Interreg
Danube Transnational Programme
Danube Cycle Plans

# Application of Updated CBA Methodology for Transport Infrastructure Projects

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# Danube Cycle Plans | Policies, plans and promotion for more people cycling in the Danube region

www.interreg-danube.eu/danube-cycle-plans

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# 1 Executive summary

Estimating the economic benefits of cycling infrastructure projects is a vital part of the planning and evaluation processes. There are already well-established methods for transportation projects that can be used to appraise a project's net value to society, such as the Cost-Benefit Analysis (CBA) or the multi-criteria analysis (MCA). Although these are widely used in the industry to evaluate all kinds of projects, using them for cycling projects requires some extension. There are several well-documented and scientifically proven benefits of cycling that other, non-active transportation modes do not have, i.e. health benefits or carbon-free transportation. To approximate the net benefit of a cycling infrastructure project, one has to consider these benefits as well. Otherwise, cycling projects might seem less favourable compared to other projects.

This document applies the „Extended CBA Methodology for Transport Infrastructure Projects" guideline for a potential EuroVelo 6 (EV6) border section as a showcase. This work has been part of the Danube Cycling Plans (DCP) project, which aims to promote cycling in the Danube region by diverse activities, including creation or update of national cycling plans, definition of a Danube wide cycle route network on the basis of national networks, provision of common infrastructure standards, estimation of investment necessities, as well as a multitude of other things (marketing, know-how exchange, mentoring, etc.).

The main differences of the new evaluation method to the CBA Guide is the introduction of health benefits using a WHO method, and the different assessment of the value of travel time.

A pilot cycle path section was selected – Štúrovo (Slovakia) – Szob (Hungary); 20 km – for the introduction of the differences of the cost benefit analyses (CBA) which, as a cross-border section, is part of the EuroVelo 6 bicycle corridor and the infrastructure has not yet been developed, but progress is expected in the near future.

As a result, the economic indicators of the project in the two versions of economic CBA are as follows.

| Economic values and indicators | | CBA Base | DCP CBA |
|---|---|---|---|
| Total costs (EUR, 2022 prices) | | 3,696,120 | 3,696,120 |
| Total benefits (EUR, 2022 prices) | | 1,296,362 | 5,421,790 |
| Economic net present value (EUR, 2022 prices) | EPV | -2,399,758 | 1,725,670 |
| Benefit/Cost ratio | BCR | 0,35 | 1,47 |
| Economic rate of return | ERR | -1,40% | 5,47% |

Table 1: Economic indicators of the project in the base and DCP updated CBA methodology

It is profoundly demonstrated how important the quantification of the positive effects and benefits of cycling is in terms of the project's social utility indicators. We propose these benefits (especially health benefits and perceived safety as an additional value of travel time) to be included in the CBA guide of the European Commission.

# 2 Introduction

Cycling policies have become more and more important over the last decade. This mode of transportation can be part of the solution for many of humanity's challenges in the 21st century. Travelling by bike is a carbon-neutral way of transportation, so it is an effective tool in the fight against climate change. Commuting by using an active mode of transport has significant health benefits. It is cheaper to travel by bike than by car by a magnitude. Bicycles are more silent and use less space than cars, so they have a much better impact on the urban environment. Cycling also got attention for being an infection-safe transportation mode, a vital feature since the beginning of the COVID pandemic in the spring of 2020. These benefits make cycling an appealing alternative to more and more people in Europe. However, cycling is still only a minority in the transportation modal split in the vast majority of countries in Europe. Most commuters still find individual car usage a more attractive alternative.

Several factors must come together to make people change their commuting behaviour and insert cycling into their daily routine. A cultural shift is necessary, meaning that individuals have to think more consciously about their travelling habits. They must be willing to reorganize their lives to accommodate cycling into it. This cultural shift includes the spread of knowledge about the benefits of cycling, the actual risk, and information on the adverse environmental and other effects of individual motorised transportation modes. But another critical element is infrastructure: the lack of proper bike lanes and paths can discourage travellers from trying this form of transportation. So the number one priority for advocates of cycling has been the creation of adequate infrastructure that provides safe and comfortable routes for cyclists.

There are huge differences among the European countries regarding how developed their cycling route network is. In recent years, there has been a breakthrough in many cities and countries, with the political willingness to design roads and urban spaces with cyclists in mind becoming stronger and stronger; in others, this breakthrough is yet to come. Whatever the situation might be in a given area, estimating the economic benefits of cycling infrastructure projects is a vital part of the planning and evaluation processes. There are already well-established methods for transportation projects that can be used to appraise a project's net value to society, such as the Cost-Benefit Analysis (CBA) or the multi-criteria analysis (MCA). Although these are widely used in the industry to evaluate all kinds of projects, using them for cycling projects requires some extension. There are several well-documented and scientifically proven benefits of cycling that other, non-active transportation modes do not have, i.e. health benefits or carbon-free transportation. To approximate the net benefit of a cycling infrastructure project, one has to consider these benefits as well. Otherwise, cycling projects might seem less favourable compared to other projects.

