Evaluation of Transport Infrastructure Investments

Problems and solutions
illustrated by the example of the new proposal for the
"Instructions for the Standardized Assessment of
Infrastructure Investments in Public Transport" in
the Federal Republic of Germany

Contribution for the World Conference on Transport Research 1983

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1. PROBLEM

The intention of the "Instructions for the Standardized Assessment of Infrastructure Investments in Public Transport" is to standardize the decision material on public investment in public transport facilities in the Federal Republic of Germany. The standardization enables consistent evaluation of projects which differ in location and in their technical and transport economic aspects according to uniform standards. The comparability of the results of assessments is an important assumption both for evaluating single projects and also for establishing priorities within a group of measures even if they are distributed over the conurbations of the Federal Republic.

There is no controversy on the fact that the evaluation method in combination with the operational economic study requires the inclusion of national economic aspects. In pursuing this objective a first "Instruction for the Standardized Assessment of Infrastructure Investments in Public Transport" was drafted in 1976 and applied in a test phase over a period of several years. The intensive analysis of the experience gathered with the old instructions together with the criticism of the administration, the academic world and of those applying them was the basis for the further development of the evaluating method in 1980/82 and gave first solutions and indications which have been integrated in the modified concept of the instructions.

2. FUNCTION OF THE "STANDARDIZED ASSESSMENT METHOD"

Considering the magnitude as well as the economic and social importance of the investment measures to be expected, the Federal Government and the Federal States (Länder) were concerned to obtain universal, comprehensive instructions which would be practical and operational with reasonable expenditure.

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The function of the "Standardized Assessment Method" has two distinct aspects (Appendix 1, Page 7):

- the recording (quantification) of objective information,
- the assessment, i.e. the transformation of this information or indicators recorded with different physical dimensions to a uniform measuring scale in order to obtain one or several composite indicators.

The first task principally represents the problem of data recording and data processing. In this phase the conflict between the wish for a perfect as well as for a practicable instrument must be settled. The essential working steps for this are:

- Deriving a comprehensive list of objectives, which considers - as far as possible - all the effects of a proposed measure,
- Determinating the assessment criteria to be recorded quantitatively or only qualitatively,
- Developing procedures which are able to record the quantitative objective contributions in the original measured dimensions.

At this stage it seems appropriate to point out once more that the list of objectives includes all possible imaginable effects of a measure in the field of public transport,

whereby

- 7 (9) indicators concerning the objective aspect "user" (or passenger) of a transport system,
- 3 indicators concerning the objective aspect "operator",
- 16 indicators concerning the objective aspect "general public",

were included in the relevant objective system (Appendix 2, Page 8).

The reliability and quality of the quantified effects is, however, necessarily very different. In addition, more uncertainty is created by the process of assessment. The extent of this uncertainty, however, depends on the indicator being considered. This means that with an increasing number of components taken into consideration the information content on the nature and the extent of the effects increases but at the same time there is an increase in the uncertainty in the assessment methods and results (Appendix 3, Page 9). For this reason what follows is intended to show how the indicators can be combined step by step corresponding to their reliability in quantifying and assessing the single effects. As a result several composite indicators are obtained.

If the original measurment of several indicators has the same dimension there is no special assessment problem. In this case the different indicators can be combined without any further theoretical reflections. In the present case it applies to all operational economic effects (capital charges of the investment, operating expenditure, revenues) available in monetary form. These can be combined to operational economic indicators from the viewpoint of the "operator" as well as from the viewpoint of the "investor and operator".

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With regard to the desirable and necessary inclusion of national economic indicators in the assessment of an investment measure, there is one great difficulty. Because of the differing dimensions of the objective contributions it is not possible to estimate their respective importance when trying to evaluate a project as a whole. For that purpose it is necessary to transform the objective contributions to a uniform measurment scale in order finally to be able to derive composite indicators.

The different procedures of cost-benefit-studies allow an integration not only of the technical, operational efficiency and purely economical components of an investment measure but also of the effects on the transport customer, on the economic structure and envirement of the area, on other modes of transport and even on other transport infrastructure, and on the general public in the evaluating process. These methods are all more or less specific due to their historical and specialised scientific development, in their methodical structure and have differing application emphases and differing criteria and decision patterns. Therefore there is no single correct and strictly demarcated method which applies to all the questions arising.

