19. Economic aspects of traffic safety

Introduction

Every road traffic crash imposes costs on society: medical treatment, lost productivity, property damage, administrative expenses, and the immeasurable human suffering of victims and their families. Globally, road crashes cost countries an estimated 3% to 5% of their Gross Domestic Product (GDP), a burden that falls disproportionately on low- and middle-income countries (LMICs). Understanding these costs is essential for making informed decisions about the resources required for investment in road safety and the measures to prioritise.

This module covers how to estimate the societal costs of traffic injuries, how to use cost-benefit analysis (CBA) as a tool for setting priorities among safety measures, and how different funding mechanisms, including road pricing and insurance-based models, can support road safety investment. It also examines the tensions between economic efficiency and ethical frameworks such as Vision Zero, and the controversial question of whether the monetary value of preventing a fatality should vary by income level.

Learning outcomes

After completing this module, the students should be able to:

- recall the main components of the societal cost of crashes (human costs, loss of output, medical costs, property damage, administrative costs) and describe how and why these costs are estimated
- explain how cost-benefit analysis is used to assess priorities among road safety measures, including the concepts of marginal cost and value of a statistical life (VSL)
- apply cost estimates to compare the costs and benefits of alternative road safety measures and determine which combination of measures maximises the net benefit
- analyse the strengths and limitations of cost-benefit analysis, including the tension between economic efficiency and equity considerations
- evaluate road safety funding mechanisms (taxation, road pricing, insurance-based models) and propose approaches suitable for different country contexts, including LMICs.

Key messages to learners

- The societal costs of road crashes include five main components: human costs (pain, grief, loss of quality of life), loss of output (foregone earnings and productivity), medical costs (treatment and rehabilitation), property damage (vehicle and infrastructure repair), and administrative costs (police, legal, insurance). In most countries, human costs represent the largest share.
- Road crashes impose a heavier relative economic burden on LMICs. The WHO estimates that road crashes cost LMICs 3 to 5% of GDP annually, compared with 1 to 3% in high-income countries. Since these countries also have fewer resources to invest in safety, the economic case for preventive measures is particularly strong: even low-cost interventions can yield high returns.

- Two main approaches exist for valuing the prevention of traffic injuries. The human capital approach values lost economic output. The willingness-to-pay (WTP) approach estimates how much people would pay for a small reduction in their risk of death or injury. WTP-based estimates are typically much higher than human capital estimates because they capture the value people place on safety beyond just earnings.
- The value of a statistical life (VSL) is the monetary value of a risk reduction that statistically corresponds to preventing one fatality. It does not place a price on any individual life. Instead, it represents the value of reducing fatality risk across a population. It is a tool for comparing the costs and benefits of safety investments. Empirical estimates of VSL vary enormously across studies, partly due to different methodological approaches. These approaches typically fall into two major approaches: revealed-preference methods and stated-preference methods.
- Cost-benefit analysis identifies the combination of measures that produces the greatest net benefit for a given budget. The key principle is equalising marginal costs: resources should be shifted from measures where the last unit of spending prevents fewer casualties to measures where it prevents more, until marginal cost per prevented fatality is equal across all measures.
- In practice, additional factors play a role in influencing road safety policy compromising the CBA recommendations, including political considerations, public pressure, equity concerns, and institutional inertia. Studies consistently show a gap between what CBA recommends and what governments actually do.
- Vision Zero and the Safe System approach reject the monetary valuation of human life as a basis for policy. However, prioritising measures by cost-effectiveness (achieving the greatest safety improvement per unit of expenditure) is fully consistent with these frameworks. The distinction is between accepting any level of death as economically 'optimal' versus maximising lives saved within available resources.
- A controversial question is whether VSL should vary by income. If it does, the value of preventing a fatality in a low-income country is dramatically lower than in a high-income country. An important point here is that the VSL does not aim to reflect how much an individual person 'is worth', but rather how much the society is willing or is able to pay for preventing an 'average' fatality. Still, the moral implications raised here illustrate the limitations of the CBA and remind that in certain cases a broader view and discussion are necessary.
- For LMICs that lack the capacity to conduct original WTP studies, international value transfer (adjusting HIC estimates by income ratios) offers a pragmatic alternative. However, such transfers embed the assumption that willingness-to-pay is proportional to income, which may not reflect local preferences or ethical norms.
- Road pricing, where every road user pays the marginal societal cost of their travel per kilometre, offers an alternative to traditional cost-benefit analysis. It bypasses the need for valuation studies by letting the market reveal how much people are willing to pay for road use. Where road pricing is not feasible, incorporating safety costs into motor vehicle insurance premiums provides a simpler funding mechanism that links payment to risk.

