

GIS Support for Managerial Decision-Making in Enhancing Cycling Tourism Routes

Peter Márton, Romana Vaščáková

University of Žilina

Faculty of Management Science and Informatics

Department of Mathematical Methods and Operations Research

Univerzitná 8215/1, 01026 Žilina, Slovakia

{peter.marton@uniza.sk, vascakoval}@stud.uniza.sk

Abstract. Cycling tourism is a form of recreational travel in which individuals explore destinations by bicycle. Interest in this mode of transport has been growing due to environmental awareness, healthy lifestyles, and continuous investments in cycling infrastructure. This article presents a comprehensive literature review focusing on the environmental, health, and economic importance of cycling, while highlighting the critical role of infrastructure in its development. It synthesizes selected case studies on the application of geographic information systems (GIS) and multi-criteria decision-making (MCDM) methods for planning and evaluating cycling routes through spatial analyses. Finally, the paper outlines an ongoing research framework utilizing Strava Metro data and GIS-MCDM modelling on the Váh Cycle Route, establishing the baseline for future spatial and cost-benefit evaluations.

Keywords. cycling tourism, cycling infrastructure, geographic information systems, sustainable mobility

1 Definition of Cycling Tourism

According to Greene, cycling tourism is a form of recreational travel in which individuals explore destinations by bicycle. This definition applies to all types of cycling tourism, whether short, independent trips or organised multi-day group cycling tours through urban or rural areas, regardless of whether a conventional or electric bicycle is used. (Greene, 2024)

Weston et al. from the European Parliament define cycling tourism as travelling between different places by bicycle for recreational purposes, with cycling itself forming an integral part of the tourist experience. (Weston et al., 2012)

Interest in cycling tourism is constantly growing, mainly due to increasing awareness of environmental issues, healthy lifestyle and investments in cycling infrastructure. (Greene, 2024; Grand View Research, 2026)

1.1 Cycling as an environmentally friendly mode of transport

Cycling and cycling tourism represent environmentally friendly modes of transport that contribute to reducing carbon emissions and supporting sustainable mobility. (Functional Areas in the EU, 2023) Within the so-called sustainable transport hierarchy, walking and cycling are among the most environmentally friendly modes of movement, while individual car and air transport are at the opposite end of the spectrum in terms of environmental impact, as can be seen in Fig. 1. (Functional Areas in the EU, 2023; Philips et al., 2020)

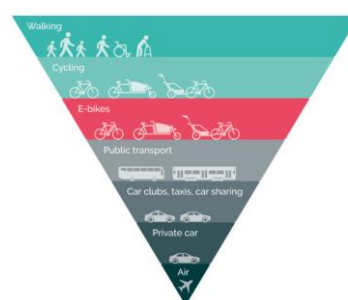


Figure 1. Sustainable transport hierarchy (Philips et al., 2020)

According to estimates by CREDS (Centre for Research into Energy Demand Solutions), CO₂ emissions over the life cycle of an electric bicycle are significantly lower compared to other modes of transport, reaching approximately 22 g/km. In contrast, emissions from electric cars are approximately 104 g/km, from hybrid cars 168 g/km and from petrol cars 258 g/km. (Philips et al., 2020)

Another advantage of cycling is its low spatial demand. In one hour, approximately 14,000 cyclists can pass through a 3.5-metre-wide section in a city, whereas in the case of car transport, this figure is only

around 2,000 people. Cycling transport is therefore more efficient in terms of space utilisation. In addition, up to 15 bicycles can be parked in a single car parking space. (European Cyclists' Federation, 2018; Dekoster & Schollaert, 1999)

1.2 Cycling as a tool for health promotion

In addition to their positive impact on the environment, cycling and cycling tourism also provide health benefits. Regular physical activity plays a key role in the prevention of chronic non-communicable diseases, such as cardiovascular diseases, diabetes, hypertension, obesity and certain types of cancer. At the same time, they have a positive effect on mental health. (Functional Areas in the EU, 2023; European Cyclists' Federation, 2018)

In 2014, Kelly et al. published a comprehensive systematic review and meta-analysis summarising the results of studies examining the relationship between cycling and the risk of all-cause mortality (ACM) among healthy adults. Based on a sample of approximately 200,000 adults aged 20–93 years, they found that cycling at a physical activity level of 11.25 MET-hours per week, corresponding to approximately 116 minutes of cycling per week at a speed of 15.1 km/h, was associated with a 10% reduction in mortality risk. (Logan et al., 2023; Kelly et al., 2014; Ainsworth et al., 2011) Based on these studies, it can be concluded that the promotion of cycling and cycle tourism is also important from the perspective of public health.