So it seems appropriate and possible to use the advantages of the different procedures by combining them. In principle all investment calculations and cost-benefit-studies - depending on the respective decision problem - should have the following objectives:

a) to come to a decision concerning the absolute advantage of a project (Yes/No decision),

b) to come to a decision concerning the relative advantage of an alternative solution against another or several other solutions for a definite project (choice of alternatives),

c) to come to a decision on the relative advantages of spatially and sectorally independent investment measures (making a priority list within an investment program).

d) to ascertain the optimum point in time for investment.

When assessing projects which are financially promoted by the German Gemeinde-Verkehrs-Finanzierungsgesetz (Community-Transport-Financial-Law) decisions as in d) need hardly be taken as the availability of the financial means depends mostly on technical or financial policy constraints. The function of the decision preparation is reduced therefore to the questions a), b) and c) which have to be solved by the procedures suggested here.

With the setting up of a comprehensive list of objectives and then laying down the instructions for the registration of the single objective contributions an important assumption for evaluating investment measures has been created, which is totally independent of any evaluating method.

The transparent derivation and representation of all objective contributions - at least in their original measuring quantities - is thus a contribution for a better understanding of the assessment procedure and therefore also for a greater confidence in the offered decision aid. Thereby that considerable part of the discussion of principles on the procedures of cost-benefit-studies, which concerns the question of monetary assessment or points assessment, becomes superfluous.

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That monetary assessment is necessary in cost-benefit-analysis brings with it without doubt a lot of problems. But on the other hand, the points assessment in cost-effectiveness-analysis and in multicriteria analysis is certainly not less problematic, as in both cases all effects have to be brought into a uniform measurment dimension. The objection raised against cost-benefit-analysis that a non-existent accuracy is simulated cannot hold good for the "Standardized Assessment Method" where the objective contributions are represented in their original measured dimensions and the assessment procedure is specified in an transparent manner. The same applies for the points assessment of the cost-effectiveness-analysis and the multicriteria analysis.

However, for those cases where effects cannot be measured using a cardinal scale the question of scale transformation arises in a different form. The problem of how to bring those indicators onto a cardinal points scale in the framework of a cost-benefit-analyses cannot be solved scientifically in a satisfying manner. The integration of such components in intensive cardinal assessment methods therefore remains difficult.

However, the nature of ordinal scales only allows - also when registrating the effects in the originally measured dimension - the justification of an order of precedence. The intention to use only ordinal scales for all objective contributions would consequently imply that the laborious quantification of those objective contributions, that can be recorded in cardinal dimensions, is rendered useless. With this a considerable loss of information would be involved which seems by no means justifiable in view of the great importance to be accorded to just these cardinally measurable effects for transportation infrastructure.

For the further development of the "Standardized Assessment Procedure" the above mentioned considerations imply the suggestion that should be utilized the advantages of the different procedures of cost-benefit-studies and built up to an evaluation procedure with several resultant indicators, as is described in the following paragraph (3.5).

3. FUNDAMENTALS OF THE PROPOSED PROCEDURE

The new procedure can be characterized as follows:

(3.1) There is a clear separation between recording the data and assessing the data. This is emphasised by the fact that the work of those applying for the transportation measure finishes with the representation of all objective facts (data in originally measured dimensions).

(3.2) The transformation of the effects or indicators available in the different originally measured dimensions to a uniform measurment scale is done as clearly as possible. This is achieved on the one hand by specifiying the evaluation assumptions, on the other hand by the investor doing the assessment on the basis of the recorded objective facts himself.

(3.3) The necessity of an interregional comparability of the assessment basis requires a far reaching standardization of the instructions on the procedure and the evaluation input.

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This refers to

- the determination of the basic date (conception of the transport supply and the forecasting of transport demand),
- the procedures for recording the different effects in their originally measured dimensions,
- the assessment of these measured quantities.

Such a standardization reduces on the one hand the possibility to fully consider local conditions but, on the other hand, a renunciation of any standardization would increase the scope for manipulation for the applicant to such a degree that the requirement for an interregional comparability would be seriously impaired. Thus the procedure has to make a (first) compromise between the requirement for standardization and the requirement for consideration of local conditions.