This document applies the „Extended CBA Methodology for Transport Infrastructure Projects" guideline for a potential EuroVelo 6 (EV6) border section as a showcase. This work has been part of the Danube Cycling Plans project, which aims to promote cycling in the Danube region by diverse activities, including creation or update of national cycling plans, definition of a danube wide cycle route network on the basis of national networks, provision of common infrastructure standards, estimation of investment necessities, as well as a multitude of other things (marketing, know-how exchange, mentoring, etc.).

# 3 Economic cost-benefit analysis

## 3.1 GENERAL METHODOLOGY

As the DCP methodology (DCP CBA, 2022) affects exclusively the economic analysis including its benefit side, only the economic analysis is presented in the cost-benefit analysis; the usual supplementary parts of the analysis – financial analysis and sustainability, sensitivity analysis, risk analysis – are not included.

In terms of methodology, the calculation developed in EuroVelo 6 Feasibility Study (EV6 FS; Hegyen-völgyön, 2014) has been modified for the section we selected based on the most current EU and Hungarian CBA guidelines.

The latest EU CBA guide is the Vademecum (Sartori et al., 2021), which defines the social discount rate at 3% by default if no other value is given based on the national CBA guide, and the residual value of the individual elements of the project during the period examined (30 year) is based on its remaining service life at the end of the year. This was implemented in the latest Hungarian guide in general (KPÚ; Trenecon, 2022), however, in the case of transport projects the former transport CBA guide (Trenecon, 2018) is still in use, while the new Hungarian transport CBA guide is currently under preparation.

In addition, the cycling CBA methodology of the EV6 FS (Hegyen-völgyön, 2014) has a high significance as well, as the cycling chapters in the general and traffic CBA guidelines are rather poor.

The economic CBA was evidently also developed using an incremental approach (compares with-the-project scenario with a counterfactual baseline scenario without-the-project) with a new 3% default social discount rate established for the for the 2021-2027 program period and constant prices at 2022 level. EUR rate (2022) is 403.49 HUF, which is the 2022Q3 average of the Hungarian National Bank (MNB).

First the methodology used by the EV6 FS (Hegyen-völgyön, 2014) were updated based on the current CBA guidelines, then the assessment of the new section was carried out, and finally the economic CBA had been implemented in the base (using CBA guidelines) and DCP updated versions.

## 3.2 THE EV6 CYCLE ROAD PROJECT

A section was selected for the analysis which, as a cross-border section, is part of the EuroVelo 6 bicycle corridor and the infrastructure has not yet been developed, but progress is expected in the near future. Our choice fell on the Štúrovo (Slovakia) – Szob (Hungary) section, which is 20 km long. Currently, this is the only section that is not part of the bicycle corridor on the left bank of the Danube at the border of the two countries, but the reason of it is the lack of infrastructure, after its construction this section is certainly expected to become part of EuroVelo 6 corridor.

The following map shows the route of the new bicycle path between Štúrovo (Párkány) and Szob:

