Contribution to the Discussion of Infrastructure Project Appraisal: The German FTIP 2030 Case

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In 2016 the revision of the German Federal Transport Infrastructure Plan 2030 (FTIP 2030) was completed. The paper describes major methodical changes and focuses on the new benefit components "reliability" and "implicit benefit difference". The impacts of selected new or updated indicators[1] are shown by the comparison of appraisal results reflecting the assessment methodology of the FTIP 2030 and the outdated methodology from 2003, respectively. The calculations rest upon a simplified road network most suitable to crystallize the methodological differences.

INTRODUCTION

At the European Transport Conference 2014 (ETC 2014) one of the authors[2] already presented interim results of the methodological revision of the FTIP 2030. Based on this methodology the FTIP assesses proposed infrastructure projects. This assessment finally results in a list distinguishing between projects to be implemented within the scope of the FTIP and those which have virtually no chance of being realized. It is important to emphasize that the FTIP and its project list is a planning tool of the federal government, but neither a financial plan nor a law. The federal parliament receives the FTIP as presentation of the government and has the right to adapt the list of infrastructure projects. The finally accepted priority projects pass the parliament as "upgrading acts including requirement plans". For these projects the sectoral planning process can start to achieve construction law and hence get financial means from the annual budget.

The overall process of the FTIP follows a prioritization procedure consisting of three main steps:

- Determination of necessary financial means for maintenance and replacement
- Distribution of the remaining budget to three transport carriers: road, railways und inland waterways
- Urgency classification (prioritization) of projects for each transport carrier.

The assessment procedure for comparing project ideas submitted within a certain transport carrier has four pillars:

- Benefit-Cost-Analysis (BCA)
- Environmental assessment (for those environmental aspects which cannot be evaluated by monetizable indicators and hence, cannot be included in BCA)
- Spatial impacts (accessibility of regions and transport nodal points)
- Urban development (in case of city bypasses).

The mentioned contribution to ETC 2014 gave detailed explanations with respect to the overall framework of FTIP 2030, the prioritization procedure, improved plausibility checks for the estimated investment costs, and an overview on improvements of BCA so far. Consequently, the paper at hand informs in detail about the new benefit components "reliability" and "implicit benefit difference", the latter an approach to bring FTIP methodology closer to international concepts of consumer and producer surplus. Finally, the paper assesses a fictional infrastructure project exemplarily based both on the new and the previous assessment methodology of FTIP. This gives evidence on the impacts of FTIP 2030 methodological revision.

REMARKABLE ENHANCEMENT OF BCA

The following aspects of BCA have been modified to a noteworthy extent. The paper explains in this context:

- the assessment of travel and transport time savings
- the integration of induced traffic and changes of mode choice into the concept of BCA
- the consideration of changes in reliability for all modes
- the valuation of traffic safety (improvements) and
- the assessment of greenhouse gas emissions of transport infrastructure over life time.

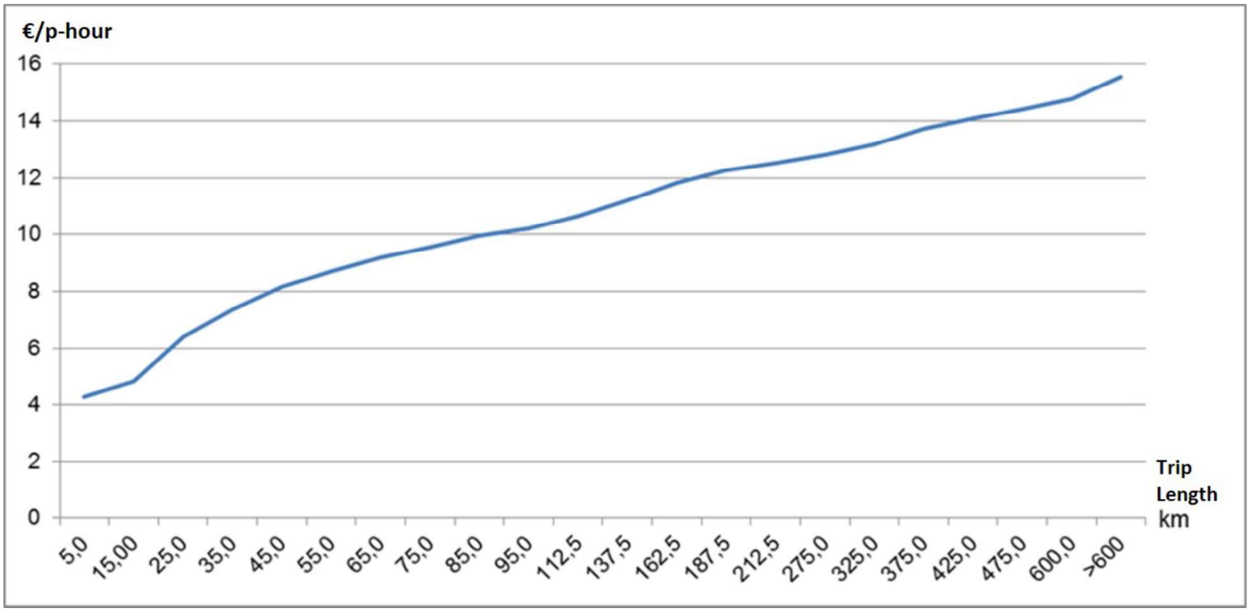
Assessment of Travel and Transport Time Savings

Within the scope of the FTIP methodology upgrade, two research projects concerning valuation approaches for travel and transport time savings and reliability aspects were initiated. One study focused on passenger[3], the other on freight transport[4]. In both studies, revealed (RP) and stated preference (SP) surveys were conducted. The common data base, set up by the results of RP and SP, were exploited to generate up to date-values of time (VoT) and values of reliability (VoR), the latter as percentage of VoT.