Hendriksen et al., in a study conducted on a sample of 1,236 Dutch employees, found that regular commuting to work by bicycle was associated with a lower rate of sickness absence. They found that, during the observed year, the average length of work absence among cyclists was more than one day shorter compared with non-cyclists. Cyclists were absent from work for an average of 7.4 days in the observed year, whereas non-cyclists were absent for 8.7 days. At the same time, the more frequently and the longer employees cycled, the fewer days they were absent from work. (European Cyclists' Federation, 2018; Hendriksen et al., 2010)

1.3 Investments in cycling infrastructure

The systematic development and modernisation of cycling infrastructure also have a significant impact on the growing interest in cycling tourism. These processes are closely related to the objectives of the European Green Deal, which aims to achieve a 90% reduction in transport-related greenhouse gas emissions by 2050. The development of cycling infrastructure plays an important role in achieving this objective. (Functional Areas in the EU, 2023; European Commission, n.d.)

1.4 Economic benefits of cycling

Cycling and cycle tourism also bring economic benefits, among others. In 2025, the global cycling tourism market reached a value of USD 146.19 billion, with Europe representing the largest market. The global cycle tourism market is expected to reach a value of approximately USD 332.48 billion by 2033, with an estimated annual growth rate of 11.1% from 2026 to 2033. (Grand View Research, 2026)

The EU Cycle project, implemented under the INTERREG programme, has identified and quantified the annual economic benefits associated with cycling. These benefits include a reductions in CO₂ emissions, a reduction of noise and air pollution, fuel savings, longer and healthier lives, a reduction in the number of employee sickness absence days, the expansion of the cycling market, the development of cycle tourism, a reduction in traffic congestion and lower costs for the maintenance and construction of road infrastructure for motor vehicles.

The total annual economic benefit of cycling in the European Union is estimated at between EUR 150 and EUR 155 billion, with the most significant share coming from health benefits and the development of cycle tourism, as shown in Fig. 2. The calculation of these benefits is based on an annual cycling volume of 146 billion kilometres in the EU-28 countries. (Functional Areas in the EU, 2023; European Cyclists' Federation, 2018)

Benefit	Estimated Value (billion euros)
CO ₂ emissions savings	0.6 - 5.6
Reduction of air pollution	0.435
Reduction of noise pollution	0.3
Fuel savings	4.0
Longer and healthier lives	73
Less sickness absence at the workplace	5
Bicycle market	13.2
Cycle tourism	44
Easing of road congestion	6.8
Saving on construction and maintenance costs for road infrastructure for motorised vehicles	2.9
Total annual benefits	150 - 155 bn euros

Figure 2. Estimate of the annual economic benefits of cycling in the European Union (Functional Areas in the EU, 2023)

An example of the economic benefits of cycling is the 750 km network of cycle superhighways in the Hovedstaden region of Denmark. This project, with a total investment of approximately EUR 29 million, generates a social benefit of up to EUR 76 million, while its internal rate of return reaches 11%. According to economic analyses of Danish infrastructure projects, the cycle superhighway network has also been ranked among the top five most profitable projects. (Garrett, 2019)

Another example is Cykelslangen, a 235-metre cycle bridge in Copenhagen, Denmark, which, with construction costs of EUR 4.2 million, generated benefits of EUR 5.9 million over the observed period, while the internal rate of return of this project reached 9%. The study also estimated that a shift from car transport to cycling brings savings of at least EUR 1.34 for every kilometre travelled. These data confirm that investments in cycling infrastructure represent not only an environmentally friendly solution, but also a highly economically efficient one. (Garrett, 2019)