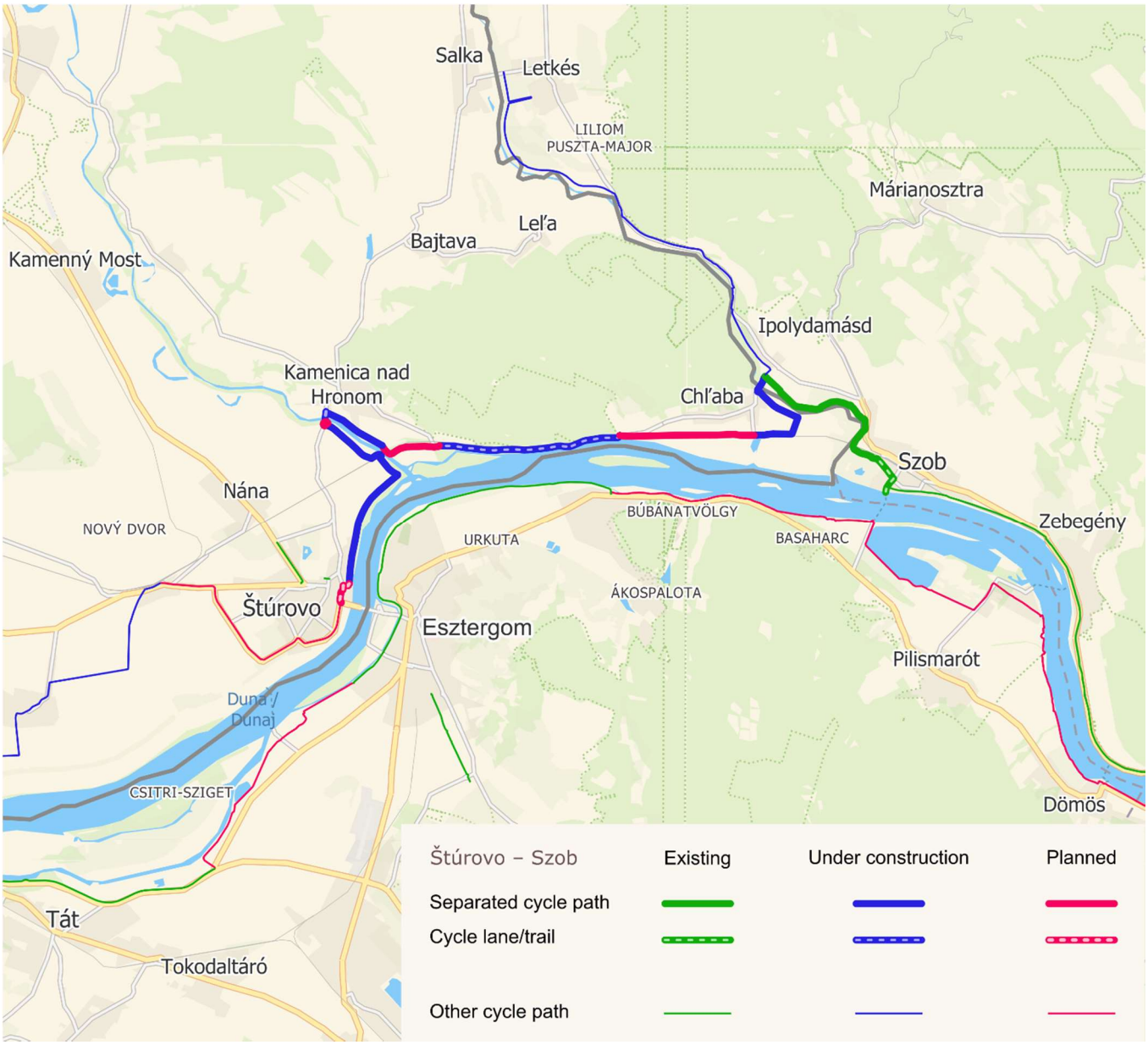


*Figure 1: Štúrovo (Párkány) – Szob cycle path*

During determinig a project for the whole section the projects which have been recently completed or under construction in the studied section were involved and three phases were identified.

In the first phase, the cycle path between Ipolydamásd and Szob was realized, which was completed in June 2021.

In the second phase, the construction of the Ipeľ/Ipoly border bridge between Chľaba (Helemba) and Ipolydamásd, which also includes a separated cycle path on its southern side, is identified as ongoing, and it may be completed at the beginning of 2023. In the meantime, the construction of the cycle path is also in progress at Štúrovo (Párkány) on embankments of the Danube, then on both sides along the Hron (Garam), as well as at Chľaba (Helemba) on the north side of the railway next to the Danube and finally along the Ipeľ/Ipoly. The works began in the fall of 2022 and are expected to be completed by March 2023. Routes are marked (with cycle trail or advisory cycle lane) on the intermediate road sections.

In the third phase, which we have projected, the construction of the bicycle path next to the Štúrovo (Párkány) – Szob railway is taking place near Chľaba (Helemba), thus the bicycle path under construction in phase 2 near the mouth of Ipeľ/Ipoly will actually become an operational part of the EV6, as well as other minor gaps are also finalized. According to current predictions, the third phase can be completed by the beginning of 2026.

At the end of the project, with the exception of the 3.4 km road section next to the Burda Mountains and smaller inland sections, the whole distance can be covered with a separated cycle path, while on the mentioned narrow public roads cyclists can use a cycle trail or an advisory cycle lane on the public roads together with cars with traffic mitigation and a reduced speed limit.

## 3.3 ECONOMIC COSTS

**Investment, maintenance and operation costs**

The investment, maintenance and operation unit cost data of the EV6 FS (Hegyen-völgyön, 2014) were updated with the Hungarian construction industry inflation (2014-2022 index: 202.3%).

The total investment costs of the sections to be completed at the beginning of 2021/2023/2026 were simplified and assigned to the end of the previous years, with the fact that in the case of the sections completed in 2021, the related benefits were not taken into account until 2022, since the impact of the absence of an the Ipeľ / Ipoly bridge.

The residual value was calculated in a simplified manner based on the timespan of the 20-year renewal period.