(3.4) In order to get an optimal (and second) compromise between the opposing requirements for a complete recording of the effects on the one hand and for a reasonable expenditure related to the project to be assessed on the other, both a simplified and a comprehensive procedure are offered. The design of the instructions allows, however, a comparison of the results for different projects independent of the procedure applied.

In contrast to the comprehensive procedure the simplified procedure does not consider changes in the modal-split as a result of investment nor the possible increased demand for public transport. The application of the simplified procedure pre-supposes that the effects of the infrastructure investment on private transport and on total transport volume can be neglected. Only in this case it can be assured that none of the essential benefit components will be neglected and that the result does not contain a relevant impairment. Criterion for the decision which procedure to use is the maximum time saving related to a single trip caused by the investment. The additionally recorded benefit components when applying the comprehensive procedure result principally from a consideration of changes in the modal-split, out of which result changes

- in the operating expenses for private transport,
- in air pollution,
- in the demand for energy,
- in accidents,
- in land usage requirements.

In the field of public transit the comprehensive procedure additionally takes into consideration changes in fare revenue and, if need be, the increase of travel demand in consequence of an improved transport supply.

(3.5) In order to utilize the advantages of the different procedures of cost-benefit-studies when finally assessing the effects in their originally measured dimensions and in order to build up the evaluation procedure on the basis of several composite indicators, the indicators are combined in several groups or stages according to the degree of accuracy in recording and assessing the effects (compare paragraph 2 and appendix 4). It was recommended to examine the following composite indicators:

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A) An operational economic indicator (from the viewpoint of the "operator" as well as "operator and investor") for which every individual component indicator is cardinally measurable; every originally measured quantity is in cardinal monetary units.

B) A cost-benefit-indicator (national economic viewpoint) every individual component indicator is cardinally measurable; originally measured quantities are either monetary or can be monetarized by a conventionally recognized conversion method; the scale is cardinal in monetary units.

C) A multicriteria indicator;
every individual component indicator is cardinally measurable; originally measured quantities cannot be transfered into monetary quantities or possible transformations are not sufficiently well established and/or recognized;
a cardinal scale (points) is used [1]).

D) A quality class indicator;
individual component indicators can only be registered on an ordinal scale, i.e. in quality classes (eventually also on a nominal scale).
Details can be taken from appendix 5, page 11.

Summarizing it can be said that the procedure is suitable for making the investment decisions on the different public transport projects which compete for the scarce financial means more objective.

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[1]) In principle a transformation in monetary units is imaginable; irrespective of this a segregated presentation of the composite indicators B and C is thought to be appropriate.

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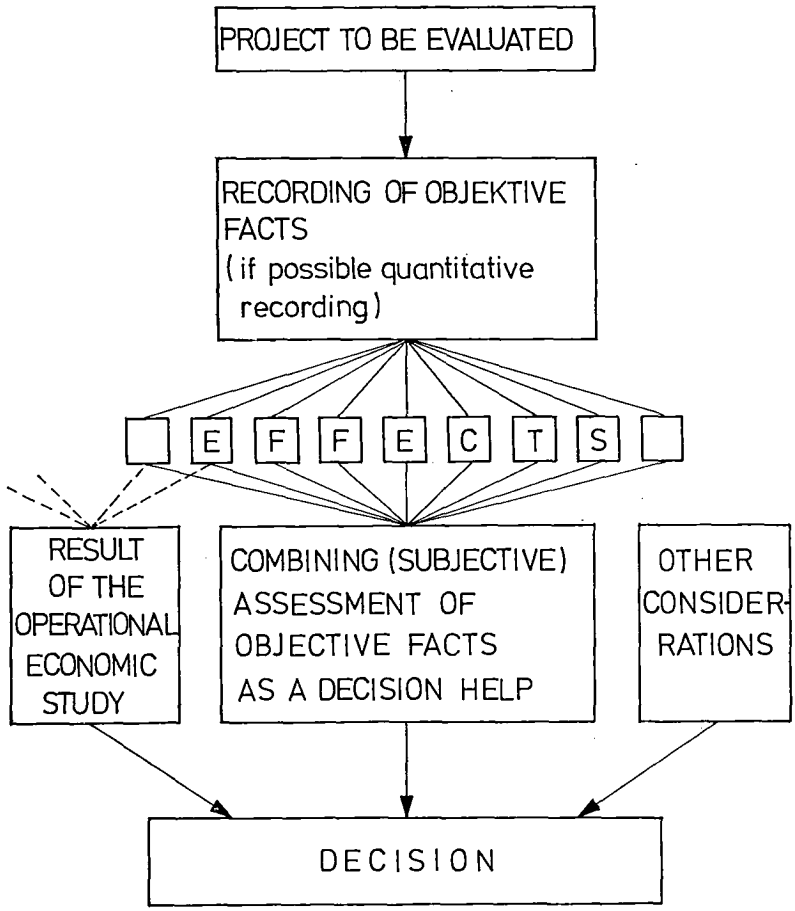
Appendix 1



