

COST–BENEFIT ANALYSIS AS AN UNDERUSED MECHANISM IN MACEDONIA

CASE STUDY: PUBLIC URBAN TRANSPORT IN TETOVO

Merita MUSTAFAI², Verica DANCEVSKA³, Elmir MUSTAFAI⁴

Abstract

Transport is a crucial factor in the modern economy. But there is constant conflict in society regarding the choice of priorities and the decision to favor one project over another (Button, 2010; Banister, 2008)

Cost–Benefit analysis (CBA) is a standard economic tool for evaluating infrastructure and transport projects in European Union countries (European Commission, 2014; Boardman et al., 2018). However, in the Republic of North Macedonia, its application in planning and implementing public transport projects is very limited, that is, it is rarely used as an economic tool in the evaluation and decision-making process. The aim of this paper is to present the significance and applicability of CBA through an analysis of a proposed model of organization of public urban transport in the city of Tetovo. By defining costs and benefits and calculating basic economic indicators, the paper shows that CBA can provide a relevant basis for making rational and transparent decisions in transport planning (Mackie et al., 2014; World Bank, 2020).

Keywords: Cost–Benefit analysis, public urban transport, transport planning, economic evaluation, Tetovo

1. Introduction

The role that public urban transport plays in the economy has contributed in recent decades to continuous investment in the development of this activity in order to improve the quality of services, as well as introduce innovations to better respond to user demands (Vuchic, 2007; European Commission, 2014).

In such conditions, quality public transportation has become an indispensable part of modern life. And the main prerequisite for developed public urban transportation is a good fleet of vehicles as well as good road infrastructure, which is often compared to the bloodstream of a modern society.

However, often in larger urban areas, the organization and operation of quality public urban transport require large investment projects that are of vital importance for the users of public transport. Making decisions about investments in transport infrastructure is a complex process that requires balancing financial possibilities, social needs, and long-term effects on the economy and the environment (OECD, 2015).

² Merita Mustafai PhD student Faculty of Technical Sciences Bitola, Tetovo, N.Macedonia, e-mail: meritamustafai@yahoo.com

³ Verica Dancevska, PhD, professor Faculty of Technical Sciences Bitola, Bitola, N.Macedonia, e-mail: verica.dancevska@tfb.uklo.edu.mk

⁴ Elmir Mustafai, PhD student Faculty of Technical Sciences Bitola, Tetovo, N.Macedonia, e-mail: elmmus@yahoo.com

In developed European countries, Cost–Benefit analysis is a mandatory tool when evaluating such projects, especially when it comes to public urban transportation (European Commission, 2014).

Public urban transport is a key segment of urban mobility, with a significant impact on economic efficiency, social inclusion and quality of life in cities. Effective public transportation not only facilitates population mobility, but also contributes to reducing traffic congestion, pollution, and energy consumption. In the context of cities in the Republic of North Macedonia, public transport often faces limited resources and a lack of systematically planned interventions, which highlights the need for scientifically based approaches to project evaluation.

Cost–Benefit analysis (CBA) is a recognized economic tool that allows for the systematic comparison of the economic benefits and costs of projects throughout their life cycle. In Macedonia, although there is a normative framework for planning the transport system, economic evaluation through CBA is rarely applied in practice. Decisions are often based on financial possibilities or short-term operational goals, while the broader social and economic effects remain insufficiently quantified (OECD, 2015). This limitation emphasizes the importance of applying an economic approach that treats transport infrastructure as a long-term investment with measurable social benefits.

The aim of this paper is to investigate the application of Cost–Benefit analysis in public urban transport in Tetovo and to assess the economic feasibility of the proposed public transport model. This seeks to demonstrate how the economic approach can increase transparency and rationality in decision-making, as well as to highlight the importance of a systematic assessment of economic benefits and costs. The paper also uses data and findings from the doctoral dissertation, providing an integrated analysis that connects theory with practice and the national context.