Economic costs of the project between 2020 and 2051 are the following.

| Economic costs | EPV (2022) | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment | 3,604,021 | 877,986 | 0 | 1,913,127 | 0 | 0 | 917,471 | 0 | 0 | 0 | 0 |
| Operation | 202,801 | 0 | 2,858 | 2,858 | 8,399 | 8,399 | 8,399 | 10,956 | 10,956 | 10,956 | 10,956 |
| Maintenance | 81,212 | 0 | 429 | 429 | 1,850 | 1,850 | 1,850 | 2,416 | 2,416 | 2,416 | 2,416 |
| Replacement | 668,950 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Residual value (-) | 860,864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total costs** | **3,696,120** | **877,986** | **3,286** | **1,916,413** | **10,249** | **10,249** | **927,720** | **13,372** | **13,372** | **13,372** | **13,372** |

| Economic costs | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operation | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 |
| Maintenance | 9,601 | 2,416 | 19,428 | 2,416 | 2,416 | 11,284 | 2,416 | 2,416 | 2,416 | 2,416 | 9,601 |
| Replacement | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 249,853 |
| Residual value (-) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total costs** | **20,557** | **13,372** | **30,384** | **13,372** | **13,372** | **22,240** | **13,372** | **13,372** | **13,372** | **13,372** | **270,410** |

| Economic costs | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operation | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 | 10,956 |
| Maintenance | 2,416 | 19,428 | 2,416 | 2,416 | 2,416 | 2,416 | 2,416 | 2,416 | 2,416 | 2,416 | 2,416 |
| Replacement | 0 | 689,134 | 0 | 0 | 317,154 | 0 | 0 | 0 | 0 | 0 | 0 |
| Residual value (-) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,089,543 |
| **Total costs** | **13,372** | **719,518** | **13,372** | **13,372** | **330,526** | **13,372** | **13,372** | **13,372** | **13,372** | **13,372** | **-2,076,171** |

Table 2: Economic costs of the project (EUR)

## 3.4 ECONOMIC BENEFITS

### 3.4.1 Travel time

The determination and indexing of the unit travel time values were determined based on the transport CBA guide (Trenecon, 2018), which, however, only gives the same unit time value as the one for the buses in case of transportation purpose. The tourist unit time value was matched to the unit time value of other trips by passenger cars for the base CBA version, which was modified by 1.4 muliplier according on the DCP CBA updated methodology (2022). In the case of a separated cycle path, the greater value of bicycle travel time than that of a passenger car is justified by the increase in perceived safety. (For the sake of simplicity, we considered the final state of the section as a separate cycle track throughout.) In another approach, the perceived safety is equivalent to 30% of the increased travel time value, which is roughly the same as the additional travel time value of cycling.

The unit time values of the year 2017 used by the CBA guide were updated to 2022 with inflation and GDP growth. Based on Vademecum's guidance, GDP growth was multiplied with an elasticity of 0.8 in the case of business trips, and 0.7 in other cases.

With regard to traffic data, the starting traffic for transport purposes (2022) was determined to be an average of 20 cyclists/day at any point of the section, while the tourist traffic is approximately the same as the traffic measured in the Danube Bend in 2014 (EV6 FS, 2014) considering that this is an area with less frequent traffic, which is offset by the dynamic increase in traffic over 8 years (400 cyclists/day).

The annual multiplier related to the traffic reference daily traffic (190 days/year) also comes from the EV6 FS (Hegyen-völgyön, 2014), while the related daily distance is the length of the examined section (19.9 km). This study considers the FS's calculation, in which it calculates the average daily distance (5.9 or in the case of tourist cyclists: 50 km/person/day as a unit value) when calculating the total traffic, to be wrong, as it only gives the total performance made by cyclists appearing at one point of the network and not the performance of the entire section.

The annual multiplier (70 days/year) related to the tourist reference daily traffic (average summer weekend) was determined based on the data available online from the bicycle traffic counters of the VeloClass[1] national road

[1] VeloClass https://veloclass.kozut.hu

network. At the time of the EV6 FS (Hegyen-völgyön, 2014), such data were not yet available, 38 days/year were determined based on the (annual) daily peak of bicycle traffic of Balaton ferries.

There is an annual growth of 10% expected until 2030 for both transport and tourist traffic.

Based on the above, the mileage incurred on the section is as follows.

| Traffic | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031-2051 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Regular transport** | **75,550** | **83,105** | **91,416** | **100,558** | **110,613** | **121,675** | **133,842** | **147,226** | **161,949** | **161,949** |
| Existing users | 75,550 | 75,550 | 75,550 | 75,550 | 75,550 | 75,550 | 75,550 | 75,550 | 75,550 | 75,550 |
| New users | 0 | 7,555 | 15,866 | 25,007 | 35,063 | 46,124 | 58,292 | 71,676 | 86,399 | 86,399 |
| **Tourism** | **556,687** | **612,356** | **673,591** | **740,950** | **815,045** | **896,550** | **986,205** | **1,084,826** | **1,193,308** | **1,312,639** |
| Existing users | 556,687 | 556,687 | 556,687 | 556,687 | 556,687 | 556,687 | 556,687 | 556,687 | 556,687 | 556,687 |
| New users | 0 | 55,669 | 116,904 | 184,263 | 258,358 | 339,863 | 429,518 | 528,139 | 636,621 | 755,952 |
| **Total** | **632,237** | **695,461** | **765,007** | **841,508** | **925,659** | **1,018,225** | **1,120,047** | **1,232,052** | **1,355,257** | **1,474,588** |

Table 3: Mileage of the cycle path section (vkm per year)

The total travel time was determined based on the length of the examined section and the average speed value (traffic: 15 km/h, tourist: 20 km/h) used by the EV6 FS (Hegyen-völgyön, 2014). The travel time saving was determined at 5% for the whole project section.