VoT for Passenger Transport

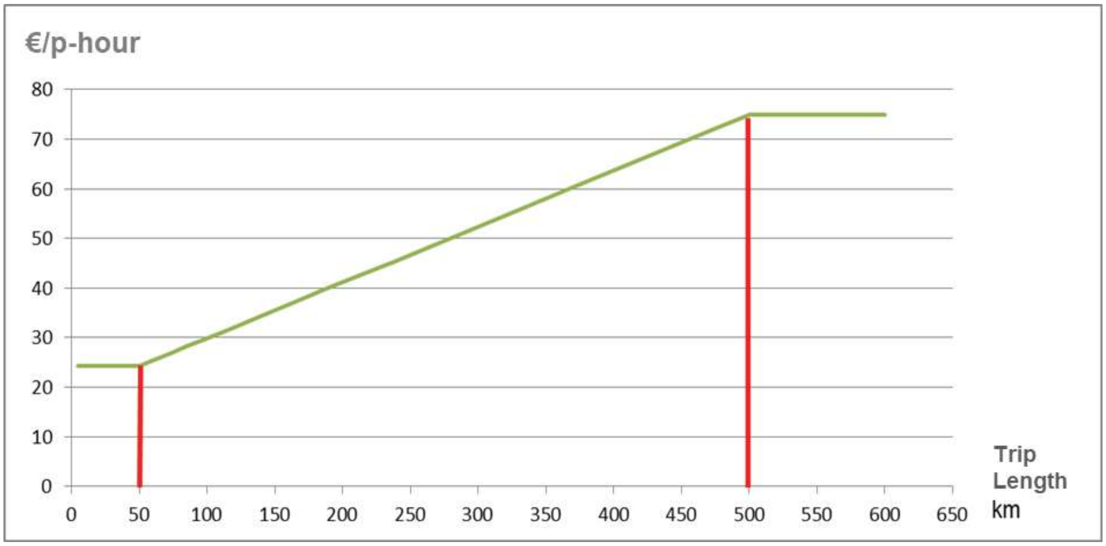
In accordance with this exercise in passenger transport, the Value of Time (VoT) will from now on be determined as a function of the travel distance. With increasing travel distance between origin and destination the valuation for time savings increases. This applies to all trip purposes in passenger transport. But furthermore, the results of the study suggest that the magnitude of VoT within a certain range of distance depends significantly on trip purpose, so that FTIP 2030 distinguishes between non-commercial and commercial trips. The trip purpose "commercial" includes all kinds of business trips (e.g. trips of craftsmen and businessman) whereas non-commercial trips comprise all other purposes of passenger transport (e.g. leisure, shopping, commuting). Figure 1 shows the VoT applied within the FTIP 2030 for non-commercial trips. The values are based on the abovementioned research project dealing with VoT of passenger transport.

FIGURE 1
DISTANCE-DEPENDENT TIME VALUES OF NON-COMMERCIAL PASSENGER TRANSPORT, SOURCE : PTV ET AL. (2016) (RESULTS BASED ON SWISS FEDERAL INSTITUTE OF TECHNOLOGY, TNS INFRATEST (2015))



This study also comprises VoT for commercial trips. However, these VoT are not applied within the FTIP 2030 as the respective values turned out to be lower than average labor costs. The reported values in commercial passenger transport were considered underestimated as travellers do obviously not take into account the impacts of additional travel times on production, business processes etc. They rather seem to quantify the personal welfare loss comparing leisure time and working hours. FTIP 2030 applies for this reason for commercial trips up to 50 km VoT derived from labor costs of economic sectors relevant for these short distances (delivery services, craftsmen, etc.). International studies show that transport users with higher income tend to commercial trips with higher distances. Accordingly, the FTIP 2030 incorporates increasing VoT with increasing trip distances for commercial trips. As there is no statistical data applicable for deriving VoT for long distance trips, the upper VoT (for distances of 500 km and more) is derived from calibrated volume-capacity-functions of the FTIP transport model. VoT for travel distances between 50 and 500 km can be interpolated (see Figure 2).

FIGURE 2
DISTANCE-DEPENDENT TIME VALUES OF COMMERCIAL PASSENGER TRANSPORT, SOURCE: PTV ET AL. (2016)



VoT for Freight Transport

For the first time FTIP 2030 includes VoT for goods being transported based on survey results (see above). Until now only the potential cost savings for the operation of vehicles and staff in case of transport time savings were taken into account. The FTIP 2030 evaluates transport time savings in freight transport more comprehensively. Decreased capital costs and logistic advantages on the receiver's side because of transport time savings are also considered. The VoT in freight transport depends on the travel distance and the category of goods. In order to get an idea about the scale of VoT for freight transport the following Table 1 shows average values for different commodity groups and intermodal transport.

