Evaluation guide – Executive Summary

ÖKONVER – Economically sound evaluation of new technologies and measures in the European transport system – TP 1000 Valuation methods

Stand: 25.11.2019

DLR

1. Context and motivation

As part of the ÖKONVER project (economically sound assessment of new technologies and measures in the European transport system), a practical guide to the proper use of assessment methods in transport was developed. This guideline provides an overview of how systematic support can be provided from a scientifically neutral perspective for decision-making problems relating to new transport technologies and measures. The term "economic evaluation" describes a structured weighing up of decision options with regard to a defined target system and limited resources. This handbook provides both a description of the basic evaluation process, including the relevant evaluation methods, and a discussion of their limitations and applicability.

Decisions have to be made in all areas of the private and public economy. In a structured decision, the task is to systematically weigh up various consequences against each other. It goes without saying that this challenge also applies to transport and involves a wide range of decision-making problems - from the decision to implement political measures to the choice of technological lines and the organisation of specific products and designs.

DLR has a dual role as a point of contact for industry and politics and as a mediator between these two spheres: firstly, to support private and public decision-makers with regard to their decision-making problems and, secondly, to mediate between different interest groups in a process of interaction and consideration.

This practical guide serves as an aid to the development of economically sound evaluation expertise at DLR and thus creates added value for the broad mass of potential users at DLR by:

- Presenting and explaining an overview of the main assessment procedures and processes.
- The reference to transport is explained and visualised for the assessment procedures and processes.
- A common understanding is created within the DLR.
- To provide a practical guide for application in the political environment for scientists with different professional backgrounds.
- The limits of economic evaluation and the prerequisites for an adequate implementation of the evaluation process are demonstrated.

2. Basic structuring of evaluation processes

The structure of the evaluation guideline is directly orientated towards the basic process of systematic decision-making. A problem to be identified by the decision-maker is the prerequisite for a decision-making and evaluation process. This means that it must be clear who is making the decision (decision subject) and what is to be evaluated or ultimately decided on (decision object).

Figure 1 shows the general sequence of the evaluation process. After identifying the problem, the objectives are defined, which describe the desired states of the (economic) system or the entrepreneurial activity and are operationalised using suitable indicators. If there are hierarchical relationships between the objectives, these are referred to as target systems, which depend heavily on the decision-maker and the economic context.