As a starting point, cyclists had two options to go along this section before this project and the new Ipeľ / Ipoly road bridge:

1. The distance is 17 km through the sidewalk of the Ipeľ / Ipoly rail bridge (on the north side) and on the Slovakian side, using mainly unpaved roads.
2. In the direction of the nearest road bridge of Ipeľ / Ipoly between Salka (Ipolyszalka) and Letkés, the entire Štúrovo (Párkány) – Szob section is 24.7 km (along public roads).

As an alternative for the route described above, the 19.9 km long asphalted cycle path will be a new option, which at the end of the project will 'only' have a cycle trail of about 4 km – there is not enough (cost efficient) additional space because of geographical and environmental reasons –, while the other sections will boast a separated cycle path, and for about 1.5 km it is foreseen to run on a common track of public roads with little traffic. Better journey times can be obtained with the project due to more route choices, the paving of the unpaved roads and the designation of the cycle trail or advisory cycle lanes.

In the case of new users – in the absence of a base travel time – the travel time saving was determined at half the value of the existing users based on the CBA guidelines. The value of travel time savings during the project is as follows.

| Travel time savings | EPV (2022) | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Regular transport** | **117,426** | **0** | **3,571** | **3,846** | **4,154** | **4,497** | **4,879** | **5,304** | **5,779** | **6,310** | **6,393** |
| Existing users | 79,308 | 0 | 3,401 | 3,480 | 3,564 | 3,650 | 3,738 | 3,828 | 3,920 | 4,014 | 4,067 |
| New users | 38,117 | 0 | 170 | 365 | 590 | 847 | 1,141 | 1,477 | 1,859 | 2,295 | 2,326 |
| **Tourism** | **473,319** | **0** | **14,050** | **15,096** | **16,269** | **17,571** | **19,019** | **20,630** | **22,425** | **24,426** | **26,402** |
| Existing users | 305,030 | 0 | 13,381 | 13,662 | 13,958 | 14,261 | 14,571 | 14,887 | 15,210 | 15,540 | 15,725 |
| New users | 168,289 | 0 | 669 | 1,435 | 2,310 | 3,309 | 4,448 | 5,743 | 7,215 | 8,886 | 10,677 |
| **Total** | **590,745** | **0** | **17,621** | **18,942** | **20,423** | **22,068** | **23,897** | **25,935** | **28,204** | **30,735** | **32,795** |

| Travel time savings | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Regular transport** | **6,477** | **6,563** | **6,650** | **6,737** | **6,826** | **6,916** | **7,008** | **7,100** | **7,194** | **7,289** |
| Existing users | 4,121 | 4,175 | 4,231 | 4,286 | 4,343 | 4,400 | 4,458 | 4,517 | 4,577 | 4,637 |
| New users | 2,356 | 2,387 | 2,419 | 2,451 | 2,483 | 2,516 | 2,549 | 2,583 | 2,617 | 2,652 |
| **Tourism** | **26,716** | **27,034** | **27,356** | **27,681** | **28,011** | **28,344** | **28,681** | **29,023** | **29,368** | **29,717** |
| Existing users | 15,912 | 16,101 | 16,293 | 16,487 | 16,683 | 16,882 | 17,083 | 17,286 | 17,492 | 17,700 |
| New users | 10,804 | 10,932 | 11,063 | 11,194 | 11,327 | 11,462 | 11,599 | 11,737 | 11,876 | 12,018 |
| **Total** | **33,193** | **33,597** | **34,005** | **34,419** | **34,837** | **35,260** | **35,689** | **36,123** | **36,562** | **37,007** |

| Travel time savings | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Regular transport** | **7,385** | **7,483** | **7,582** | **7,682** | **7,783** | **7,886** | **7,990** | **8,096** | **8,203** | **8,311** |
| Existing users | 4,699 | 4,761 | 4,824 | 4,887 | 4,952 | 5,017 | 5,084 | 5,151 | 5,219 | 5,288 |
| New users | 2,687 | 2,722 | 2,758 | 2,795 | 2,831 | 2,869 | 2,907 | 2,945 | 2,984 | 3,024 |
| **Tourism** | **30,071** | **30,429** | **30,791** | **31,157** | **31,528** | **31,903** | **32,283** | **32,667** | **33,056** | **33,449** |
| Existing users | 17,910 | 18,124 | 18,339 | 18,557 | 18,778 | 19,002 | 19,228 | 19,457 | 19,688 | 19,922 |
| New users | 12,161 | 12,305 | 12,452 | 12,600 | 12,750 | 12,902 | 13,055 | 13,211 | 13,368 | 13,527 |
| **Total** | **37,456** | **37,912** | **38,373** | **38,839** | **39,312** | **39,790** | **40,273** | **40,763** | **41,259** | **41,761** |