TABLE 1
AVERAGE VOT FOR FREIGHT TRANSPORT

Commodity Group	VoT [€/h and t]
Maritime intermodal traffic	0,305
Continental intermodal traffic	1,180
Food	1,011
Mining products and soils	0,374
Petroleum products	0,746
Chemical products and fertilizers	0,727
Metals	0,827
Vehicles, machines and devices	1,506
Other products and goods	0,201

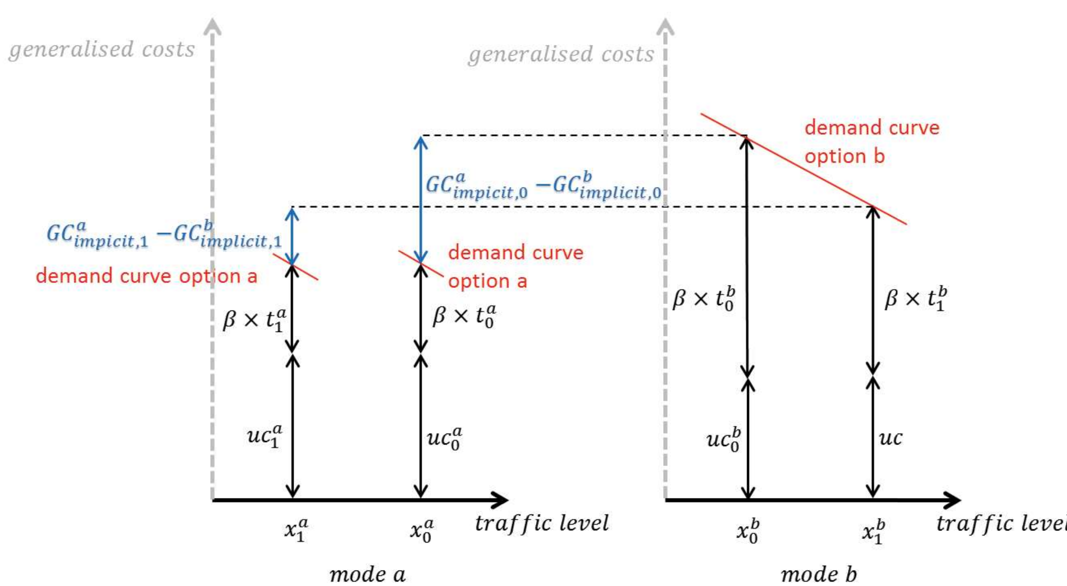
Integration of Induced Traffic And Changes of Mode Choice Into The Concept of BCA

BCA approaches are based on the concept of welfare change. On the international level this concept is put into practice by measuring changes in the consumer's and producer's surplus due to new or modified transport infrastructures. These changes represent the benefits of the respective transport infrastructure and are brought into relation to the construction and maintenance costs. Within this concept, impacts of induced and diverted traffic are considered by applying the so-called rule-of-half. For the time being, the FTIP considered diverted and induced traffic and their impacts on benefits only roughly. During the general examination of the FTIP methodology it became clear that improvements on this issue were necessary to catch up with international standards. As a baseline, German FTIP measures welfare changes by changes in resource consumption. Therefore, benefits of transport infrastructure are measured by changes in operational and maintenance costs, clean air or harmful emissions, respectively, travel time and others. Due to this conceptual difference the rule-of-half cannot be applied directly to the BCA of FTIP. Therefore, a new approach[5] has been developed by introducing a new benefit component "implicit benefit difference" which allows to keep the relevant elements of the former approach while going beyond it, in order to make it more comparable with international practice of using economic surplus measures.

The "implicit benefit difference" and its meaning can be explained with a simple example as follows. An accelerated rail connection (option b) still remains slower than the competing road connection (option a). Travel times[6] (and therefore the generalized costs) of option b decrease from t_0^b (GC_0^b) to t_1^b (GC_1^b) due to the acceleration, whereas all (generalized) user costs and the corresponding operational costs are assumed to remain constant.

Nevertheless, one can observe (and predict by models) some users (Δx) switching from road to rail due to the improved rail connection. It is obvious to see that these behavioral changes are caused by a difference in generalized costs which are not part of travel times and (generalized) user costs. This part of the generalized costs is unobserved or unobservable and we call it implicit costs of rail or road connection, respectively. According to Nagel et al. (2012) implicit costs can easily be calculated for switching users. Figure 3 shows the situation. Corresponding to the usual assumptions underlying the rule-of-half concept, the demand curve for option b between x_0 and x_1 is assumed linear. It is obvious that travel time costs plus user costs for option b are higher than those for option a for all users, including the marginal users between x_0 and x_1. However, these users would only switch from option a to b in case the generalized costs of both options are equal or generalized costs of option b are less than those of option a. This requires that implicit costs or rather their difference are taken into account. Figure 3 shows the difference of these implicit costs on the left-hand side both for the marginal user at x_0 and x_1.