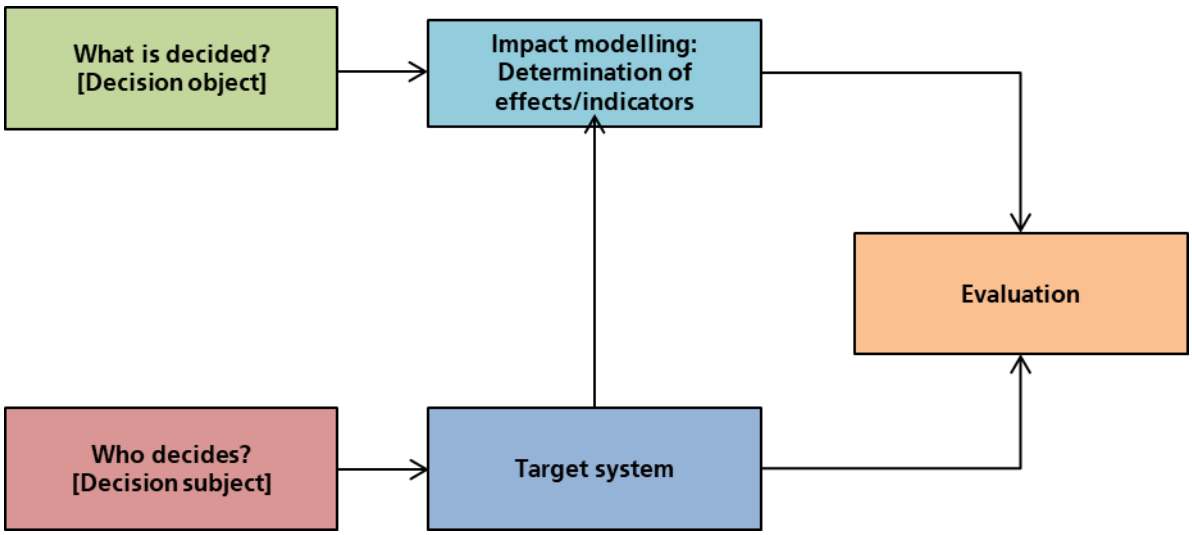

Figure 1: Overview of the decision-making process

The next step is the impact assessment, which uses quantitative models to estimate the potential impacts of the individual action alternatives and thus provides the quantitative framework for the evaluation. The impacts to be determined depend on the previously defined target system and the selected indicators. In addition to the methodological aspects and the economic categorisation of models, the evaluation guideline also presents the determination and particularities of specific benefit and cost components.

This is followed by the selection of a suitable evaluation procedure as part of a decision-making process. In the literature on systematic decision-making in complex trade-off situations, there are two different streams: on the one hand, prescriptive decision theory, which attempts to derive strategies and methods that address the cognitive abilities of the decision-maker and guide them towards objectively better decisions. These are essentially so-called multi-criteria procedures. The second stream involves benefit-cost methods, which deal with investment appraisal from an

operational perspective and apply the so-called benefit-cost analysis in various modifications at a macroeconomic level.

3. Evaluation Methods

3.1 Prescriptive Decision-Making Methods / Multi-Criteria Methods

Prescriptive decision-making processes include the utility analysis (including the Multi-Actor-Multi-Criteria Analysis (MAMCA) for different stakeholders and the Analytical Hierarchy Process (AHP) for pairwise comparisons), as well as the cost-effectiveness analysis.

Utility analysis (also known as a point-rating method or scoring model) is a method for evaluation and decision-making that can consider both qualitative and quantitative objectives. Unlike static or dynamic investment calculation methods, non-monetary evaluation criteria are also included. The advantage of utility analysis lies in its simple, transparent handling of very diverse objectives and the aggregation of evaluations into a utility value for each alternative. However, when apparently objective rankings are created based on the utility value, it must not be forgotten that the selection of objectives, their weighting, and sometimes even the evaluation of the degree of achievement are subjective.

Application Example for Utility Analysis: Comparison of Transport Modes

For a trip from Hamburg to Munich, the utility values of various transport modes are to be calculated. This could be done according to the following table:

Objectives	*Weighting*	*Car*		*Long-Distance Bus*		*Train*		*Plane*	
		Points	*Wt*	*Points*	*Wt*	*Points*	*Wt*	*Points*	*Wt.*
Travel Time	*25 %*	*2*	*0,50*	*1*	*0,25*	*3*	*0,75*	*4*	*1,00*
Cost	*40 %*	*3*	*1,20*	*4*	*1,60*	*2*	*0,80*	*1*	*0,40*
Comfort	*20 %*	*3*	*0,60*	*1*	*0,20*	*4*	*0,80*	*2*	*0,40*
Environmentally Friendly	*15 %*	*1*	*0,15*	*3*	*0,45*	*4*	*0,60*	*2*	*0,30*
Utility Value			***2,45***		***2,5***		***2,95***		***2,1***
Ranking			***3.***		***2.***		***1.***		***4.***

Table 1: Application Example of Utility Analysis

The following points should be noted in this example:

- *The perspective of the traveler is mainly considered here.*
- *The target criteria are understandable, but ultimately subjectively chosen; for example, it is assumed here that the traveler is environmentally conscious.*
- *The weightings vary individually depending on the passenger.*
- *The degree of goal achievement (points) is measured here in a clear ranking from 1 to 4 (with 4 being the best value). If corresponding values are available, one could instead use the ratios of the actual travel times, prices, etc. for the different modes of transport. However, the sum of the points awarded must be the same for each goal (normalization), and high degrees of goal achievement must always lead to high points (low travel time and low price, but high comfort and high environmental friendliness).*

When multiple stakeholders are affected by a decision and therefore need to be included in the decision-making process, the Multi-Actor-Multi-Criteria Analysis (MAMCA) is a suitable approach.