In 2009, Mercat et al. published a study in which they analysed the average daily expenditure of cyclotourist and tourists in France. They found that cyclotourist spend, on average, EUR 10 more per day than regular tourists, while in the case of touring cyclotourist who travel from place to place, this difference is as much as EUR 21. Higher expenditure is mainly associated with accommodation, where cyclotourist spend an average of EUR 11 more, and to food, where the difference is approximately EUR 5. Expenditure related to visits to cultural monuments and other activities is also higher, by approximately EUR 1 per day. Cyclotourist who travel from place to place have the highest transport costs among all groups. Compared with regular tourists, they spend an average of EUR 5 more. The study also found that this group of cyclotourist uses rail transport up to three times more frequently than regular tourists. (Atout France, 2009) A more detailed breakdown of individual expenditures by group is shown in Fig. 3.

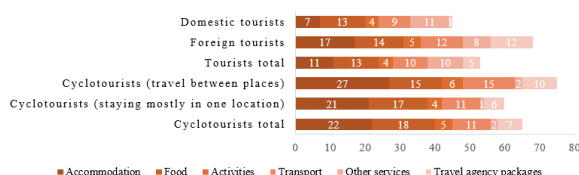


Figure 3. Comparison of daily expenditure by tourists with daily expenditure by cyclotourist (Atout France, 2009)

2 Tools and approaches for evaluating cycling infrastructure projects

Various analytical approaches and decision-making tools are used in the evaluation of projects, including those in the field of cycling infrastructure, among which are cost-benefit analysis (CBA) and multi-criteria decision-making (MCDM).

Cost-benefit analysis (CBA) is a systematic approach used to calculate and compare the benefits and costs of a specific project or decision. It examines whether the expected benefits and costs are in balance,

while expressing them in terms of net present value. It can therefore be understood as a list of advantages and disadvantages that supports financial decision-making. The main advantages of CBA include its simplicity, clarity and the possibility of comparing different solution alternatives. (Al Moussawi et al., 2020) According to academics, another strength is its theoretical clarity, which makes the analysis a common language that is known and used worldwide. At the same time, it is a widely used and well-established tool for project evaluation. (Annema et al., 2015) A disadvantage is the need to use uniform units of measurement, which is impossible in the case of qualitative benefits. (Al Moussawi et al., 2020) Qualitative benefits may include impacts on equity and environmental impacts, such as the deterioration of nature and landscape caused by new infrastructure, which cannot be accurately expressed in monetary terms. (Annema et al., 2015)

Multi-criteria decision-making (MCDM), also known as multi-criteria decision analysis (MCDA) or multi-criteria analysis (MCA), is considered one of the most accurate decision-making methods and is regarded as a revolutionary approach in this field. (Annema et al., 2015; Taherdoost & Madanchian, 2023) This method considers various qualitative and quantitative criteria, such as cost, quality, or safety, which need to be defined to identify the best solution. Experts assign different weights to individual criteria based on their importance in a specific project. (Taherdoost & Madanchian, 2023) Within MCDM, there are several specific methods, such as the Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW), Weighted Sum Model (WSM), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and the Best-Worst Method (BWM), each of which has its own advantages and disadvantages. (Taherdoost & Madanchian, 2023; Alsalem et al., 2018) The case studies included in this article used the BWM and TOPSIS methods. To process and visualize the spatial criteria of these models, the selected MCDM approaches were implemented within a GIS environment.