2. Methodology

Regarding the preparation of this paper, data that were used in the preparation of a doctoral dissertation were used, which integrated methods for qualitative and quantitative analysis of public transport in Tetovo, i.e. a survey of 201 respondents, which was then processed through SPSS, CBA, as well as a strategic approach to transport policy and infrastructure solutions. This combination of different approaches represents a type of innovative combinatorics that is being used for the first time in Macedonia.



Figure 1. Integrated model for optimization of public urban transport in Tetovo

Source: Author's work based on the developed integrated model for optimization of public urban transport in Tetovo

In transport economics, CBA is widely used in the assessment of road infrastructure, rail and public transport projects, and is a mandatory part of the methodology for assessing investments financed by the European Union (European Commission, 2014; Boardman et al., 2018; Mackie et al., 2014). The basic indicators used in this analysis are:

- NPV (Net Present Value) – difference between discounted benefits and costs;
- IRR (Internal Rate of Return) – discount rate at which NPV = 0;
- B/C Ratio (Benefit-Cost Ratio) – ratio between the present value of benefits and costs;
- Payback Period – the period in which the investment is paid off through generated profits (Boardman et al., 2018; Sartori et al., 2014).

Within the framework of this paper, public urban transport in Tetovo has been selected as a case study, in order to assess the economic feasibility of the proposed service model. The proposed service model includes 10 new electric buses, 5 kilometers of dedicated bus lanes, and the introduction of 3 new bus lines. With these innovations, public transportation is expected to be much more organized, more accessible to users, to have a positive impact on the growth of the economic parameters of the city's economy, as well as to have a very positive impact on reducing air pollution (UITP, 2019; European Environment Agency, 2020; OECD, 2015).

