EVALUATION OF URBAN TRANSPORT PROJECTS WITH RESPECT TO SUSTAINABLE MOBILITY

Davor Krasić
Institute for Tourism, Department of Transport Planning, Croatia

Abstract

In the middle and in the second half of the last century, the development of transport infrastructure in cities was approached in a purely functional way in planning practice. The functional approach was based on meeting the growing traffic demand, primarily individual road traffic, which resulted in huge investments in the city's road infrastructure. The short - term view of the future and the fascination of planners with individual road traffic relatively quickly proved to be a failure of planning theory and practice. Many urban areas have become unacceptable for the quality of life of residents due to harmful products of individual road traffic, such as noise, air pollution, traffic accidents and disrupting the landscape aesthetics of the urban area. Bad experiences with such an approach have resulted in a turnaround that took place at the end of the century and, in particular, at the beginning of this century at least when it comes to cities within the European Union. This shift means abandoning a purely functional approach to transport planning and turning to balanced development based on the principles of sustainable mobility. This paper provides recommendations on how to evaluate transport projects that respect the principle of sustainable mobility, i.e. sustainable urban development.

Keywords: urban transport, project evaluation, sustainable mobility, cost – benefit analysis, multi – criteria analysis

1 Introduction

Deciding on the implementation of an individual transport project should be a consequence of a consistently implemented transport planning procedure. This need is particularly expressed in high-value transport infrastructure projects. The urban transport system is much more complex than the state or regional system because there is an interaction of a large number of its users in a very limited space: drivers in cars, passengers in public transport, cyclists and pedestrians. Particular emphasis should be placed on vulnerable groups of people (disabled, children, the elderly) who appear daily in urban transport. The city's road network is generally heavy congested due to daily travel such as business trips, school trips, shopping trips, etc. One example is that the average daily traffic on motorways in Croatia in 2019 was 14.7 thousand vehicles, while the average daily traffic on many main roads in the city of Zagreb was in the range of 20-40 thousand vehicles and on the busiest bridges 50-70 thousand vehicles. It is not difficult to conclude that transport planning in cities is the most complex task for transport planners. Making decisions about which urban transport projects should be implemented and which rejected requires a lot of understanding of the problem and knowledge by city decision makers and this is not always the case. The carefully conducted transport planning process provides a number of useful data that can help to

DOI: https://doi.org/10.5592/CO/CETRA.2022.1367

make the best decision, but it is necessary to understand the data presented and know what potential “pitfalls” they hide.

This paper points out the weak points in the usual process of evaluation of urban transport projects with special emphasis on the neglect of the principle of sustainable mobility. A proposal is also given on how to improve the evaluation process.

Some of the main goals of sustainable mobility are contained in a European Commission document entitled White Paper on Transport [1], of which the following applies to urban transport and transport infrastructure: reduction of environmental pollution generated by transport (by 20 % in the period from 2008 to 2030), increasing the efficiency of the use of the existing transport infrastructure by applying modern information and communication technologies, greater use of urban public transport and bicycle transport with a reduction in individual vehicle transport, spatial planning aimed at reducing the amount of traffic on the roads, significant reduction in road deaths (reduce the number of fatalities by 50 % by 2020 and move closer to the “no fatalities” target by 2050).

Transport policy in cities should follow the objectives set out in this document, but this is often not the case, especially in less developed countries of the European Union. There are still inherited (unrealized) transport projects in the city’s spatial plans that emerged in the 1970s or 1980s, and which have not been reconsidered in the context of new circumstances and new approaches in urban transport planning. Transport solutions developed forty or more years ago were largely based on favouring the construction of high-capacity roads, to meet the demands of strong growth of individual motorization. In many cases, there is no courage to reduce or eliminate the reserved corridors for such city roads from spatial plans and to repurpose the space in accordance with the principles of sustainable development. Keeping these corridors in spatial plans gives some legitimacy to the supporters of intensive road infrastructure construction who, despite the guidelines of the European Commission, update transport projects that are contrary to the principle of sustainable mobility.

2 Evaluation of transport projects in cities

Transport planning is characterized by a complex process that can be roughly divided into five basic phases: Setting goals and constraints ⇢ Analysis of the current state of the transport system ⇢ Forecasting future development and future transport problems ⇢ Evaluation of alternative transport solutions (transport projects) ⇢ Selection of the best transport solutions (projects).