2.1 Application of CBA in the Netherlands

In 2000, the Dutch government introduced CBA as a mandatory tool to support decision-making on major transport infrastructure projects. At that time, MCDM was rejected for two main reasons. The first reason was the assignment of weights to individual criteria, which is not always clear. The second reason was the higher probability of double-counting project effects, as MCDM lacks strictly defined criteria for their inclusion compared to CBA. (Annema et al., 2015)

In 2015, J. A. Annema, N. Mouter, and J. Razaei published a study in which they examined the opinions of 21 politicians working in the field of transport on CBA. They found that politicians do use CBA, but not as a decisive tool, rather, they use it only as one of the

inputs in decision-making. According to the politicians, CBA is not sufficiently transparent, and the net present value indicator does not provide a complete picture. As an example, they mentioned the expansion of Amsterdam Schiphol Airport, where they considered it more important to openly discuss whether, for instance, the creation of new jobs is more important than increased noise for residents living nearby, rather than focusing only on one specific number. (Annema et al., 2015)

Based on interviews with politicians, the authors formulated three main considerations. The first is that CBA can be considered a useful tool, as it is used by most politicians. At the same time, however, it is not a decisive tool, politicians approach it critically and perceive it more as one of several inputs in the decision-making process. (Annema et al., 2015)

Second, the results do not indicate that MCDM is better than CBA. (Annema et al., 2015)

The third consideration is that a combination of CBA and MCDM is not an ideal solution. Combining these two different methods could further reduce the transparency and credibility of the results. (Annema et al., 2015)

The authors and politicians see an alternative in a simpler approach used in the United Kingdom and Switzerland, which is based on presenting politicians not with a single indicator, but with several criteria to which no weights are assigned. Politicians then decide on the individual criteria and seek compromises. (Annema et al., 2015)

From the perspective of the authors and politicians, an interesting solution is also the so-called “trade-off sheet” - a list of the most important trade-offs. In this case, CBA could provide information on economic efficiency, while MCDM would focus on economic or social aspects that cannot be expressed in monetary terms. The result of such a “trade-off sheet” would serve as a basis for political discussion. (Annema et al., 2015)

2.2 Application of CBA in Sweden

Similarly to the Netherlands, Sweden also uses CBA to support decision-making on major national transport investments. In doing so, it applies the ASEK guidelines (Arbetsgruppen för SamhällsEkonomiska Kalkyler), which are regularly updated, usually every three to five years. One of the main objectives of using the ASEK guidelines is to ensure the comparability of individual CBA analyses of transport projects, so that priorities can be effectively set among projects from different parts of the country. (Eliasson, 2013)

Since 2009, every proposal for a national transport investment must undergo a comprehensive assessment, which includes, in addition to the project proposal itself, the expected impacts, reasons for implementation, status, CBA results and effects expressed in non-monetary terms. (Eliasson, 2013)

Awareness that CBA will be used as a tool for prioritising projects has led to greater cost-effectiveness of investment proposals, which many consider to be the most significant benefit of using CBA. Planners therefore focus on the cost-effectiveness of a project already in its early stages and, to some extent, prevent inefficient and overestimated projects from progressing to further stages of preparation. Compared with Norway, which does not rely on CBA in project selection, Sweden has a lower share of socially unprofitable projects, i.e. projects whose benefit-cost ratio (BCR) is lower than 1. (Eliasson, 2013)

2.3 Different application of MCDM and GIS in cycling infrastructure planning

Geographic information systems (GIS) are also used, among other tools, in the planning and modernisation of cycling infrastructure. An example is a case study from the Italian city of Palermo, which focused on the use of GIS in assessing the potential of multimodal transport based on a combination of cycling and rail transport. The main objective of this case study was to reduce individual car transport in the city and support more environmentally friendly alternatives. In the case study, the authors focused on three residential districts on the outskirts of Palermo with a low frequency of public transport services and an absence of cycle routes and shared bicycles. They developed a GIS-based methodology that made it possible to assess the potential for introducing new cycle routes and bike-sharing stations in connection with the existing public transport infrastructure. When designing new cycle routes, the authors considered several factors, such as road width, gradient, traffic density, cycle crossings and distance from public transport stops. Attention was paid to the Go2School bike-sharing programme and to secondary school students. Based on a questionnaire survey, the authors found that the introduction of new cycle routes and bike-sharing stations would increase the percentage of students cycling on their own or shared bicycles from 1.5% to 10.1%, while reducing the percentage of students commuting to school by private car from 21% to 15.7%. An increase was also recorded in the use of public transport. (Capodici et al., 2021)