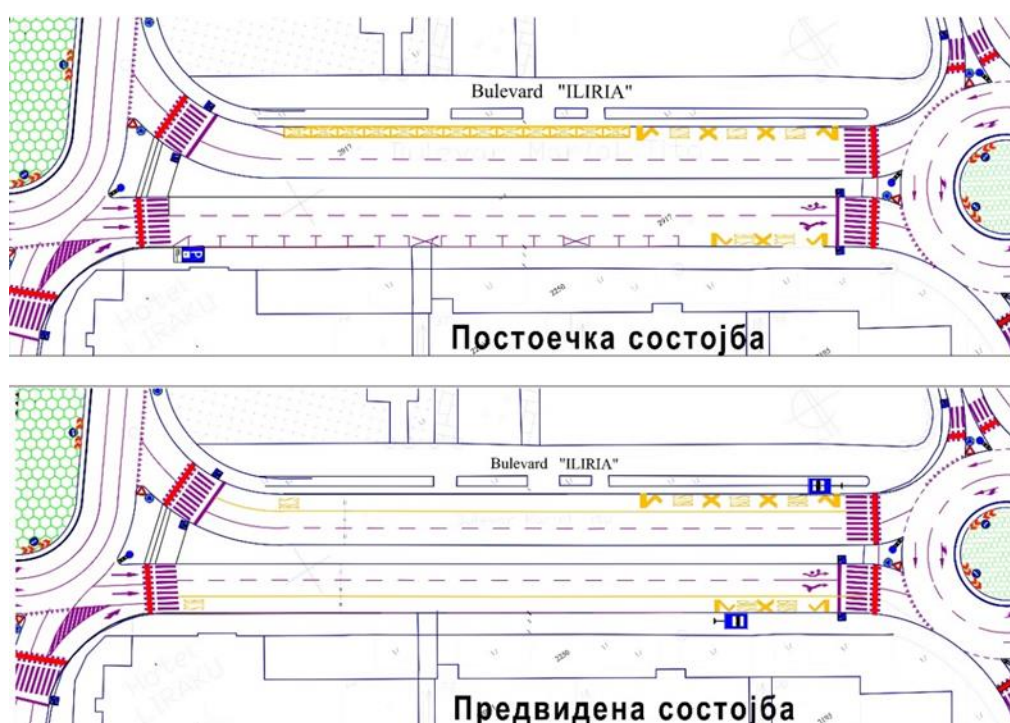


Figure 2. Proposed solution for introducing a separate bus lane

Source: Author's own work

The choice of Tetovo is motivated by the need to improve urban mobility, as well as the insufficient application of systematic economic approaches in decision-making on public transport in Macedonian cities. For the purposes of the analysis, data on the number of passengers, average time savings, construction and maintenance costs, as well as the economic value of time, compared to the average gross salary in the country, are used (Boardman et al., 2018; Mackie et al., 2014).

In the case of Tetovo, the optimization of the public transport system – through the introduction of electric buses, new lines and dedicated bus lanes – creates significant economic and social benefits that can be quantified (UITP, 2019; European Environment Agency, 2020). Discount analysis allows for determining long-term profitability, while scenarios (conservative, realistic, optimistic) provide an assessment of risks and sensitivity of outcomes (Sartori et al., 2014; European Commission, 2014).

The calculation of economic benefits (Bt) is performed by identifying and quantifying the key components. The most significant benefit is the time savings for passengers, which is calculated using the formula:

$$B_{time} = N_p \cdot \Delta t \cdot VOT$$

where N_p represents the annual number of passengers, Δt is the average time savings per passenger, and VOT is the economic value of time (Mackie et al., 2014; Boardman et al., 2018; ITF, 2019).

Пресметка на вредност на заштедено време				
Чекор	Параметар	Вредност (пример за Македонија, 2025)	Пресметка	Резултат (EUR)
1	Просечна месечна бруто плата (W)	70,700	(денари)	1,150
2	Просечен број работни часови (H)	160	W/H	7.185
3	Заокружена вредност според ЕУ стандарди	-	-	7

Economic costs (Ct) include investment costs (CapEx) and operating costs (OpEx), which are adjusted in accordance with economic prices, including potential taxes, subsidies and market distortions. The goal is to provide an accurate assessment of the total economic cost of the project over the analyzed time horizon (European Commission, 2014; Boardman et al., 2018).

Трошоци				
Капитални трошоци (CapEx)				
Компонента	Единица	Количина	Цена по единица (EUR)	Вкупен трошок (EUR)
Електрични автобуси	10 автобуси	10	350,000	3,500,000
Изградба на посебни автобуски ленти	5 km	5	200,000	1,000,000
Инфраструктура за полнење и депо	паушално	–	–	250,000
Модернизација на постојки, сигнализација и систем за билетирање	паушално	–	–	200,000.00
Вкупно капитални трошоци	–	–	–	4,950,000
Оперативни трошоци (OpEx)				
(1) ФИКСНИ ТРОШОЦИ	Единица	Количина	Цена по единица (EUR)	Вкупен трошок (EUR)
Плати за возачи и персонал	За 20 возачи (за покривање 3 смени на 10 автобуса- 900 евра месечна бруто плата/возач)	20	10,800.00	216,000.00
Осигурување на автобуси		10	1,200.00	12,000.00
Гаражирање и депо трошоци	паушално		30,000.00	30,000.00
Лиценци и административни обврски				
(2) ВАРИЈАБИЛНИ ТРОШОЦИ				
Потрошувачка на електрична енергија	10.00	60,000	0.20	120,000.00
Техничко одржување		10	5,000.00	50,000.00
Потрошни материјали (гуми, филтри, сопирачки)		10	3,000.00	30,000.00
Чистење и санации				
(3) ТРОШОЦИ ЗА АМОРТИЗАЦИЈА				
автобуси	Животниот век на електричен автобус е приближно 10 години	10	35,000.00	350,000.00
Инфраструктура (стојалишта, ленти, полначи):	Животен век: 15 години	1	96,700.00	96,700.00
(4) ОСТАНАТИ ОПЕРАТИВНИ (ЕКСПЛОАТАЦИОНИ) ТРОШОЦИ				
ИТ систем за билетирање и надзор		1	15,000.00	15,000.00
Маркетинг и комуникација		1	5,000.00	5,000.00
Непредвидени трошоци		1	10,000.00	10,000.00
Вкупно оперативни трошоци	–	–	–	934,700
			вкупно 10 години	9,347,000.00