Transport projects in cities can in principle be divided into two categories: infrastructure and non-infrastructure projects. This paper considers infrastructure projects because they significantly affect space and quality of life.

So far, the most used procedure in the evaluation of transport projects is cost-benefit analysis (CBA). It is described in many manuals and guidelines for project evaluation, both in Europe and abroad [2-4]. As a traditional method of economic evaluation, it has been applied in most projects. Its main feature is the converting all costs and benefits of the project to monetary value. Although these projects are valued from a social point of view, the main indicators of cost-benefit analysis are terms borrowed from the banking sector: net present value (NPV), cost-benefit ratio and internal rate of return (IRR) and the acceptability of transport projects is based on them.

When preparing a CBA, project costs are calculated in detail, which include the costs of: preparing project documentation, land acquisition, facility construction, maintenance and administrative costs. The costs can be calculated with satisfactory accuracy. However, the assessment of project benefits is based on a number of assumptions and approximations. The benefits of the project that are expressed in the CBA are: reduction of vehicle operating costs, savings in travel time, reduction of the number of traffic accidents, reduction of traffic noise, reduction of air pollution. Most of these benefits are related to the reduction of congestion in road or public transport, i.e. shortens travel and increases average travel speed. Roughly speaking: vehicle operating costs are reduced if stopping at intersections is reduced and average travel speed is increased, drivers and passengers travel time is reduced due to faster travel, the number of accidents is reduced because the new road has better technical characteristics, noise is reduced because it is travelled shorter on the new road than in the existing state (which is called: do-nothing). Many of the benefits included in the CBA are questionable, especially when it comes to urban transport projects [5], [6]. Regional and national transport projects are much easier to implement CBA because there are no such strong interactions between transport infrastructure and the residents, and the area where the infrastructure project is implemented is much larger with fewer restrictions on project implementation. In addition, in the monetary values used in cost-benefit analysis there are a number of approximations and assumptions such as: value of travel time, value of human life, value of noise reduction, etc. Different valuation methods are applied such as “willingness to pay”, “willingness to accept”, stated preferences, revealed preferences, etc. The value of human life varies considerably from country to country even within the EU and, although this is a calculated value for CBA purposes, it is questionable to what extent it can be considered ethically justified. The willingness to pay method shows how much someone is willing to pay to make something happen or not. So, it is a hypothetical payment for something that has not happened yet, that is, for something that the interviewed man/woman has never experienced. In addition, total calculated benefits in the CBA depend significantly on the results of the transport model because it provides data on future traffic volumes on a road or public transportation facility. It is known that the reliability of a model depends on a number of factors and many authors consider a model to be good if it does not produce a larger estimation error than 15 %. The calculation of the benefits of a transport project could in many cases be described as an “accurate calculation with unreliable input data”.

The question arises as to what extent decision makers (local politicians) trust the results of the CBA. They probably trust it more the less they know about how a CBA is made. A survey conducted in the Netherlands [7] showed that most of the 21 interviewed politicians who decide on the transport projects at national, regional and city level, accept the CBA only as an information document but not as the only source on which to make a decision. Distrust of the CBA results was radicalized by one of the politicians, who said that “the CBA just shows what the people in power want.”

The greatest manipulation is possible with travel time values, i.e. with savings that are calculated by multiplying the individual travel time reduction by the travel time value. Given that total money savings are the product of individual savings and number of drivers and passengers on the future road (from the transport model), it is clear that the final result of the CBA can be changed by an increase or decrease in the value of time by just a few percent. Also, insufficient quality transport model can further compromise CBA results.

Weaknesses of the CBA are even more pronounced in transport projects in cities. The main problem is insufficient respect to the principles of sustainable mobility. One example is the Croatian guidelines for the preparation of CBAs for roads and railways [8], which follow the methodology accepted in the EU. The risks of traffic accidents are presented in such a way that the monetary cost is calculated as the product of the number of vehicles, the length of the road section and the average cost of the accident. The same procedure is applied to all projects in one city, not considering the specifics of each project from the aspect of traffic safety. This means that if we have two roads of approximately the same length and similar volume of vehicles, the CBA will assign them almost the same risk of accidents. It is well known that the risk of accidents on two roads can be very different, depending on whether the road is in a residential area or in the business part of the city, whether the road passes by a primary school or kindergarten, whether there are facilities along the road which attract