Learning activities

Exercise 1

Using the five-component framework (human costs, loss of output, medical costs, property damage, administrative costs), explain how the approximate cost of a fatal road crash in your country can be estimated. For each component, explain what data you would need, where you might find it, and what assumptions you would have to make. Discuss which components are hardest to estimate and why.

Exercise 2

A government has a fixed budget to invest in road safety. Two measures are available: (A) installing median barriers on a high-risk highway (cost: $2 million, expected to prevent 10 fatalities per year) and (B) a nationwide seatbelt enforcement campaign (cost: $2 million, expected to prevent 4 fatalities per year). Using cost-effectiveness reasoning, explain which measure should be prioritised.

Then discuss: if, additionally, the seatbelt campaign reduces serious injuries by 200 per year, and median barriers reduce serious injuries by 50 per year, how will this affect your answer? What additional information would you need?

Exercise 3

The value of a statistical life in Norway is approximately $4 million, while an income-adjusted transfer to Ghana yields approximately $100 000. Discuss the ethical implications of this difference. Should international donors apply donor-country or recipient-country VSL when analysing road safety projects in LMICs? Present arguments for both positions and state your own view.

Assessment quiz

The assessment quiz can be used as part of the examination or as an additional learning activity.

Question 1

What are the five main components of the societal costs of road crashes?

a. Fuel costs, congestion costs, environmental costs, repair costs, insurance premiums (incorrect)
b. Police costs, legal fines, vehicle taxes, toll payments, emergency response fees (incorrect)
c. Human costs, loss of output, medical costs, costs of property damage, administrative costs (correct)
d. Time delays, psychological stress, fuel consumption, road maintenance, litigation costs (incorrect)

Comment: The five standard components are human costs (pain, grief, quality of life), loss of output (foregone earnings), medical costs (treatment and rehabilitation), property damage (vehicles and infrastructure), and administrative costs (police, courts, insurance). Human costs typically represent the largest share, especially when willingness-to-pay methods are used.

Question 2

What are the two main approaches to monetary valuation of preventing traffic injury?

a. The human capital approach and the willingness-to-pay approach (correct)
b. The productivity approach and the consumer surplus approach (incorrect)
c. The replacement cost approach and the taxation approach (incorrect)
d. The cost-recovery approach and the insurance-based approach (incorrect)

Comment: The human capital approach values lost economic output (earnings). The willingness-to-pay approach estimates how much individuals would pay for small reductions in their risk of injury or death. WTP-based estimates are typically much higher because they capture the full value people place on safety, not just lost income. Most high-income countries now use WTP-based estimates.

Question 3

What is the chief argument for using cost-benefit analysis to set road safety priorities?

a. To ensure that all stakeholders agree on the chosen measures (incorrect)

b. To identify the combination of measures that gives the greatest value for money (correct)

c. To avoid political discussions and make decisions purely technical (incorrect)

d. To guarantee that all measures are implemented regardless of costs (incorrect)

Comment: Cost-benefit analysis identifies the allocation of resources that maximises net benefit. By equalising the marginal cost per prevented fatality across all measures, it ensures that the budget produces the greatest possible reduction in casualties. However, in practice, political and equity considerations often override CBA recommendations.

Question 4

What does willingness-to-pay for reduced road crash risk reflect?

a. The government's annual budget allocation for road safety measures (incorrect)

b. The hypothetical demand for improved road safety (correct)

c. The insurance companies' assessment of compensation payouts (incorrect)

d. The actual amount paid in traffic fines by road users (incorrect)

Comment: Willingness-to-pay reflects how much people would hypothetically pay for a small reduction in their risk of being killed or injured in traffic. It is not based on actual market transactions but on stated preferences. This hypothetical nature is one of the main criticisms of the approach, as estimates vary enormously across studies and cannot be independently verified.

Question 5

Is the willingness-to-pay (WTP) for improved road safety subject to actual market transactions?

a. No, it is based on hypothetical valuations, not real market exchanges (correct)

b. Yes, people routinely buy road safety in open markets (incorrect)

Comment: There is no market where people can directly purchase reductions in their road crash risk. WTP estimates are derived from either stated preference surveys (hypothetical choices) or revealed preference studies (e.g. wage premiums for dangerous jobs). Neither represents a direct market transaction for road safety, which is one reason why estimates vary so widely.