Table 4: Travel time savings according to the current methodological guidelines (EUR per year)

In two sections – 3 km long in front of Burda Mountains and on the Garam Bridge – road traffic slows down significantly, but this is due to the traffic generated by the new Ipeľ / Ipoly road bridge. Here, regardless of the construction of the cycling infrastructure, speed limits (60 and 50 km/h) must be introduced in the extremely narrow intersections, where until now this was not necessary because of the low traffic.

### 3.4.2 Accidents

The relative injury units of roads for 2017 were adopted from the CBA guide (Trenecon, 2018), with the difference that only local roads were taken into account (while other types of the roads are not affected in the project), so the unit values became somewhat higher than the national average.

The 2017 unit accident costs of the CBA guide (Trenecon, 2018) have been updated with an increase in inflation and 0.8 elasticity-corrected GDP (2017-2022 overall index: 148.34%).

The CBA guide (2018) suggests 30% lower accident risk in the case of the construction of a separated cycle track, and a 5% improvement in the case of cycle lanes outside the settlements - unfortunately, the latter is offset by the

significantly increased road traffic. Taking into account all of these factors it is a 5% improvement from the phase 2 of the investment and a 10% improvement from the completion of the entire investment was determined compared to the accident risk before the project.

The following table shows the benefit resulting from the reduction of accident risk during the project.

| Accident risk | EPV (2022) | '22 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Regular transport** | **6,846** | **0** | **108** | **117** | **126** | **273** | **296** | **323** | **352** | **384** | **389** | **395** | **400** | **406** | **411** | **417** |
| Existing users | 4,549 | 0 | 103 | 106 | 108 | 222 | 227 | 233 | 239 | 244 | 248 | 251 | 255 | 258 | 262 | 265 |
| New users | 2,297 | 0 | 5 | 11 | 18 | 51 | 69 | 90 | 113 | 140 | 142 | 144 | 146 | 148 | 150 | 152 |
| **Tourism** | **53,062** | **0** | **797** | **859** | **929** | **2,012** | **2,184** | **2,377** | **2,591** | **2,831** | **3,065** | **3,107** | **3,149** | **3,192** | **3,235** | **3,279** |
| Existing users | 33,519 | 0 | 759 | 777 | 797 | 1,633 | 1,673 | 1,715 | 1,758 | 1,801 | 1,826 | 1,850 | 1,876 | 1,901 | 1,927 | 1,953 |
| New users | 19,543 | 0 | 38 | 82 | 132 | 379 | 511 | 662 | 834 | 1,030 | 1,240 | 1,256 | 1,273 | 1,291 | 1,308 | 1,326 |
| **Total** | **59,908** | **0** | **905** | **976** | **1,055** | **2,285** | **2,481** | **2,699** | **2,943** | **3,215** | **3,455** | **3,502** | **3,549** | **3,597** | **3,646** | **3,696** |

| Accident risk | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Regular transport** | **422** | **428** | **434** | **440** | **446** | **452** | **458** | **464** | **471** | **477** | **483** | **490** | **497** | **503** | **510** |
| Existing users | 269 | 272 | 276 | 280 | 284 | 287 | 291 | 295 | 299 | 303 | 308 | 312 | 316 | 320 | 325 |
| New users | 154 | 156 | 158 | 160 | 162 | 164 | 167 | 169 | 171 | 173 | 176 | 178 | 181 | 183 | 186 |
| **Tourism** | **3,324** | **3,369** | **3,415** | **3,461** | **3,508** | **3,556** | **3,605** | **3,654** | **3,703** | **3,754** | **3,805** | **3,856** | **3,909** | **3,962** | **4,016** |
| Existing users | 1,980 | 2,007 | 2,034 | 2,062 | 2,090 | 2,118 | 2,147 | 2,176 | 2,206 | 2,236 | 2,266 | 2,297 | 2,328 | 2,360 | 2,392 |
| New users | 1,344 | 1,362 | 1,381 | 1,400 | 1,419 | 1,438 | 1,458 | 1,477 | 1,498 | 1,518 | 1,539 | 1,560 | 1,581 | 1,602 | 1,624 |
| **Total** | **3,746** | **3,797** | **3,849** | **3,901** | **3,954** | **4,008** | **4,063** | **4,118** | **4,174** | **4,231** | **4,288** | **4,346** | **4,405** | **4,465** | **4,526** |

Table 5: Change in accident risk (benefit, EUR per year)

### 3.4.3 Environmental effects and climate change

The unit value of 0.113 EUR per vkm calculated for 2020 of the EV6 FS (Hegyen-völgyön, 2014) was updated (also with inflation and 0.8 elasticity-corrected GDP increase); the amount in 2022 is 0.127 EUR per vkm.