FIGURE 3
DEMAND CURVES AND GENERALISED USER COSTS FOR OPTION A AND B FOR THE MARGINAL USERS AT X_0 AND X_1
(OWN ILLUSTRATION BASED ON INTRAPLAN, PLANCO, TU BERLIN, 2014)



We repeat that the generalized costs are the sum of generalized implicit and generalized explicit costs, whereas the generalized explicit costs consist of travel times and generalized user costs:

$$GC^a = GC^a_{implicit} + GC^a_{explicit} = GC^a_{implicit} + uc^a + \beta \times t^a. \tag{1}$$

Using definition (1), it holds for the average switching user between x_0 and x_1 (meaning: $GC^a = \overline{GC^b}$):

$$\overline{GC^b_{explicit}} = \overline{uc^b} + \beta \times \overline{t^b} = uc^a + \beta \times t^a + \left(GC^a_{implicit} - \overline{GC^b_{implicit}}\right) \tag{2}$$

being

- uc^a (generalized) user costs for option a
- $\overline{uc^b}$ average user costs for option b, $\overline{uc^b} = \frac{1}{2} \times (uc^b_0 + uc^b_1)$
- t^a travel time for option a
- $\overline{t^b}$ average travel time for option b, $\overline{\mathrm{t^b}} = \frac{1}{2}(\mathrm{t^b_0} + \mathrm{t^b_1})$
- β value of time
- $GC^a_{implicit}$ implicit generalized costs for option a
- $GC^a_{explicit}$ explicit generalized costs for option a
- $\overline{GC^b_{implicit}}$ average implicit generalized costs for option b, $\overline{\mathrm{GC^b_{implicit}}} = \frac{1}{2}\left(\mathrm{GC^b_{implicit,0}} + \mathrm{GC^b_{implicit,1}}\right)$

From this, equation (2), we get in accordance with Figure 3:

$$\overline{\mathrm{GC^b_{implicit}}} - \mathrm{GC^a_{implicit}} = (\mathrm{uc^a} + \beta \times \mathrm{t^a}) - \left(\overline{\mathrm{uc^b}} + \beta \times \overline{\mathrm{t^b}}\right) \tag{3}$$

Switching from implicit user costs of the average switching user to implicit benefits of all switching users, equation (3) – multiplied by -1 and being Δx the number of switching users - becomes:

$$\begin{aligned} \Delta B_{implicit,total} &= \left(\overline{B^b_{implicit}} - B^a_{implicit}\right) \times \Delta x \\ &= \left[\left(\overline{uc^b} + \beta \times \overline{t^b}\right) - (uc^a + \beta \times t^a)\right] \times \Delta x \end{aligned} \tag{4}$$

being

- $\Delta B_{implicit,total}$ implicit benefit difference of all switching users
- $B^a_{implicit}$ implicit benefit of option a and the average switching user
- $\overline{B^b_{implicit}}$ average implicit benefit of option b and the average switching user
- Δx number of switching users.

This "implicit benefit difference" can be added to the conventional benefit components which have already been considered by the methodology of FTIP 2003. These benefit components consist – generally spoken - of differences of operational costs and travel time costs between with and without measure-case:

$$B_{operational} + B_{travel\ time} = \left(oc^a - oc^b\right) \times \Delta x + (\beta \times t^a - \beta \times t^b_1) \times \Delta x \tag{5}$$

being

- $B_{operational}$ benefits from operational cost savings
- $B_{travel\ time}$ benefits from travel time savings
- oc^a operational costs of option a

oc^b operational costs of option b
t_1^b travel time of option b after implementation of infrastructural investment

Using equation (4) and (5), the total benefit B_{total} becomes

$$B_{total} = \Delta B_{implicit,total} + B_{operational} + B_{travel\ time} \tag{6}$$
$$= \begin{bmatrix} (oc^a - oc^b) + (\beta \times t^a - \beta \times t_1^b) \\ + (\overline{uc^b} + \beta \times \overline{t^b}) - (uc^a + \beta \times t^a) \end{bmatrix} \times \Delta x$$
$$= \left[\beta \times (\overline{t^b} - t_1^b) + (\overline{uc^b} - oc^b) - (uc^a - oc^a)\right] \times \Delta x$$

This is exactly the calculation resulting from the welfare concept:

$$B_{total} = \Delta CS + \Delta PS$$
$$\Delta CS = \beta \times (\overline{t^b} - t_1^b) \times \Delta x = \beta \times (t_0^b - t_1^b) \times \frac{1}{2} \times \Delta x \tag{7}$$

$$\Delta PS = \left[(\overline{uc^b} - oc^b) - (uc^a - oc^a)\right] \times \Delta x \tag{8}$$

being

B_{total} total benefit of infrastructural investment
ΔCS change in consumer surplus due to infrastructural investment
ΔPS change in producer surplus due to infrastructural investment

Assessing Changes in Reliability of Different Transport Carriers

The initially mentioned contribution for ETC 2014 focused on the concept of standard deviation for measuring reliability in the road sector. Here, the functional determination of standard deviation depends only on the volume-capacity ratio of a certain link and is set to "zero" for all volume-capacity ratios below 75%[7]. The latter assumption simplifies the calculation as beyond this threshold the same speed can be applied for passenger cars and trucks. The underlying understanding of non-reliability for this concept is the missing ability of a road link to provide a defined level of service for given "standard" traffic situations (excluding extreme weather situations, men made attacks etc.). The alternative interpretation of non-reliability is the deviation of the realized travel time from the expected travel time. Within this concept the daily traffic jam between seven o'clock and eight o'clock in the morning can be reliable with a small standard deviation from the expected, even though frustrating travel time. The mathematical description of this approach is given by the so-called mean-variance model including mean of travel time, standard deviation, cost terms and an error term for the utility function to be maximized.