Question 6

What is road pricing?

a. A tolling scheme limited to financing new highway construction projects (incorrect)

b. A tax on fuel sales designed to cover road maintenance costs (incorrect)

c. A system where car owners pay an annual fixed fee for unlimited road use (incorrect)

d. A system where every road user pays for the marginal societal costs of road use per kilometre of travel (correct)

Comment: Road pricing charges users the full marginal social cost of each kilometre they drive, including crash risk, congestion, emissions, and road wear. It bypasses the need for valuation studies by letting the price mechanism allocate resources. Where road pricing is not technically or politically feasible, incorporating safety costs into motor vehicle insurance premiums is a simpler alternative.

Question 7

What can be a viable alternative to road pricing for funding road safety measures in less technology-mature contexts?

a. Donations from international tourism revenues (incorrect)

b. A voluntary system where drivers pay only if they want to (incorrect)

c. Incorporating safety costs into motor vehicle insurance premiums (correct)

d. Using lottery proceeds earmarked for transport infrastructure (incorrect)

Comment: Motor vehicle insurance provides a practical mechanism for funding road safety because it already links payment to vehicle use and risk level. By including the societal cost of crashes in insurance premiums, the cost of road safety is borne by those who generate the risk. This approach is particularly relevant for LMICs where road pricing infrastructure may not be available.

Recommended reading and resources for students

- Elvik, R. (2001). Cost–benefit analysis of road safety measures: applicability and controversies. *Accident Analysis & Prevention*, 33(1), 9–17. https://doi.org/10.1016/S0001-4575(00)00010-5
- Elvik, R. (2025). What can empirical utility functions tell us about the value of a statistical life? *Research in Transportation Economics*, 110, 101534. https://doi.org/10.1016/j.retrec.2025.101534
- Hills, P. J., & Jones-Lee, M. W. (1983). The role of safety in highway investment appraisal for developing countries. *Accident Analysis & Prevention*, 15(5), 355–369. https://doi.org/10.1016/0001-4575(83)90014-3

Recommended (additional) reading for teacher

- Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2018). *Cost-Benefit Analysis: concepts and practice* (Fifth ed.). Cambridge University Press.
- Elvik, R. (2016). *The Value of Life: the rise and fall of a scientific research programme* (TØI Report 1531/2016). Institute of Transport Economics. https://www.toi.no/getfile.php?mmfileid=44020
- Elvik, R. (2010). Strengthening incentives for efficient road safety policy priorities: the roles of cost–benefit analysis and road pricing. *Safety Science*, 48(9), 1189–1196. https://doi.org/10.1016/j.ssci.2010.01.005
- Hauer, E. (1994), Can one estimate the value of life or is it better to be dead than stuck in traffic? *Transportation Research Part A: Policy and Practice*, 28 (2), 109–118. https://doi.org/10.1016/0965-8564(94)90032-9
- Hultkrantz, L., M. Svensson (2012), The value of a statistical life in Sweden: review of the empirical literature, *Health Policy*, 108 (2), 302–310. https://doi.org/10.1016/j.healthpol.2012.09.007
- Martensen, H., Daniels, S., Van den Berghe, W., Wijnen, W., Weijermars, W., Carnis, L., Saadé, J., & Elvik, R. (2018). *Guidelines for priority setting between measures with practical examples* (Deliverable 3.5). Horizon 2020 project SafetyCube. https://www.safetycube-project.eu/wp-content/uploads/SafetyCube-D3.5-GuidelinesForPrioritySettingBetweenMeasuresWithPracticalExamples.pdf

- Viscusi, W. K., Masterman, C. J. (2017). Income elasticities and global values of a statistical life. *Journal of Benefit Cost Analysis*, 8, 226–250. https://doi.org/10.1017/bca.2017.12
- Wijnen, W., H. Stipdonk (2016), Social costs of road crashes: an international analysis, *Accident Analysis & Prevention*, 94, 97–106, https://doi.org/10.1016/j.aap.2016.05.005.

Prepared by experts

In case you have specific questions, need a discussion partner, or just want feedback on your lecture materials, you may reach out the authors of this module. Please, put 'AfroSAFE curriculum' in the email subject.

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