appendix E).

C1. Formal Requirements

The analysis should preferably be written in English, with a summary in Czech of the main findings. If a good case can be made, it will be allowed to write the analysis in Czech.

All monetary calculations will be done in Czech Crowns (CZK) in base year prices. The base year is the year in which the evaluation is done. All other prices must be converted to base year prices using the deflator from the Czech Statistical Office. For more details on the use of prices and a convenient tool see Chapter 6.1.3.

Document structure

1. Abstract
2. Background info
    a. Introduction to the research question, rationale for intervention, precise definition of the intervention and its possible alternatives
    b. Definition of baseline
    c. Discussion of analyzed alternatives (options that have been considered)
    d. Current legislation, historical overview, experience from abroad
    e. Literature review (the state of knowledge and the theoretical background in the field)
3. Comprehensive list of impacts, assigning impacts to stakeholders
    a. Logical framework
    b. List of all direct and indirect impacts
    c. List of all stakeholders
    d. Assignment of impacts to stakeholders
    e. Classification of impacts: monetized/quantified/described qualitatively
4. Data description (quality of data discussion), notes on methodology
    a. Description of data sources
    b. Discussion of limitations of the data
5. Monetization of impacts
    a. Monetization of individual impacts
    b. Discussion of limitations of the data and estimates used for monetization
    c. Location of impact along the lifespan of the intervention
6. Results
    a. Presentation of discounted costs and benefits
    b. Benefits to Costs ratio
    c. Presentation of quantified but non-monetized impacts on the quality of life indicators
    d. Discussion of other impacts (non-quantified)
    e. Budgetary impact of intervention
7. Distributional analysis
    a. Discussion of affected groups of stakeholders
    b. Generational accounting if relevant
8. Evaluation of the strength of evidence / Testing for Robustness
    a. Sensitivity analysis
    b. Risk assessment
    c. Conclusion about the robustness of results
9. Conclusions and policy recommendations
10. Appendices
    a. Data
    b. Complete and fully functional calculations in standard Excel template

C2. Process: Timing, Deadlines, Approvals, Peer-reviews

Throughout the process of creating the final analysis, researchers and representatives of Czech Priorities should work closely together, making an effort to engage other relevant stakeholders at appropriate stages of the analysis.

For each analysis, there will be an appointed person in Czech Priorities (the CP editor), who is entitled to approve further steps in the analysis. He/she will also be at the researchers' disposal in order to help solve any problems and facilitate contacts with other experts, representatives of the state administration, etc. Researchers are encouraged to contact the CP editor proactively and use his or her expertise when problems arise.

Definition of Intervention and Research Objectives
Researchers, CP representatives (the CP editor and Advisory board members), and other professionals from the field should participate in the preparation of the analysis at the stage of defining the evaluated intervention and the expected outcomes. The final proposal for the analysis, including its budget and timeline, will be approved by both a CP representative and the researchers and will be an integral part of their contract.

Progress Checkpoints
Approval by the CP editor is required at the following times before work on the analysis will be allowed to proceed:

1. Definition of assumptions and evaluated alternatives of the intervention
2. Baseline scenario
3. List of impacts and stakeholders
4. Proposal of main data sources and crucial assumptions
5. Lifespan of the intervention used for calculations
6. Determination of results, robustness testing
7. Recommendations
8. First draft (of the complete analysis)

Peer Review
The first draft of the analysis will be reviewed first by the CP Editor. After the researchers respond to the CP Editor's comments, the analysis will be subjected to peer review by two independent reviewers. After the researchers respond to the comments of the reviewers, the analysis will be discussed and as appropriate, approved by the CP Advisory Board.

Escalation Procedure
The CP Editor will ask the CP Advisory Board (or its Scientific Committee) to intervene in any situation where the CP Editor is in doubt, cannot find a reasonable solution to a problem, and/or cannot reach an agreement with a researcher.

C3. Other Requirements

Disclosure Policy
Authors shall provide a disclosure statement at the beginning of their analysis that identifies potential conflicts of interest they may have with regard to the subject matter.

Data Availability Policy
Data used in the analysis should be well-documented and made available for replication by other researchers. The data must include information on the computations and formulas necessary for replication. Any failure or refusal to do so must be approved by CP.