FUNCTIONS OF THE "STANDARDIZED ASSESSMENT METHOD"

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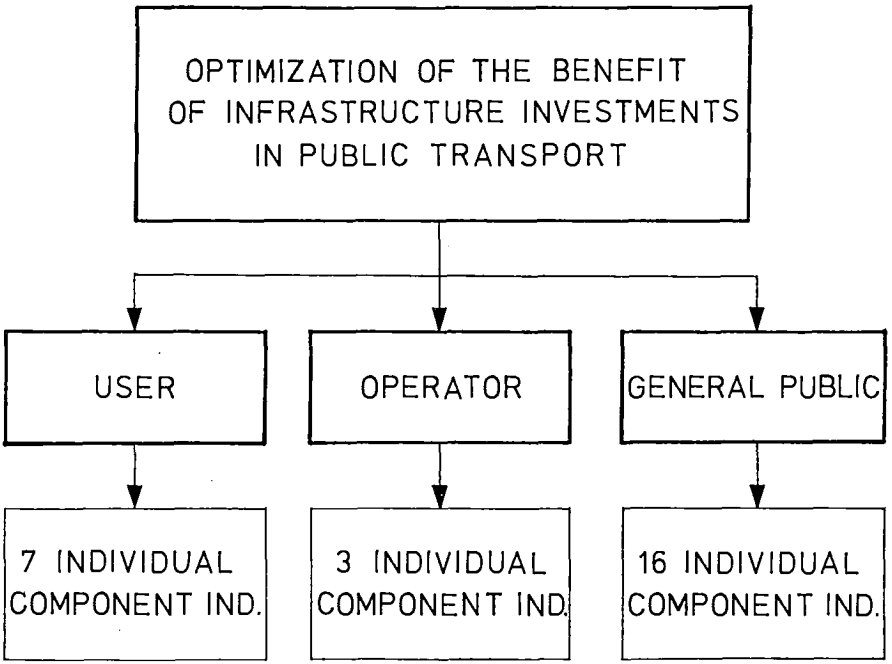
Appendix 2



OBJECTIVE SYSTEM OF THE "STANDARDIZED ASSESSMENT METHOD"