The FTIP 2030 functional determination of the standard deviation must be applied for each single link, although reliability is mainly an KPI for the whole route from origin to destination. To calculate reliability of a route as square root relating to the sum of variances of all links included, the non-correlation of incidents on adjacent links must be given. FTIP 2030 methodology recommends calculating a hypothetical reference length for the network under consideration based on the volume-capacity ratios, which guarantees the independence of incidents on neighbored links. The quotient of individual link length and reference length is applied to adapt the calculated standard deviation.

For the rail sector, deviations from contracted arrival times in schedule bound systems (schedule delay) in frequency (percentage of arrivals) and extent (delays measured by e.g. minutes) are appropriate for measuring non-reliability. These delays can be replaced by (anticipated) buffer times to avoid delays. Calculating und using buffer times converts uncertain time losses with a big range into certain time losses, sparing a small risk not to be in time.

Within the framework of FTIP the future rail network 2030 does not provide a deeply elaborated time schedule. Instead of this, standardized times for changing trains according to the classifications of trains involved are proposed. Moreover, it is assumed, that the design of the schedule contains sufficient buffer times to reach the desired destinations in time and to get connecting trains. The priority of passenger trains over freight trains in train operations supports this expectation. Last but not least, the influence of all-weather hazards, men made attacks etc. on reliability are not considered in the FTIP approach, as it is an assessment procedure for deriving a pure strategic implementation plan for transport infrastructure. Concisely, reliability is not captured for passenger rail transport.

For freight trains the modelling of reliability can be realized by an endogenous train line system between marshalling yards with defined transport times serving as an artificial schedule. During the assignment process, waiting times on passing loops occur due to the number of prioritized passenger trains as base load and the increasing volume of the freight trains. This modelling procedure generates the frequency of delay and the extend of delay for each origin-destination relation and each commodity group. Reference values for reliability are related to one percentage point of punctuality for one ton of a commodity group. Herewith, punctuality is defined as delay exceeding scheduled transport time by 20% and more. The reference values must be calculated for each relation and commodity group using the first derivation of the corresponding utility function[8].

To complete the section, it must be stated that for the transport carrier inland waterways transport time variabilities are not relevant due to the long delivery periods of supply chains the transport by vessel is part of. Reliability is mainly influenced by the water level fluctuations. There are special transport insurances, which pay for alternative transports (road or rail) in case of low water levels and corresponding low loaded drafts. Increasing figures of low water level incidents may reduce the profit of insurances. These costs are already considered within the BCA as part of the operational costs (and benefits will occur, if operational costs can be reduced by improved infrastructure, e.g. watergates). Therefore, there is no need for further consideration of reliability for inland waterways.

Valuation of Traffic Safety

In Germany, accident cost rates include replacement costs, costs due to loss of resources and components for considering immaterial damages. In contrast to other countries, the latter component was not considered in any BCA approach for assessing transport infrastructure projects in Germany until FTIP 2030. This circumstance is probably due to German history of the twentieth century and the resulting ethical doubts concerning the valuation of human lives.

For FTIP 2030 this component is based on results of the HEATCO project[9]. It was determined by assessing the willingness to pay of users for reducing the risk being harmed by accidents (themselves or rather relatives and friends). Due to the additional consideration of this component accident cost rates raise significantly by above 100% and more depending on the degree of injury. Accordingly, the cost rate applied for assessing fatalities is about 2.48 million Euros (2012 values).

Assessment of Greenhouse Gas Emissions of Transport Infrastructure

Previous approaches of FTIP only considered greenhouse gas emissions resulting from the operation of vehicles, vessels, aircrafts and trains. A recently completed research project funded by the German Federal Environment Agency quantifies that constructing, operating and deconstructing transport infrastructure entails a significant amount of greenhouse gas emissions. The study quantifies these emissions by material flow analyses carried out for all building materials of transport infrastructure.

Table 2 shows exemplarily lifecycle greenhouse gas emissions for road infrastructures which have been derived from this study.