Another example is a case study focusing on the Veneto region in north-eastern Italy. Its aim was to support the development of cycling tourism as part of sustainable tourism in rural areas. In selecting and evaluating the area, the authors considered environmental, cultural and economic factors. These factors were subsequently analysed using GIS and MCDA, which made it possible to comprehensively assess the suitability of the area for the development of cycling tourism. Based on the analysis, areas with the greatest potential for the construction of cycle routes were identified, while not only the accessibility of the area was evaluated, but also the existing infrastructure,

cultural value and points of interest in the surrounding area. (Parlato & Pezzuolo, 2025)

In the Turkish city of Istanbul, the authors Guler and Yomralioglu used a combination of GIS and the BWM to create an integrated framework for the optimal placement of bike-sharing stations and cycling infrastructure. The case study focused on six districts of Istanbul and considered eight key criteria, such as proximity to public parks, shopping centres, educational institutions, existing cycling infrastructure, public transport stops, bus routes, population density and terrain slope. The BWM method made it possible to effectively determine the relative importance of individual criteria through pairwise comparisons, in which the best and worst factors are evaluated against all the others. The best factor was proximity to public transport stops, while the worst factor was proximity to shopping centres. The authors subsequently created raster layers for each criterion in a GIS environment and normalised them to a value range from 0 to 1, where 0 represented an unsuitable location and 1 represented a highly suitable location. Using the weighted linear combination (WLC) method, these layers were merged into a final suitability map. Based on this map, the most suitable locations for bike-sharing stations were identified, as well as new routes extending the cycling infrastructure in Istanbul. The proposed station locations were ranked according to their suitability using the TOPSIS. Finally, a sensitivity analysis was carried out, confirming the stability of the results even when the weights of individual criteria were changed. (Guler & Yomralioglu, 2021)

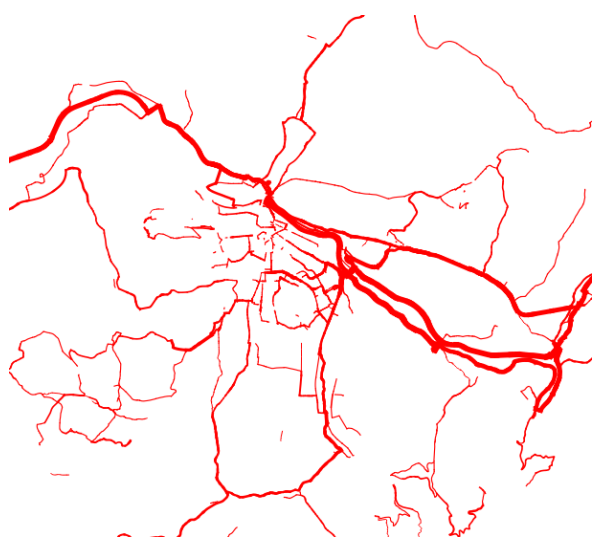


Figure 4. Bicycle traffic density around Žilina based on Strava Metro data; line thickness represents cyclist volume (Strava Metro data, 2025)

This picture shows aggregated and de-identified data from Strava Metro.

3 Spatial Decision Support Framework for Evaluating the Váh Cycle Route

Research focusing on the Váh Cycle Route in Slovakia utilising GIS and MCDM commenced in March 2026. This study centres on integrating crowdsourced Strava Metro data into a spatial analytical environment (Márton & Blažek, 2026; Márton et al., 2026) to evaluate cycling infrastructure and support evidence-based planning. By combining actual movement patterns with other spatial datasets, the framework aims to identify heavily used corridors, assess infrastructure performance, and serve as an empirical baseline for subsequent CBA and strategic managerial decision-making.

The Váh Cycle Route, which is the oldest and longest cycling tourism route in Slovakia, spans near 250 km along the Váh River across four Self-Governing Regions (SGR): Žilina (41.2 km), Trenčín (97.9 km), Trnava (43.2 km), and Nitra (65.7 km). While the route is fully signed in the field, its infrastructure has not yet been completed as a continuous, safe, and segregated cycleway. Construction is currently progressing in stages within individual SGRs. Upon completion across all four regions, it will become the longest continuous cycleway in Slovakia, impacting millions of users—as evidenced by over 3.5 million cyclists recorded on its completed sections in the Trenčín SGR since 2018 (Mazreku, 2025; SITA, 2026).