This method is an advancement of the utility analysis, which allows the inclusion of different affected groups right from the beginning of the decision process.

The Cost-Effectiveness Analysis (CEA) is a business-oriented decision-making tool. In CEA, there is no monetary evaluation of benefit-related parameters. This makes this method particularly suitable for evaluating alternatives whose benefits are difficult to describe monetarily. The basic principle of CEA consists of comparing the total costs to a previously determined effectiveness indicator. The resulting ratio describes the cost per effectiveness point, which is used to make comparable choices between different alternatives.

3.2 Benefit-cost method

Among valuation methods, cost-benefit methods hold a prominent position due to a unique feature: these methods consistently monetize all positive effects (benefits) as well as all negative effects including capital expenditures (costs). Cost-benefit methods are used to quantify the profitability of such measures or investments, make them comparable with each other or with the status quo (zero option), and thus provide decision-making bases for planners. The classical cost-benefit analysis is particularly a concept from macroeconomic evaluation. It is especially practiced, and sometimes even required, with large public investment expenditures. The interest rate reflects the technological progress and the preference for immediate consumption (compared to future consumption or the consumption of future generations). Additionally, there are Life-Cycle Costing Analysis (LCC-A) and Total Cost of Ownership (TCO) analyses, where the decision criterion is also based on the present value of cash flows, but generally involves decisions on technical design options of products.

TCO and LCC-A are methods for estimating costs over the entire life cycle of the product or the system under consideration. TCO and LCC-A serve to identify the main cost drivers and hidden costs even before an investment decision is made. For example, by determining the proportion of operating costs to total costs, the risk of an investment decision can be reduced. These two methods are applied in industry-specific practices: TCO is often used to calculate the life cycle costs of motor vehicles, while LCC-A is frequently used in the railway sector. For effective application of these methods, realistic and market-conforming reference values are necessary. There are some TCO calculators available on the internet. An example is the calculator from Iveco for calculating the costs of acquiring a truck.