Applying CBA allows for the comparison of different scenarios, from conservative to optimistic, in order to assess the sensitivity of the results to changes in key parameters, such as the number of passengers, average time savings and discount rate (Sartori et al., 2014; OECD, 2018). In our case, a comparison of scenarios was made with an increase in the price of a ticket, namely the current situation with 20 den/ride, compared to 25 den and 30 den. This approach represents a transparent and scientifically supported way of making decisions, as well as guarantees the stability of conclusions and provides a solid foundation for proper planning and implementation of projects (European Commission, 2014; Boardman et al., 2018).

3. Economic Analysis

In the next part of the paper, several tables are provided that relate to the external and total benefits, as well as the residual value of the buses and infrastructure that are part of the analysis.

Екстерни (социјални) бенефити	
Категорија	Годишна проценета економска вредност
Намалени емисии и заштеда на гориво/паркинг	120,000.00
Подобрена сообраќајна безбедност	44,000.00
Вкупно	164,000.00
Кумулативна вредност за 10 години (без дисконт)	1,640,000.00

Вкупни бенефити			
Категории	Конзервативно (20 ден карта)	Основно (25 ден карта)	Пооптимистично (30 ден карта)
Финансиски бенефити	1,986,493	2,483,116	2,979,739
Кориснички бенефити (време)	17,851,988	17,851,988	17,851,988
Екстерни бенефити	1,640,000	1,640,000	1,640,000
Вкупно	21,478,481	21,975,104	22,471,727

The residual value of a project refers to the value of the project at the end of the project analysis period, in this case 10 years. The residual value represents the remaining value of the project after a certain number of years of its use.

РЕЗИДУАЛНА ВРЕДНОСТ			
3,500,000.00	0.15	525,000.00	од Автобуси
		500,000.00	од Инфраструктурата
		1,025,000.00	ВКУПНО

Within the framework of the Cost–Benefit analysis, the calculation of the economic justification of the proposed public urban transport model is based on discounting the economic benefits (B_t) and economic costs (C_t) over the analyzed time horizon. The key economic indicators are the net present value (NPV) and the benefit-cost ratio (BCR), defined as:

$$NPV = \sum_{t=0}^T \frac{B_t - C_t}{(1 + r)^t}$$

$$\frac{B}{C} = \frac{\sum_{t=0}^T \frac{B_t}{(1 + r)^t}}{\sum_{t=0}^T \frac{C_t}{(1 + r)^t}}$$

A positive NPV value and a BCR greater than 1 indicate the economic feasibility of the project. The calculated economic benefits arise from time savings, reduced individual transport

costs and reduction of negative externalities, while the economic costs include investment and operational costs. Scenario analysis allows for an assessment of the stability of results and their resilience to changes in key assumptions.

4. Results and Discussion

According to the cost-benefit analysis methodology, results were achieved through several steps:

- Identification of alternatives, i.e. proposed measures that would improve public transport (which in this case was the goal of the research)
- Quantification of costs
- Quantification of benefits
- Monetization and discounting

The following table summarizes the results, which we will then discuss. (The entire paper is based on a comprehensive cost-benefit analysis prepared in Excel by the author, however, due to the limited possibilities in terms of the number of pages, only a few of the tables are briefly presented here)

Сценарио	NPV	IRR (%)	BCR
Случај 1	-245,020	4,0	1.09
Случај 2	13,885	5,1	1.12
Случај 3	272,792	6,1	1.14

In the first case, the net present value (NPV = –245,020 €) is negative, indicating that the project does not cover the total costs with the generated benefits. The IRR is 4.0%, which is below the reference discount rate, while the BCR = 1.09 shows minimal but insufficient economic efficiency.