many pedestrians, whether there are intersections that interrupt traffic flow and reduce vehicle speeds, etc. The CBA does not consider any of these aspects of traffic safety.
The impact of noise is monetized in the CBA guidelines by multiplying the unit cost of noise by the number of vehicles and the length of the road section. The same unit cost is applied for the whole city area, but it differs for four categories of vehicles (passenger cars, light trucks, heavy trucks, and buses). No data for tram or LRT. Again, the specifics within the urban area were not considered and one city is treated as one area, which is completely different from reality. One road in the city can pass by a noise-generating factory and the other by a recreation area where the noise must not exceed 50 dB. Also, one can pass not far from the hospital and the other next to the shopping centre. According to the current guidelines for the CBA, all these roads will be treated equally since their environment is not considered.
The CBA does not show two very important components of sustainable development at all: the impact on nature (flora and fauna) and the impact on the landscape. So, for the CBA, it doesn't matter at all whether the road passes by a valuable historical monument and whether it obscures the view of it; whether it passes directly next to the park where damages the ambience of green areas, etc. All of the mentioned above calls into question the adequacy of the CBA for the ranking of transport projects in cities based on simple monetization, especially those impacts that are associated with the principles of sustainable development, i.e., sustainable mobility.
Unlike the CBA, multi-criteria analysis (MCA) is not based on monetizing the costs and benefits of a project. This method evaluates and ranks projects based on selected criteria and the assessment of the extent to which each project meets each criterion. The following figure shows the basic structure of the most used method of multi-criteria analysis for transport projects [9] Analytic Hierarchy Process (AHP), developed by the American mathematician Saaty [10]. This method has a firmly defined mathematical background and in practice it is supported by several software (Expert Choice, Decision Lens, Super Decision, etc.)

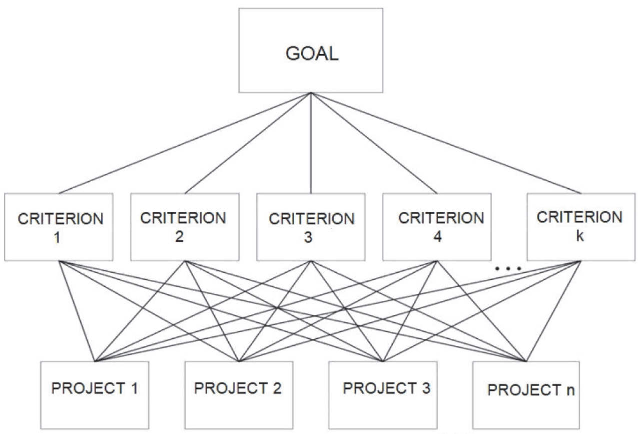

Figure 1 The structure of Analytic Hierarchy Process (AHP)

The MCA gained in importance when it became clear that the CBA, despite improvements, could hardly calculate the project's impacts from a sustainable mobility perspective. Nevertheless, CBA is still the dominant method in most manuals for the evaluation of transport projects [11]. In a few of studies, the MCA appears as an attempt to improve the process of deciding on priorities in the implementation of transport projects by combining CBA and MCA. One such example is the setting of priorities for the modernization of national secondary roads sections in Ireland, with the basis of the prioritization framework being the MCA in which the CBA results are incorporated [12]. Another example is the composite model for assessment (COSIMA) in which the result of the MCA is supplement to the CBA [13]. Explaining option analysis, the European Commission's CBA Handbook of Investment Projects [2] mention the possibility of using MCA "for shortlisting the alternatives" but without further explanation.

Two studies conducted for the city of Zagreb in the last few years have had the task of ranking transport projects with special emphasis on sustainable mobility. These are transport projects that have been designed in the past but have not been realized so far. The first study evaluated 19 road infrastructure projects [14] and the second study evaluated 34 transport projects of all types [15]. In the mentioned studies, multi-criteria analysis, i.e., Analytical Hierarchy Process (AHP), was applied. The following main criteria have been selected and each of them has been described in detail so that evaluators have known exactly what elements it includes and to avoid double-counting as much as possible:

- Contribution to the improvement of the urban public transport,
- Impact of traffic safety,
- Harmful impact of traffic on people and environment (noise, air pollution and landscape damage),
- Contribution to the accessibility of insufficiently connected areas of the city,
- Technical and financial conditions of project implementation,
- Contribution to the efficiency of the transport network and travel time reduction,
- Impact on multimodality and integration of the transport system,
- Impact on improving conditions for non-motorized traffic.