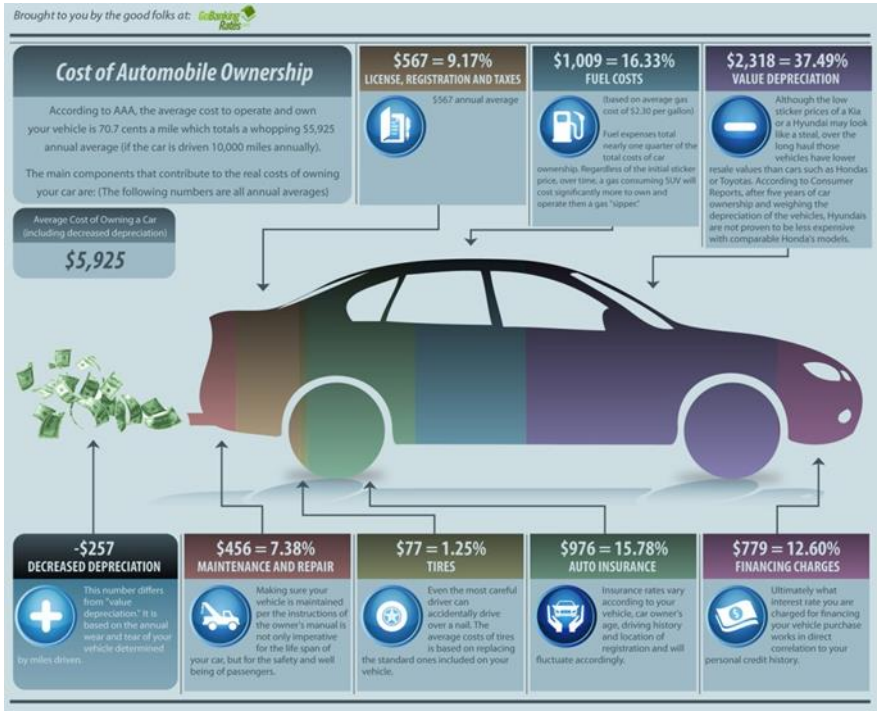

Abbildung 2: Beispiel für die Berechnung der Total-Cost-of-Ownership (TCO) eines Pkw

The economic cost-benefit analysis (CBA) aims to assess the rationality of capital expenditures/large projects by the public sector. It concerns projects that have a long-lasting impact. The characteristics of all CBAs are as follows: (1) the evaluation is performed on a monetary scale, (2) the monetary values are based on revealed, expressed, or assumed social preferences, (3) the indicators for the benefits are based on a welfare concept, and (4) two indicators are provided to the decision-maker – the aggregated benefits and the aggregated costs. A good example of the application of economic cost-benefit analysis in practice is the Federal Transport Infrastructure Plan (BVWP), which is developed every 10 to 15 years for the planning and evaluation of traffic infrastructure decisions. Employees from the DLR were also involved in the BVWP 2030.

4. Instructions for use

Economically grounded evaluation methods are used for making decisions by balancing different objectives. In institutional contexts, it is often observed that the term "evaluation" is misused as a catchphrase for a variety of different types of investigations, thus hindering its thematic, comprehensive, and consistent use. For an economically grounded evaluation, two aspects are fundamentally indispensable: first, it is necessary that the decision-maker and their motivation as the decision subject are known. Second, it is essential to clearly define the decision object in terms of the objectives that are to be achieved by selecting an alternative course of action. If these aspects are not considered in an economically grounded evaluation, there is a risk of mis-specification regarding

the relevant target system and the trade-offs between objectives. This can lead to undesirable outcomes.

Who decides? [Decision subject]	What is decided? [Decision object]	Example	Monetisability of the indicators	Mono-criteria methods			Multi-criteria methods				Remarks
				TCO	LCC-A	NKA	MCA	MAMCA	NW	KWA	
Transport policy	Infrastructure investment decision	Planning of a bypass	Yes			+					
Transport policy	Transport policy measure	Introduction of a 30 km/h speed limit for nighttime noise protection	Yes			+					
Several political actors (overall policy)	Technology innovation	Introduction of electromobility	Partly				+			+	Application of multi-criteria analyses, as an NCA consists of several NCAs from different sectors
Companies	Technology innovation	Product innovation "driving assistance system"	Yes			+					
Companies	Investment decision	Procurement of a vehicle	Yes	+	+						

Table 2: Decision Matrix for Selecting Suitable Evaluation Methods

In general, in an economic evaluation, the multitude of different decision-makers with their diverging goal systems combined with the choice of adequate indicators and different evaluation methods provide many degrees of freedom in the approach. Table 2 provides guidance on the circumstances under which certain methods should sensibly be applied. The methods used always strongly depend on the goals or the goal system of the decision-maker. If the goal of macroeconomic efficiency is considered, cost-benefit analysis is recommended. However, if the focus is purely on profit maximization through maximizing revenue or minimizing costs, investment calculation methods (TCO or LCC-A) should be used. If abstract goals are present or if there is no possibility to standardize the goals and their indicators on a scale (previously: monetary unit), prescriptive decision theories show their strengths. The multicriteria utility analysis and the cost-effectiveness analysis can be almost universally applied when abstract goals with no reference to different groups are involved. If it is necessary to balance interests between stakeholders, MAMCA is suitable.

Nevertheless, normative settings by experts are always necessary in the evaluation process. The developed guideline cannot replace expert knowledge, but instead serves as practical assistance. Furthermore, it includes literature references and mentions contact persons within the DLR.