In the second case, the project moves into the economically justified zone: the NPV is positive (€13,885), the IRR is almost at the 5% limit, meaning the project is at the limit of sustainability, and BCR = 1.12 indicates that the benefits are about 12% greater than the costs. This scenario represents a marginal, but positive justification.

Case 3 indicates that the project is the most profitable, with a high positive NPV (€272,792), the highest IRR of 6.1% and BCR = 1.14. These values indicate that the benefits significantly exceed the costs and that the project has the highest economic efficiency under these assumptions.

According to the calculated values of NPV and BCR, it is shown that there are positive results in all considered scenarios, with the greatest contribution coming from saving time for passengers. Scenario and sensitivity analysis shows stability of results to changes in key assumptions, which confirms the reliability of the conclusions and strengthens their application in the decision-making process.

5. Conclusion

Cost–Benefit analysis is a key economic tool for evaluating infrastructure and transport projects, allowing for a systematic comparison of economic benefits and costs throughout their life cycle. Through the calculation of NPV and BCR indicators, CBA provides a quantitative assessment of the economic feasibility of projects and highlights their social value.

The case study for public urban transport in Tetovo shows that the proposed model generates positive economic results in all considered scenarios, with the greatest contribution coming from time savings, reduced costs for individual transport and reduction of negative externalities. The results confirm the economic feasibility and practical value of applying CBA in the Macedonian context.

The optimization of public urban passenger transport in Tetovo is not just a technical or economic project, but a complex process of social, environmental and institutional transformation. The introduction of electric buses, dedicated lanes and a modernized network of lines is a key step towards creating a sustainable, accessible and efficient transport system, which will improve urban life and increase the city's competitiveness (Litman, 2023; European Commission, 2021).

The integration of the results with the findings from the doctoral dissertation confirms the stability and relevance of the calculated indicators. The introduction of an economic approach through CBA enables rational and transparent decisions, better allocation of limited public resources, and alignment with European standards. In conclusion, CBA represents an underutilized but essential mechanism that can significantly improve the affordability and effectiveness of public urban transport in Macedonia.

At the same time, the paper can serve as a basis for future research, as well as for the development of national methodological guidelines for the economic evaluation of public transport projects. By increasing the capacities of institutions, but also with support from international donors and the expert community, there is real potential for CBA to become a standard tool for making transparent and responsible decisions in the transport sector in Macedonia.

Reference

- [1]. Danchevska, V. (2012). *Economics in traffic and transportation, traffic politics*. UKLO University St. Climent Ohridski.
- [2]. Krstanoski, N. (2003). *Планирање на јавен градски патнички превоз*. Битола.
- [3]. Litman, T. (2017). *Evaluating public transportation benefits and costs: Best practices guidebook*. Victoria Transport Policy Institute.
- [4]. State Statistical Office of North Macedonia. (2025). Average monthly net wage by sectors. Skopje: SSO.
- [5]. Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2018). *Cost–Benefit Analysis: Concepts and Practice* (5th ed.). Cambridge University Press.
- [6]. European Commission. (2014). *Guide to Cost-Benefit Analysis of Investment Projects*. Brussels.
- [7]. European Environment Agency (EEA). (2020). *Transport and environment report*. Copenhagen.
- [8]. Mackie, P., Worsley, T., & Eliasson, J. (2014). *Transport appraisal revisited*. Research in Transportation Economics, 47, 3–18.
- [9]. OECD. (2015). *Urban Transport and Sustainable Development*. OECD Publishing.
- [10]. Sartori, D., et al. (2014). *Guide to Cost-Benefit Analysis for Investment Projects*. European Commission.
- [11]. UITP. (2019). *Public Transport Benefits for Cities*. International Association of Public Transport.