Appendix D: Alternative Approaches to Impact Assessment

There are some alternative approaches to public intervention impact assessment. However, none of them has the capacity to provide such a straightforward and comprehensive measure for comparison of policies as CBA. The main possible alternatives to CBA are listed below. This is only on overview for interested readers, because CBA has been chosen as the exclusive method to be used in CP projects.

Cost-effectiveness analysis (CEA) compares the relative costs and outcomes of an intervention. Unlike cost-benefit analysis, CEA does not express benefits with a monetary value. Rather, it determines the cost per unit of outcome. CEA is typically used to evaluate the impact of health-related policies and job creation policies. A special type of CEA is cost-utility analysis, which determines the ratio between cost expressed in monetary units and an outcome expressed in quality-adjusted life years (QALYs). Because the results are dependent on the unit of outcome, these methods cannot be used to compare the results of analysis across sectors where different outcomes are desired or expected.

Multi-criteria analysis (MCA) can be used when an intervention is expected to have significant distributional impacts or when many important impacts are too difficult to monetize. MCA allows accounting for impacts along several dimensions while disaggregating the impacts on different stakeholders or groups of stakeholders. It offers more in-depth evaluation but can only compare and rank alternative outcomes of one specific intervention at a time. Because interventions usually have different criteria for success and different groups of relevant stakeholders, MCA does not permit ranking the utility of different interventions in different sectors.

Risk-benefit analysis aims to take the dimension of uncertainty into account in cost-benefit analysis. It weighs both the positive and negative outcomes of an intervention by the risk that they will or will not occur. The biggest drawback of this approach is the difficulty in determining the level of risk associated with different outcomes where lack of data is a major concern (CBA Builder, n.d.).

Economic impact analysis seeks to estimate the change in economic activity in a given sector and area as a result of an intervention. It can be a valuable part of CBA if a partial equilibrium or general equilibrium analysis is required. As it only covers specific types of economic activity, it is not generally applicable and comparison of individual economic impact across sectors is impossible.

Fiscal impact analysis is limited to investigating the impact of an intervention on a government's budget. As such, it only takes one stakeholder (the government) into consideration and disregards the impact of a policy on all other stakeholders. It therefore does not capture the impact of an intervention on overall social welfare.

Social Return on Investment (SROI) is a method that uses the same logic as the cost-benefit analysis. It measures social and environmental impacts of an organization's investment that are not reflected in its financial accounts. It has been created as a tool for enabling managers and investors to monetize the social and environmental impacts of the actions of their organizations and more easily include them in their decision making. SROI is a much more specific form of analysis than the broader concept of CBA.[34]

The decisive characteristics that makes CBA the most appropriate method of analysis for our purposes is the ease of interpreting its results and its ability to produce results that are comparable across interventions and across sectors, while accounting not only for financial impacts but broader impacts on social welfare.

[34] For details about the difference between SROI and modern CBA, see http://www.socialvalueuk.org/sroi-and-cost-benefit-analysis

Appendix E: Template for Calculations

The Czech Priorities Excel CBA Template is available to researchers upon request. The Template performs all the calculations needed for CBA as described herein. This includes discounting, computing benefits-to-cost ratios, net present values, sensitivity analysis on impacts and parameters used in the analysis, and sensitivity analysis using three discount rates. The Template calculates a result for the entire lifespan of the intervention and also for ten- and 40-year periods.

CBA Templates prepared by other organizations all come with dedicated guidelines and include:

- New Zealand Treasury
    - Its CBAx Tool has a long list of impacts with values for New Zealand economy. The user chooses from among listed individual impacts and can add others. Parameters like lag, duration and affected population are included.
    - Available at https://treasury.govt.nz/publications/guide/cbax-spreadsheet-model-0
- Greater Manchester, UK
    - A highly practical template that includes lists of costs and benefits.
    - Available at https://www.greatermanchester-ca.gov.uk/what-we-do/research/research-cost-benefit-analysis/
- J-Pal
    - Two templates with basic and advanced levels of complexity are provided. The basic template is useful for capturing the complete costs and benefits for smaller-scale CBAs.
    - Available at https://www.povertyactionlab.org/research-resources/cost-effectiveness

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