3.1 Definition of the Research Problem

Strategic planning and managerial decision making in cycling infrastructure development often suffer from a lack of objective, continuous, and long-term empirical data on actual user behavior. Traditional data collection methods, such as manual counts or localised automatic counters, provide geographically isolated snapshots that are insufficient for evaluating multi-jurisdictional long-distance corridors like the Váh Cycle Route.

While crowdsourced Big Data platforms (e.g., Strava Metro) offer high-resolution mobility insights, utilising them directly in planning presents a key analytical challenge: raw spatial data require a standardized, long-term analytical baseline to ensure consistent multi-year monitoring (2021–2026 in our case) across evolving territorial conditions. Consequently, regional decision-makers lack a unified spatial decision-support framework to objectively evaluate multi-year mobility shifts, identify infrastructural bottlenecks, and prioritise investments along strategic cycling corridors.

3.2 Research Methodology

To address this decision making challenge, we propose an integrated spatial decision support system combining GIS, crowdsourced Big Data, and spatial MCDM. The pilot application focuses on the Váh Cycle Route, with the objective of validating a methodology that can subsequently be scaled to other national and international cycling routes. The methodology consists of three main phases:

1. **Topology-Independent Spatial Aggregation:** To enable consistent longitudinal monitoring (2021–2026), crowdsourced movement data from Strava Metro will be aggregated into the discrete global grid system Uber H3 (Brodsky et al., 2018).
2. **Integration of Behavioral and Spatial Demographics:** The aggregated spatial units will be enriched with multi-dimensional mobility attributes, including directional flow volumes, commuting vs. recreational travel purpose, e-bike share, age cohort distributions, and time-of-day temporal profiles.
3. **Spatial MCDM and CBA Decision Framework:** The spatial mobility profiles derived from the GIS analysis will serve as empirical baseline criteria within a broader managerially oriented framework. These empirical indicators (actual demand, spatial connectivity, user volume trends) will be combined with qualitative criteria (traffic safety, service proximity) using spatial MCDM techniques (Best-Worst Method - BWM and TOPSIS) and subsequent Cost-Benefit Analysis (CBA). This integrated approach translates complex spatial Big Data into prioritised strategic recommendations for local and regional authorities.

3.3 Scientific Contribution

The scientific contribution of our study lies in bridging the gap between crowdsourced spatial Big Data and strategic managerial decision making in mobility planning:

- It establishes a reproducible spatial assessment methodology that enables us to conduct reliable multi-year longitudinal monitoring (2021–2026) of cycling demand along the Váh Cycle Route and other international, national and regional cycle routes.
- It demonstrates how crowdsourced spatial mobility indicators can be effectively integrated as objective empirical weights into spatial MCDM and CBA models, replacing subjective estimates in transport planning.
- It delivers an evidence-based decision support model applied to the Váh Cycle Route, providing regional SGRs with actionable spatial insights to prioritise missing infrastructure segments, target safety interventions, and optimize the location of complementary cycling services.

Conclusion

This paper highlights the multifaceted importance of cycling tourism from environmental, health, and economic perspectives, demonstrating that sustainable mobility planning requires an integrated, data-driven approach. Through a systematic literature review, it confirmed that the effective development and evaluation of cycling infrastructure depend heavily on GIS combined with decision-making frameworks such as CBA and MCDM. While extensive national cycle route networks exist, such as in Slovakia, their completion as continuous, safe, and segregated cycleways remains a critical challenge for regional authorities.

To bridge the gap between theoretical frameworks and practical infrastructure appraisal, this paper shortly introduces an ongoing research framework centred on the Váh Cycle Route. We propose utilising the H3 grid system. By converting Strava Metro movement patterns (2021–2026) into H3 grid units and enriching them with behavioural and demographic attributes, the framework establishes a reliable spatial baseline.