However, according to FS, only new passengers for transport purposes were taken into account, since there is no change in the case of existing passengers, neither in the case of those arriving for tourism purposes, who are coming over from elsewhere.

The impact of environmental effects and climate change is as follows.

| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|
| Environment and climate | 0 | 967 | 2,080 | 3,360 | 4,829 | 6,509 | 8,431 | 10,623 | 13,123 | 13,301 |
| | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 |
| | 13,482 | 13,666 | 13,852 | 14,040 | 14,231 | 14,424 | 14,621 | 14,819 | 15,021 | 15,225 |
| EPV (2022) | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 |
| **218,581** | 15,432 | 15,642 | 15,855 | 16,071 | 16,289 | 16,511 | 16,735 | 16,963 | 17,194 | 17,427 |

Table 6: Impact of environmental effects and climate change (benefit, EUR per year)

### 3.4.4 Vehicle operating costs

Based on the simplified calculation (Table 7), the benefits calculated by the EV6 FS (Hegyen-völgyön, 2014) were proportional to the section length involved in the study, and the unit values were updated (inflation x GDP growth x 1.0 elasticity).

| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle operating costs | 0 | 1,094 | 2,150 | 4,212 | 6,370 | 8,637 | 11,020 | 13,521 | 16,144 | 18,894 |
| | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 |
| | 21,775 | 24,796 | 27,957 | 28,346 | 28,744 | 29,148 | 29,554 | 29,970 | 30,388 | 30,815 |
| EPV (2022) | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 |
| **399,204** | 31,245 | 31,683 | 32,125 | 32,543 | 32,967 | 33,394 | 33,830 | 34,272 | 34,719 | 35,172 |

Table 7: Change in vehicle operating costs (benefit, EUR per year)

### 3.4.5 Health effects

The European Commission's CBA guidelines (Sartori et al., 2014, 2021) and the transport external cost guide (van Essen, H. et al., 2020) did not mention the beneficial physiological effects of cycling.

However, the EV6 FS (Hegyen-völgyön Konzorcium, 2014) has already determined such a value at the 2020 price of 0.026 EUR per km (8 HUF per km), referring to the Vancouver TransLink Public Bike System Feasibility Study (Quay, 2008), which is based on an even earlier study (Litman, 2004) that established the positive health effect of cycling of 0.1 CAD per km. From 2015, the EV6 FS consortium member Trenecon already included this reference as 0.1 USD per km (at 2008 prices) in the transport CBA guide they authored.

The current Hungarian transport CBA guide (Trenecon, 2018) also determines the health benefits of cycling at 0.1 USD per km (2008 prices); this was updated (USD inflation x US GDP growth x 0.8 elasticity with current exchange rate) to USD 0.163 per km in 2022.

Calculated with the amount of 0.026 EUR per km (2020) according to the EV6 FS (Hegyen-völgyön, 2014), the health impact would be 357.4 thousand EUR, and based on the updated unit value (0.163 USD per km, 2022 prices) of the Hungarian CBA guide (Trenecon, 2018) the net present value (2022) of the impact is EUR 2,666.1 thousand EUR. Although we appreciate this progressive handling of cycling by the Hungarian transport CBA guide, since neither the EU nor the regional CBA guidelines (such as the Slovak one) contain such an item, there is not any unit cost of health effects of cycling determined in the present base CBA version.

Using the HEAT (WHO, 2017) methodology and online interface[2], the DCP CBA method (KTI, 2022) suggests an average 9.7% reduction in mortality in the 20-64 age group, which can be achieved by 100 minutes of cycling per week, that equals to (with an average cycling speed of 15 km/h) a performance of 25 km per week (1300 km per year). Compared to the base scenario, the change is the mileage of new users. We assume that all this performance is regular in this section, so each vkm performed contributes to the health effects. We also assume that approx. 83% of the new users may belong to the age group between 20 and 64. The mortality of this age group in Hungary

[2] Health economic assessment tool (HEAT) v5.0 https://www.heatwalkingcycling.org

is 434 people/100,000 people/year, i.e. 0.434%/year. 9.7% of this, i.e. 0.0421% of the value of statistical life (VSL), is the annual health benefit of cycling for every 1300 km of performance incurred on this section. In the case of Hungary, the HEAT methodology (WHO, 2017) sets the value of VSL at 1,329,194 EUR (in 2017 prices). Based on the amount of 758,930 EUR established for the same year by the CBA guide (Trenecon, 2018), we set the starting value at 889,489 EUR for the year 2022. This value increases by 80% every year at the expected GDP growth rate (in 2051: EUR 1,423,579). In thirty years, the cycle path will bring a total of 5.53 VSL health benefits (0.23 VSL per year from 2031), which adds up to EUR 6,726 thousand over 30 years, and it represents a benefit of EUR 3,936 thousand at 2022 present value. That amount is slightly more than the present value of the discounted value of the initial investment cost or the total cost side.