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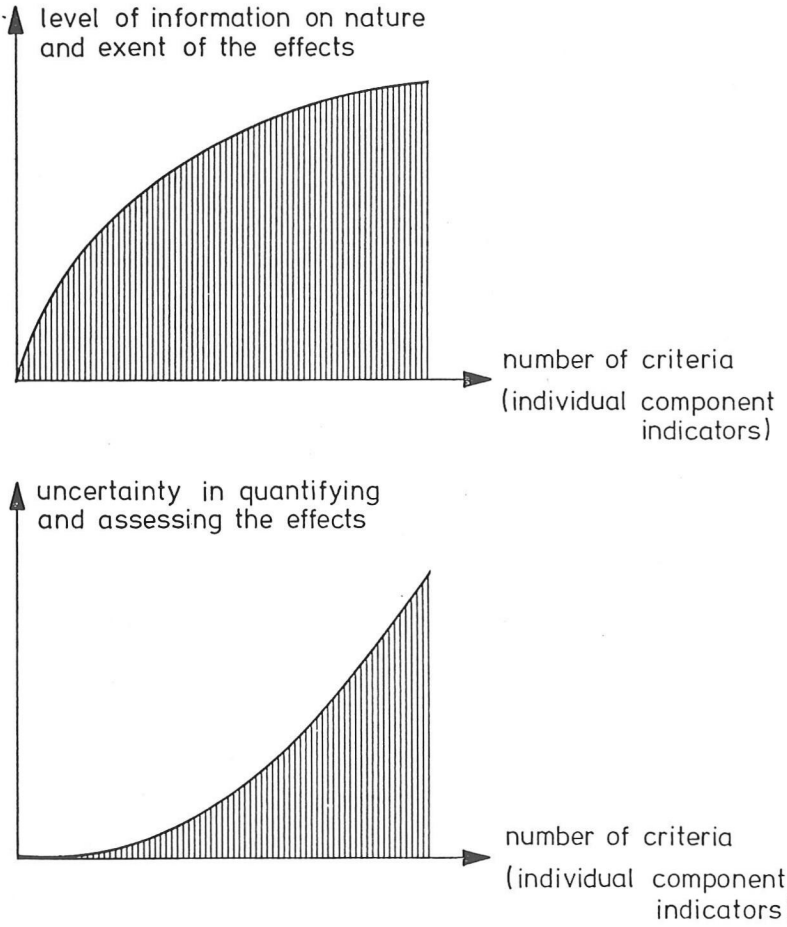
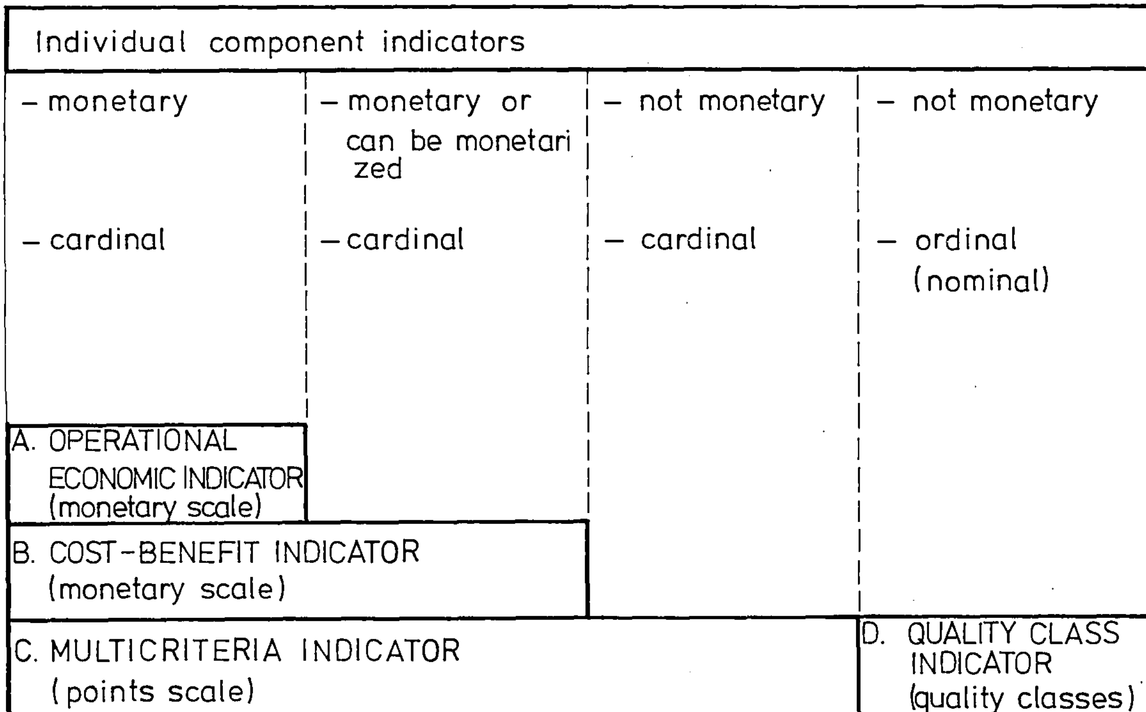


connection between number of criteria, level of information and uncertainty in assessment



SUGGESTED COMPOSITE INDICATORS FOR THE STANDARDIZED ASSESSMENT METHOD.