The importance of each criterion is determined in the first phase of AHP, when the pairwise comparison determines the strength of the influence on decision-making. In this phase of AHP it is important to involve relevant stakeholders: city politicians (decision makers), spatial planners, transport planners, environmental planners, and traffic safety experts. In the second phase, the expert group, which must know very well the characteristics of each project, assesses the extent to which each project meets each of the set criteria. Synthesizing the first and second phases leads to the ranking of projects, with the best project having a normalized value of 1.000 and all others lower values. Normalization of values clearly shows how much a particular project is weaker than the best one. In their book [16] Saaty and Peniwati explained in detail how to carry out the procedure when there are many evaluators involved and how to achieve consistent results in cases where their assessments of criteria and/or projects differ significantly.

Summarizing the above mentioned, it is possible to propose a general procedure for the evaluation of transport projects in cities (Figure. 2). It is important to note that in the proposed evaluation procedure, the MCA and the CBA are separated in such a way that the MCA is the basis for the evaluation and ranking of transport projects according to selected criteria that follows the principle of sustainable mobility. After the projects are ranked from best to worst, a list of acceptable projects and a list of projects that should be rejected are made. The CBA is used to evaluate variants of a transport project that has previously been assessed as acceptable. Thus, the CBA, due to its weaknesses in terms of sustainable mobility requirements, should not serve as the main selection tool for transport projects but as an evaluation method of different variants within a particular project. The procedure defined in this way avoids the danger that the monetized result of the CBA overshadows the "common sense" and the influence of stakeholders on the decision-making process.

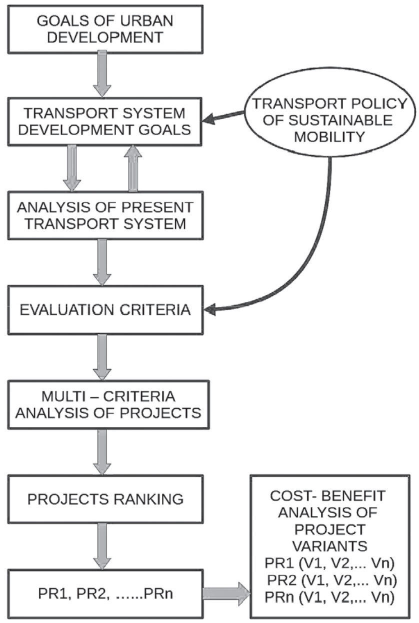

Figure 2 Proposed procedure of urban transport project evaluation

3 An example: The Jarun Bridge in Zagreb

The idea of Jarun Bridge belongs to the concept of the city road network from the late 70s of the last century. In the spatial plans of the city of Zagreb (about 770,000 inhabitants) there are many traces of planning errors from those years. The Jarun Bridge was planned before there was a recreation and sports centre on Lake Jarun. Since the end of the 1980s, this centre has become the largest urban recreational area in Zagreb and Croatia. It is often visited by up to 10,000 citizens a day. There are 6 islands and about 2.5 km of beaches for swimming and several kilometres of hiking, biking and rollerblading trails. Since the Jarun Bridge corridor (the width of the corridor is more than 40 m) has not yet been removed from the spatial plans of the city of Zagreb, proponents of its realization appear every few years to “reduce road traffic jams in the southwestern part of Zagreb”.

But from the aspect of sustainable mobility, the realization of the Jarun Bridge is questionable because it would: damage the landscape appearance of Lake Jarun and its recreational and sports centre, generate a lot of noise (calculated average level is 83 dB) originating from road traffic which is unsuitable for sports and recreational activities, endanger the safety of pedestrian movements because the corridor of the bridge and its access road is an obstacle to them visiting Lake Jarun, endanger the safety of children since the access road on the north side of the bridge passes by the primary school and kindergarten, generate air pollution.