TABLE 2
SPECIFIC LIFECYCLE GREENHOUSE GAS EMISSIONS FOR ROADS

Road Category	**Lifecycle greenhouse gas emissions [kg CO_2-eq./a*m^2 road surface]**
Roads (without bridges and tunnels)	
Motorway	6,2
Other federal roads	4,6
Premium for bridges	12,6
Premium for tunnels	27,1

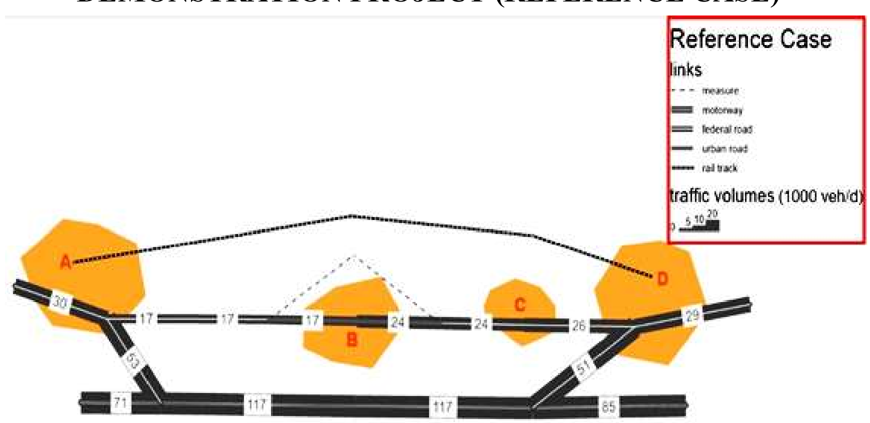
Therefore, FTIP 2030 includes an additional indicator assessing these lifecycle greenhouse gas emissions of transport infrastructure. The results of FTIP 2030 show that considering this indicator has repeatedly a significant impact on the total benefit of the assessed projects. The share of benefit of this indicator reaches 10% or more for about 7% out of all assessed projects. Furthermore, the share of benefit of this indicator exceeds the share of benefit resulting out of reduced CO_2 emissions of vehicles, vessels, aircrafts and trains for more than half of the projects of FTIP 2030.

EXAMPLARY APPLICATION

Subsequently, we demonstrate the impacts of the methodological improvements of FTIP 2030 based on a fictional infrastructure project. For this purpose, our project has been assessed by both, the previous (2003) and the current (2030) BCA approach of FTIP. To provide a deeper insight, impacts of the adaption of different indicators and combinations of indicators on project results are shown and discussed.

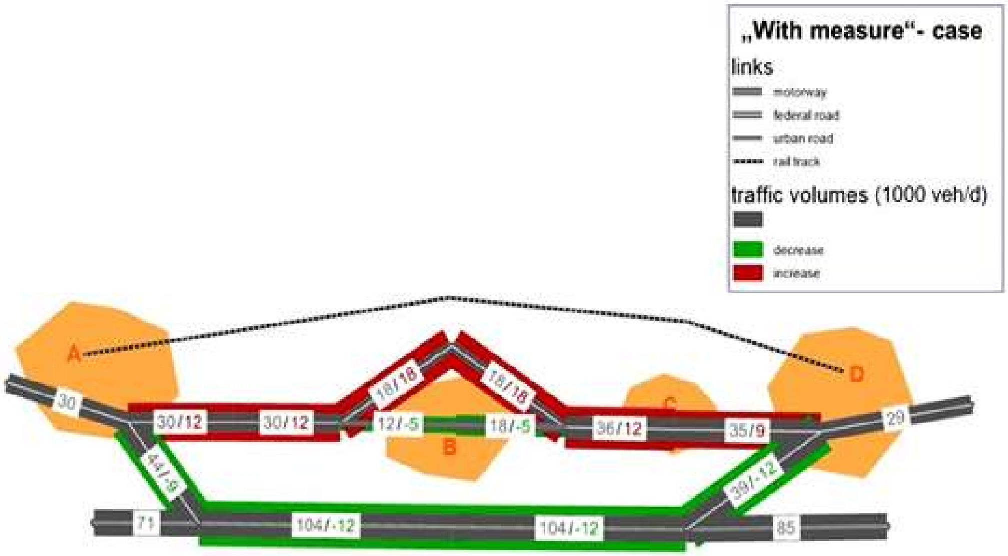
Figure 4 shows the designed and quite simple network situation excluding the project to be assessed (reference case).

FIGURE 4
DEMONSTRATION PROJECT (REFERENCE CASE)



There are four cities (A to D) with a railway track connecting A and D directly. Furthermore, there are two roads linking A and D: a motorway at the bottom and another road via B and C shown in the middle of Figure 4. The picture shows the traffic volumes for each road link in the reference case measured by vehicles per day. For the benefit of city "B" a bypass road is planned, benefits must be estimated. Figure 5 shows the network situation including the infrastructure project (with measure-case) incorporating the effects resulting from the assignment of a constant demand (FTIP 2003 did not consider induced traffic directly). The values marked at the links represent the traffic volumes of the with measure-case as well as the difference between with-measure-case and reference case.

FIGURE 5
DEMONSTRATION PROJECT
(WITH MEASUERE-CASE APPLYING CONSTANT DEMAND)



One can clearly see typical effects of a bypass road: traffic flows move from the inner city of B to the city's surroundings. Beside these primary effects, some secondary effects can be observed: because of the increased attraction of the new connection A-B-C-D some road user move from the motorway to the bypass as well. These route changes have been assessed within the context of FTIP 2003 methodology.

For comparability reasons, cost rates (reference values) of FTIP 2030 (reference year 2012) have been applied to FTIP 2003 based results, too. Table 3 shows the results for the most relevant indicators.