Teilindikatoren	Dimension der originären Meßgröße	Relevant für Indikator (A) (B) (C) (D)[2]
Saldo der Erlöse ÖV[1]	TDM/Jahr	A
Saldo des Kapitaldienstes Fahrweg ÖV	TDM/Jahr	A B C
Saldo der Unterhaltungskosten Fahrweg ÖV	TDM/Jahr	A B C
Saldo der Vorhaltungskosten Fahrzeuge OV	TDM/Jahr	A B C
Saldo der Betriebsführungskosten ÖV	TDM/Jahr	A B C
Saldo der Betriebskosten IV	TDM/Jahr	B C
Reisezeitdifferenz im verbleibenden Verkehr OV	Std /Jahr	B C
Saldo der Abgasemissionen		
– Kohlenmonoxid	t/Jahr	B C
– Kohlenwasserstoffe	t/Jahr	B C
– Stickoxide	t/Jahr	B C
– Schwefeloxide	t/Jahr	C
– Blei	t/Jahr	C
Geräuschbelastung (Saldo der je nach Geräuschintensität gewichteten Einwohner)	gewichtete Einwohner	B C
Saldo der Unfallschäden je Jahr		
– Anzahl Tote	Pers /Jahr	B C
– Anzahl Schwerverletzte	Pers /Jahr	B C
– Anzahl Leichtverletzte	Pers /Jahr	B C
– Sachschadenkosten	TDM/Jahr	B C
Saldo des Primärenergieverbrauches direkt durch Mineralölprodukte betriebener Fahrzeuge	MWh/Jahr	C
Saldo des Gesamtprimärenergieverbrauches	MWh/Jahr	C
Saldo des Verkehrsangebotes	Platz-km/Jahr	C
Saldo der Indizes der Erreichbarkeiten		
a) von Stadtzentren	Einw.-min.	C
b) von Stadtteilzentren	Einw.-min.	C
Saldo des Flächenbedarfs		
– innerorts	ha	C
– außerorts	ha	C

Teilindikatoren	Dimension der originären Meßgröße	Relevant für Indikator (A) (B) (C) (D)[2]
Teilindikatoren zur Beurteilung des Beförderungskomforts:		
Saldo der Bedienungshäufigkeiten an der Hauptstrecke[3]	Fahrtenp./Tag	C
Saldo der mittleren Umsteigehäufigkeiten[3]	–	C
Saldo der Anteile der angebotenen Platz-km auf Teilstrecken mit systemeigener Trasse[3]	%	C
Saldo der angebotenen Platz-km auf Teilstrecken niveaufrei bzw. mit Vorrang[3]	%	C
Saldo der mittleren Fußwegentfernung[3]	m	C
Saldo der mittleren Anteile von Sitzplätzen am Gesamtplatzangebot[3]	%	C
Fahrkomfort (Fahrzeug, Einstieg)	verbal erfaßt	D
Haltestelle (Wartekomfort)	verbal erfaßt	D
Saldo der Streckenlängen entlang von Entwicklungsachsen	km	C
Saldo der Streckenlängen in Wasserschutzgebieten	km	C
Saldo der Streckenlängen in Natur- und Landschaftsschutzgebieten	km	C
Wirkungen auf		
– regionale und kommunale Wirtschaftsstruktur	verbal erfaßt	D
– evtl. strukturelle Arbeitslosigkeit	verbal erfaßt	D
– regionale und kommunale Sozialstruktur	verbal erfaßt	D
Anpassungsfähigkeit an Nachfrageschwankungen	verbal erfaßt	D
Wirkungen auf den Netzzusammenhang	verbal erfaßt	D
Trennwirkungen	verbal erfaßt	D
Anpassung an die vorhandene Bebauung	verbal erfaßt	D
Wirkungen auf Natur- und Landschaftsbild	verbal erfaßt	D
stadtebauliche Wirkungen	verbal erfaßt	D
Beeintrachtigung der historischen Bausubstanz	verbal erfaßt	D
ggf. weitere Umweltbeeintrachtigungen die im rechnerischen Teil der Beurteilung nicht erfaßt werden	verbal erfaßt	D

[1] Teilindikator entfällt bei betriebswirtschaftlichem Indikator ohne Berücksichtigung des Kapitaldienstes Fahrweg ÖV

[2] A: Betriebswirtschaftliche Indikatoren · B: Kosten-Nutzen-Indikatoren · C: Nutzwertanalytischer Indikator · D: Güteklassen-Indikator

[3] jeweils gewichtet mit der Anzahl von Fahrten im verbleibenden Verkehr ÖV