In a study [15], this project was negatively assessed with the conclusion that it should not be realized because it has significantly more harmful effects than benefits from the aspect of sustainable mobility. Multi-criteria analysis (AHP) was used in the study. The question is whether the same conclusion would have been reached if the cost-benefit analysis had been used. Very likely not. In the CBA the starting point for the project evaluation would be the reduced length of travel for a number of road vehicles compared to the existing situation (do-nothing).

Reduction of the length of travel is treated as a big benefit that has an impact on the calculation of monetized savings in travel time. According to the national CBA guidelines for transport infrastructure projects [8], noise costs and accident costs are directly correlated with vehicle-km, and the reduction of the length of travel by building a bridge, the new bridge would be shown to be a better solution than the existing bridge-less situation.

Figure 3 Visual simulation of the Jarun Bridge

4 Conclusion

Evaluation of urban transport projects is a very demanding task in the process of transport planning and decision-making. Housing density, which is highest in cities, requires that all negative impacts of traffic on people's quality of life and health be carefully examined. The evaluation of transport projects, which is mainly based on shortening the length of travel and reducing travel time, especially in road traffic, is not a guarantee of sustainable development of the city. The still predominant ways of evaluating urban transport projects need to be seriously reconsidered. This paper points out some weaknesses of cost-benefit analysis when technically applied to the evaluation of transport projects in cities and it is suggested that, in the first phase of evaluation, the main selection of acceptable and unacceptable projects should be made by multi-criteria analysis with strong mathematical background and involvement all relevant stakeholders. The cost-benefit analysis retains its place in the second phase of the evaluation, when different variants within each acceptable project are evaluated.

References

[1] WHITE PAPER ON TRANSPORT: Roadmap to a Single Transport Area – Towards a competitive and resource efficient transport system, European Union, Luxembourg, 2011.

[2] Guide to Cost-Benefit Analysis of Investment Projects, European Commision, Brussels, 2014.

[3] Rouhani, O.: Transportation Project Evaluation Methods/Approaches, McGill University, Montreal, 2019.

[4] Australian Transport Assessment and Planning Guidelines: T2 Cost-Benefit Analysis, Camberra, 2021.

[5] Metz, D.: Travel Fast or Smart, London Publishing Partnership, London, 2016.

[6] Generated Traffic and Induced Travel, Victoria Transport Policy Institute, Victoria, 2020.

[7] Annema, J.A., Mouter, N., Razaei, J.: Cost-benefit analysis (CBA) or multi-criteria decision-making (MCDM) or both: politicians' perspective in transport policy appraisal, Transportation Research Procedia, 10 (2015), pp.788-797, doi: 10 .1016/j.trpro.2015.09.032

[8] Smjernice za CBA za projekte prometnica i željeznica, Ministarstvo pomorstva, prometa i infrastrukture, Zagreb, 2016.

[9] Broniewicz, E., Ogrodnik, K.: Multi – criteria analysis of transport infrastructure projects Transportation Research Part D, 83, (2020), doi: 10.1016/j.trd.2020.

[10] Saaty, T.L.: Decision Making with the analytic hierarchy process, Int. J. Services Science, 1, pp. 83-98, 2008.

[11] Beria, P., Maltese, I., Marloth, I.: Multicriteria versus Cost-Benefit Analysis: a comparative perspective in the assessment of sustainable mobility, European Transport Research Review, 4 (2012) 3, pp. 137-152, doi: 10.1007/s12544-012-0074-9

[12] Guhnemann, A., Laird, J.J., Pearman, A.D.: Combining cost-benefit and multi-criteria analysis to prioritise a national road infrastructure programme, Transport Policy, 23 (2012), pp. 15-24, doi: 10.106/j.tranpol.2012.05.005

[13] Barfold, M.B., Lelur, S.: Multi-criteria decision analysis for use in transport decision making (2nd ed.), DTU Transport, Delft, 2014.

[14] Studija optimalizacije prometnih tokova na cestovnoj mreži grada Zagreba, Institut za turizam, Elipsa S.Z. i Fakultet prometnih znanosti, Zagreb. 2019.

[15] Revizija Prometne studije grada Zagreba iz 1999. sa smjernicama za primjenu u prostorno-planskoj dokumentaciji Grada Zagreba, Prometheum, Zagreb, 2021.

[16] Saaty, T., Peniwati, K.: Group Decision Making: Drawing out and Reconciling Differences, RWS Publication, Pittsburgh, 2012.