| Health effects | EPV (2022) | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|
| **EU CBA Guides** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| EV6 FS 2014 | 357,350 | 1,394 | 2,998 | 4,843 | 6,959 | 9,382 | 12,151 | 15,311 | 18,914 | 22,335 |
| CBA Guide Hun 2018 | 2,666,109 | 10,403 | 22,371 | 36,135 | 51,922 | 69,996 | 90,655 | 114,234 | 141,114 | 166,640 |
| **DCP CBA 2022** | **3,936,100** | **15,359** | **33,027** | **53,348** | **76,655** | **103,339** | **133,838** | **168,650** | **208,333** | **246,018** |

| Health effects | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 |
|---|---|---|---|---|---|---|---|---|---|---|
| **EU CBA Guides** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| EV6 FS 2014 | 22,639 | 22,947 | 23,259 | 23,576 | 23,896 | 24,221 | 24,551 | 24,884 | 25,223 | 25,566 |
| CBA Guide Hun 2018 | 168,906 | 171,203 | 173,532 | 175,892 | 178,284 | 180,708 | 183,166 | 185,657 | 188,182 | 190,741 |
| **DCP CBA 2022** | **249,364** | **252,755** | **256,193** | **259,677** | **263,209** | **266,788** | **270,417** | **274,094** | **277,822** | **281,600** |

| Health effects | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 |
|---|---|---|---|---|---|---|---|---|---|---|
| **EU CBA Guides** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| EV6 FS 2014 | 25,914 | 26,266 | 26,623 | 26,985 | 27,352 | 27,724 | 28,101 | 28,484 | 28,871 | 29,264 |
| CBA Guide Hun 2018 | 193,335 | 195,965 | 198,630 | 201,331 | 204,069 | 206,845 | 209,658 | 212,509 | 215,399 | 218,329 |
| **DCP CBA 2022** | **285,430** | **289,312** | **293,246** | **297,235** | **301,277** | **305,374** | **309,527** | **313,737** | **318,004** | **322,329** |

Table 8: Value of the health effects of cycling according to different guidelines (benefit, EUR per year)

### 3.4.6 Tourism effects

In contrary to the previous ones, the more recent CBA guidelines do not allow the consideration of broader economic effects, since the positive effect on a narrower economic segment draws demand away from other areas.

### 3.4.7 Other effects

Additional effects were not taken into account or quantified during the calculation. It is important to mention that the DCP CBA (KTI, 2022) would take into account additional benefits based on the freed public space owing to the change of mode and the reduction of car parking, but all of this applies primarily to cycling for transportation purposes and in urban environments. Due to the low traffic especially the lack of traffic within the settlement, as well as the rural character of the region, this effect is negligible, and the tourism which determines the economic indicators of the examined section also includes significant road transport and parking activities (vehicle transport, accompanying staff of tourist cyclists).

## 3.5 THE RESULT OF THE ECONOMIC COST-BENEFIT ANALYSIS, ECONOMIC PERFORMANCE

As a result, the net present value of the overall costs and benefits is the following.

| Economic costs and benefits | CBA Base | DCP CBA |
|---|---|---|
| Investment | 3,604,021 | 3,604,021 |
| Operation | 202,801 | 202,801 |
| Maintenance | 81,212 | 81,212 |
| Replacement costs | 668,950 | 668,950 |
| Residual value (-) | 860,864 | 860,864 |
| **Total costs** | **3,696,120** | **3,696,120** |
| Travel time | 590,745 | 780,073 |
| Accidents | 59,908 | 59,908 |
| Environmental effects | 246,505 | 246,505 |
| Vehicle operating costs | 399,204 | 399,204 |
| Health effects | 0 | 3,936,100 |
| Tourism effects | 0 | 0 |
| Other effects | 0 | 0 |
| **Total benefits** | **1,296,362** | **5,421,790** |
| **Benefit-cost difference (economic net present value)** | **-2,399,758** | **1,725,670** |

Table 9: Net present value of economic costs and benefits of the base CBA version and the DCP updated methodology (EUR, 2022)

As a result, the economic indicators of the project in the two versions are as follows.

| Economic indicators | | CBA Base | DCP CBA |
|---|---|---|---|
| Benefit/Cost ratio | BCR | 0,35 | 1,47 |
| Economic net present value (EUR, 2022 prices) | EPV | -2,399,758 | 1,725,670 |
| Economic rate of return | ERR | -1,40% | 5,47% |

Table 10: Economic indicators of the project in the base and DCP updated CBA methodology

It is profoundly demonstrated how important the quantification of the positive effects and benefits of cycling is in terms of the project's social utility indicators. We propose these benefits (especially health benefits and perceived safety as an additional value of travel time) to be included in the CBA guide of the European Commission.

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