TABLE 3
ASSESSMENT RESULTS (SELECTED INDICATORS)
ACCORDING TO FTIP 2003 METHODOLOGY

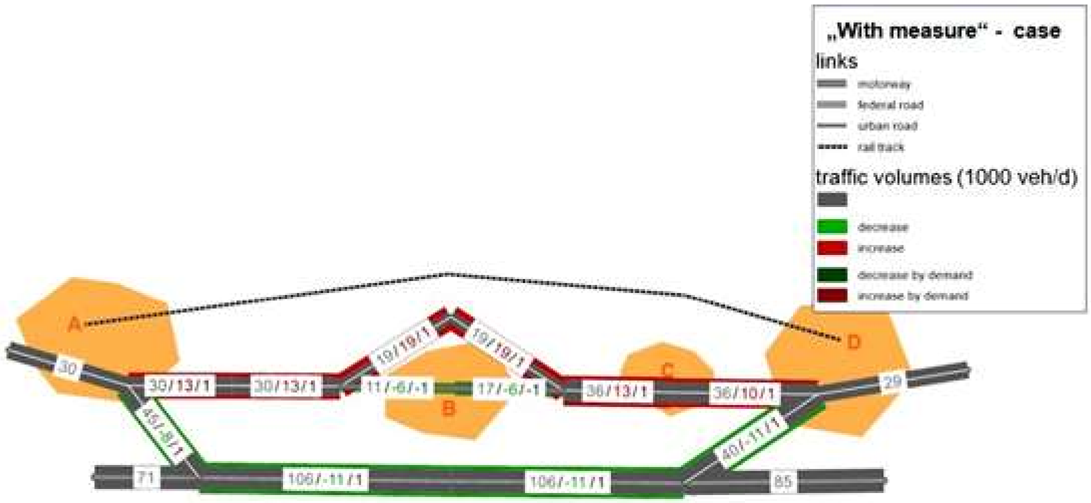
Indicator	**Benefit (FTIP 2003) [1.000 €/a]**
Infrastructure maintenance costs	-117
Traffic safety	-1.738
Travel and transport time	24.557
Environmental impacts	3.039
Operational and energy costs	50.993
Total	**76.734**

The major effects result from travel and transport time savings as well as operational and energy cost reductions. The specific impact of the individual benefit components stems from the boundary conditions of this fictional example and can't be generalized.

But FTIP 2030 took some steps further. Besides the adoption of new cost rates[10] and the new indicator for assessing reliability improvements by infrastructure projects, the approach integrates demand changes induced by new projects into BCA using the new indicator "implicit benefit difference" (see section 3.2).

Figure 6 illustrates the impacts of the re-calculated transport demand including modal shift effects between road and rail and changes in destination choice as results of the modified impedance values on network links. The third number on road links (on the right side of the link) reflects impacts of the adopted matrix.

FIGURE 6
DEMONSTRATION PROJECT
(WITH MEASUERE-CASE INCLUDING ADOPTED DEMAND)



To conclude the main effect, induced and shifted traffic require substantial shares of the extended capacity. These additional traffic flows on road network lead to assessment results not that positive as expected. But higher traffic volumes generate more travel time, more operational costs, critical situations regarding traffic safety (see chapter 3.4) and more emissions compared to the reference case. However, the induced traffic causes a positive effect concerning the indicator “implicit benefit difference”. Additionally, this project improves the network reliability (mainly along the motorway).

Table 4 and Figure 7 show the results for selected indicators for FTIP 2030 methodology.