The primary scientific contribution of our future research lies in demonstrating how crowdsourced spatial Big Data can be transformed into objective, empirical weights within spatial MCDM and CBA models. Rather than relying on subjective assumptions or isolated manual counts, this integrated approach enables to conduct consistent longitudinal monitoring, identify infrastructure bottlenecks, and optimise the spatial distribution of complementary services.

Finally, embedding crowdsourced spatial analytics into regional decision support systems provides local and regional managers with an evidence based tool for strategic planning. This approach ensures that future investments in cycling infrastructure along the Váh Cycle Route and similar international, national or regional cycle routes maximize public health, environmental sustainability, and economic returns.

References

- Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett, D. R., Jr., Tudor-Locke, C., Greer, J. L., Vezina, J., Whitt-Glover, M. C., & Leon, A. S. (2011). 2011 compendium of physical activities: A second update of codes and MET values. *Medicine & Science in Sports & Exercise*, 43(8), 1575–1581. <https://doi.org/10.1249/MSS.0b013e31821ece12>
- Al Moussawi, H., Fardoun, F., & Louahlia, H. (2020). Optimization and decision-making methods in realization of tri-generation systems. *Towards Sustainable Chemical Processes: Applications of Sustainability Assessment and Analysis, Design and Optimization, and Hybridization and Modularization* (pp. 43-67). Elsevier.

- <https://doi.org/10.1016/B978-0-12-818376-2.00002-8>
- Alsalem, M. A., Zaidan, A. A., Zaidan, B. B., Hashim, M., Albahri, O. S., Albahri, A. S., Mohsin, H. A. & Mohammed, K. I. (2018). Systematic review of an automated multiclass detection and classification system for acute leukaemia in terms of evaluation and benchmarking, open challenges, issues and methodological aspects. *Journal of Medical Systems*, 42, Article 204. <https://doi.org/10.1007/s10916-018-1064-9>
- Annema, J. A., Mouter, N., & Razaei, J. (2015). Cost-benefit analysis (CBA), or multi-criteria decision-making (MCDM) or both: Politicians' perspective in transport policy appraisal. *Transportation Research Procedia*, 10, 788–797. <https://doi.org/10.1016/j.trpro.2015.09.032>
- Atout France. (2009). *Spécial économie du vélo: Étude complète*. <https://ekladata.com/iSZpvbgl7Dsa5xeFa4h4iYNf7B0/2009-PDF-economie-velo.pdf>
- Brodsky, I. (2018, June 27). H3: Uber's hexagonal hierarchical spatial index. *Uber Engineering Blog*. <https://www.uber.com/blog/h3/>
- Capodici, A. E., D'Orso, G., & Migliore, M. (2021). A GIS-based methodology for evaluating the increase in multimodal transport between bicycle and rail transport systems: A case study in Palermo. *ISPRS International Journal of Geo-Information*, 10(5), Article 321. <https://doi.org/10.3390/ijgi10050321>
- Dekoster, J., & Schollaert, U. (1999). Cycling: The way ahead for towns and cities. *Office for Official Publications of the European Communities*. https://aa.ecn.cz/img_upload/3a7e18c1249b899407e75e7f626db792/cycling_en.pdf
- Eliasson, J. (2013). *International comparison of transport appraisal practice: Annex 4 Sweden country report*. Institute for Transport Studies. <https://assets.publishing.service.gov.uk/media/5a7ba777ed915d1311060a4c/annex-4-sweden.pdf>
- European Commission. (n.d.). *Sustainable transport. Mobility and Transport*. https://transport.ec.europa.eu/transport-themes/sustainable-transport_en
- European Cyclists' Federation. (2018). *The benefits of cycling: Unlocking their potential for Europe*. https://www.ecf.com/media/resources/TheBenefitsOfCycling_final-v2.pdf
- Functional Areas in the EU. (2023). *Developing world-class cycling infrastructure at the functional area level*. <https://functionalareas.eu/wp-content/uploads/2023/08/Cycling-Infrastructure-at-the-FA-level.pdf>
- Garrett, A. (2019). *Cost-benefit of cycling infrastructure*. Cycling Embassy of Denmark. <https://cyclingsolutions.info/cost-benefit-of-cycling-infrastructure/>
- Grand View Research. (2026). *Cycle tourism market size, share & trends analysis report by group, by booking mode, by age group, by region, and segment forecasts, 2026–2033*. <https://www.grandviewresearch.com/industry-analysis/cycle-tourism-market-report>
- Greene, J. (2024). *Bicycle tourism*. EBSCO Research Starters. <https://www.ebsco.com/research-starters/history/bicycle-tourism>
- Guler, D., & Yomralioglu, T. (2021). Location evaluation of bicycle sharing system stations and cycling infrastructures with Best Worst Method using GIS. *The Professional Geographer*, 73(3), 535–552. <https://doi.org/10.1080/00330124.2021.1883446>
- Hendriksen, I. J. M., Simons, M., Galindo Garre, F., & Hildebrandt, V. H. (2010). The association between commuter cycling and sickness absence. *Preventive Medicine*, 51(2), 132–135. <https://doi.org/10.1016/j.ypmed.2010.05.007>
- Kelly, P., Kahlmeier, S., Götschi, T., Orsini, N., Richards, J., Roberts, N., Scarborough, P., & Foster, C. (2014). Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. *International Journal of Behavioral Nutrition and Physical Activity*, 11, Article 132. <https://doi.org/10.1186/s12966-014-0132-x>
- Logan, G., Somers, C., Baker, G., Connell, H., Gray, S., Kelly, P., McIntosh, E., Welsh, P., Gray, C. M., & Gill, J. M. R. (2023). Benefits, risks, barriers, and facilitators to cycling: A narrative review. *Frontiers in Sports and Active Living*, 5, Article 1168357. <https://doi.org/10.3389/fspor.2023.1168357>
- Márton, P., & Blažek, B. (2026). Architektúra open-source infraštruktúry pre spracovanie a priestorovú optimalizáciu geografických big data. *Proceedings of the 14th Conference on Open Source Software in Education, Research and IT Solutions (OSSConf 2026)* (pp. 97–106). University of Žilina
- Márton, P., Gogola, M., & Vaščáková, R. (2026). Využitie dát Strava pre rozvoj cyklo dopravy a projektovú výučbu v oblasti geoinformatiky. *Proceedings of the 14th Conference on Open Source Software in Education, Research and IT Solutions (OSSConf 2026)* (pp. 106–116). University of Žilina
- Mazreku, A. (2025, December 30). *Výstavba unikátnej cyklotrasy napreduje. Vážska magistrála spája tri kraje, pri Ilave stavajú kľúčový úsek*. TA3. <https://www.ta3.com/clanok/1026771/vystavba-unikatnej-cyklotrasy-napreduje-vazska-magistrala-spaja-tri-kraje-pri-ilave-stavaju-klucovy-usek>