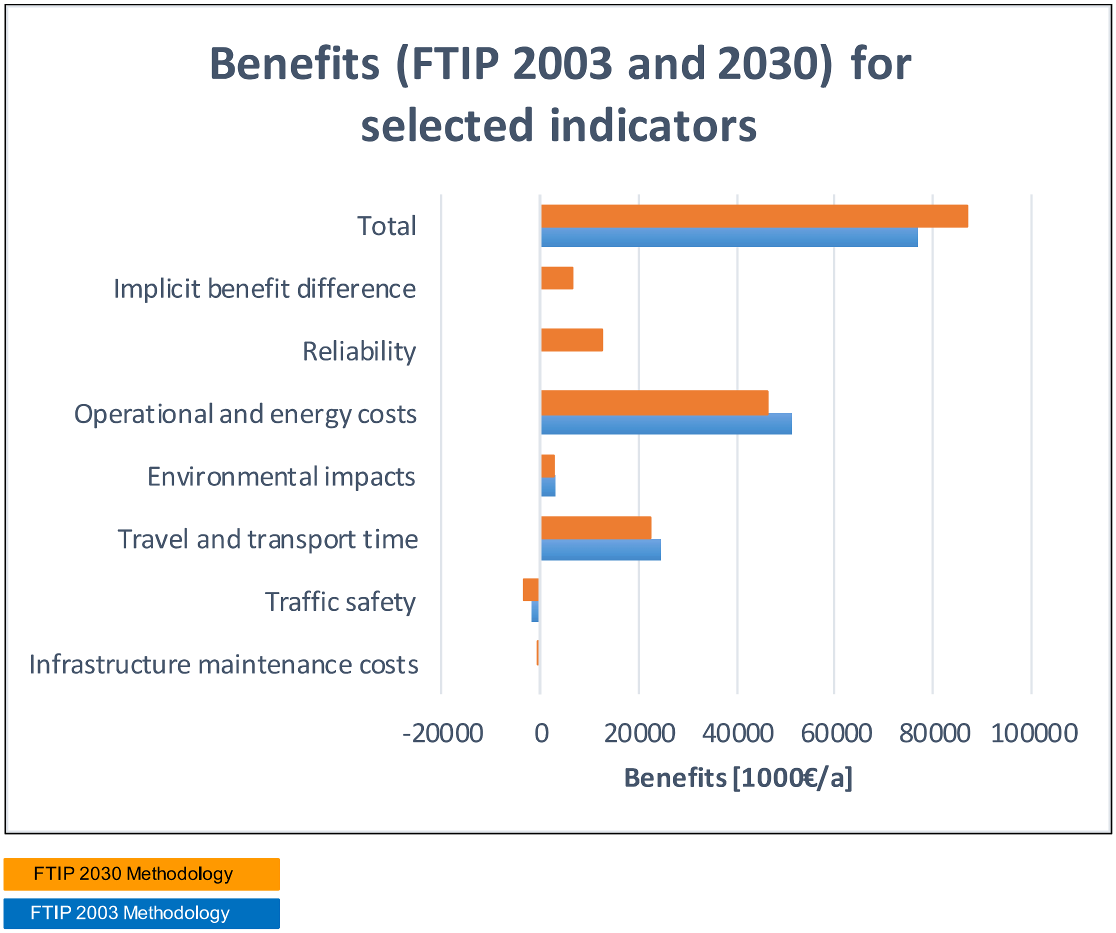
TABLE 4
ASSESSMENT RESULTS (SELECTED INDICATORS)
ACCORDING TO FTIP 2030 METHODOLOGY

Indicator	**Benefit (FTIP 2030) [1.000 €/a]**
Infrastructure maintenance costs	-117
Traffic safety	-3.374
Travel and transport time	22.445
Environmental impacts	2.825
Operational and energy costs	46.210
Reliability	12.693
Difference of implicit benefits	6.283
Total	**86.965**

The effects of methodological improvements of FTIP 2030 are most interesting (see Figure 7). Both new indicators, implicit benefit difference and reliability, add additional (in this case positive) benefits to the assessment result. These effects were missing in FTIP 2003 assessments. The negative impacts of accidents due to more road traffic are valuated twice compared to the former FTIP methodology.

However, the more realistic handling of demand changes due to the measure (induced traffic, modal shift) leads to reduced benefits of the hitherto existing indicators. These are negative effects of increased traffic volumes on environment, traffic situation and traffic safety. For our small project, the total sum of benefits according to FTIP 2030 methodology exceeds that based on FTIP 2003 methodology, but again, this result is only valid for our example and not significant in general. However, it gives an idea on how the methodologic improvements of FTIP 2030 close some well-discussed gaps of FTIP 2003 methodology.

FIGURE 7
COMPARISON OF ASSESSMENT RESULTS (SELECTED INDICATORS) ACCORDING TO FTIP 2030 AND FTIP 2003 USING FTIP 2030 COST RATES



CONCLUSION

The handbook on FTIP 2030 methodology has a volume of more than 400 pages and thousands of pages of study reports form the background for this publication. For this reason, the authors intend to highlight the most relevant improvements, to show that this complex procedure is applicable, and that results can be interpreted. The extremely simple example of a network with less than 20 links illustrates the effects of the improvements clearly. Most important, two (out of four) new indicators (reliability and implicit benefit difference) are integrating previously missing effects of infrastructural changes. The integration of model-based demand changes in the assessment leads to a better handling of (negative) effects of additional demand caused by new infrastructure and makes the FTIP 2030 methodology comparable with international standards.

In the meanwhile, more than 2.000 road projects, about 40 huge rail projects, and a sample of projects for the inland waterways have been assessed using the updated methodology. The results have been acknowledged by the scientific community as well as by the German parliament, finally. Although we are facing years of sufficient budgets for infrastructure investments the shortage of planning capacities and the complexity of legal processes to achieve construction law could hinder Germany to realize its ambitious investment plan of FTIP 2030.

ENDNOTES

1. We use the term "indicator" for variables (like hours of travel time saved) showing the extent of target achievements. The values of these variables regarding a certain project represent the benefit of its realization.
2. Walther et al.: Revision of project evaluation as part of the German Federal transport infrastructure plan, in Transportation Research Procedia 2015, Elsevier
3. Swiss Federal Institute of Technology, TNS Infratest (2015)
4. BVU, TNS Infratest, KIT (2016)
5. Nagel et al. (2012)
6. To simplify the explanation, an average value of time (VoT), weighted across all distances and trip purposes, is used.
7. Geistefeldt et al. (2014)
8. For the road sector, the reference value per hour standard deviation (as measure for reliability) could be specified as 70 % of the reference value for travel time savings (based on survey results)
9. Bickel et al. (2005)
10. The impacts of the adoption of cost rates are not shown. It was decided to apply costs rates of FTIP 2030 also for the assessment based on the FTIP 2003 approach in order to focus on the impacts of the methodological improvements.

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