- Parlato, M. C. M., & Pezzuolo, A. (2025). Rural–urban linkages and development: A GIS-MCDA approach to sustainable cyclo-tourism and rural land protection. *Land Degradation & Development*, 36(14), 4809–4826. <https://doi.org/10.1002/ldr.5669>
- Philips, I., Anable, J., & Chatterton, T. (2020). *E-bike carbon savings – How much and where?* CREDS. <https://www.creds.ac.uk/publications/e-bike-carbon-savings-how-much-and-where/>
- Taherdoost, H., & Madanchian, M. (2023). *Multi-criteria decision making (MCDM) methods and concepts*. *Encyclopedia*, 3(1), 77–87. <https://doi.org/10.3390/encyclopedia3010006>
- TASR. (2026, March 11). *Na jeseň bude dokončených 90 % stokilometrovej Vážskej cyklomagistrály*. TERAZ.sk. <https://www.teraz.sk/spravy/na-jesen-bude-dokonceny-90-stokil/947355-clanok.html>
- Weston, R., Davies, N., Lumsdon, L., McGrath, P., Peeters, P., Eijgelaar, E., & Piket, P. (2012). *The European cycle route network EuroVelo*. European Parliament. https://www.researchgate.net/publication/262099932_The_European_Cycle_Route_Network_EuroVelo