Transportation Project Evaluation Methods/Approaches- Version 2

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Abstract

Building upon an earlier version, I further review the key methods to evaluate transportation projects. Since transportation projects offer substantial social benefits and costs, it is vital to provide a comparative analysis on the commonly-used methods, i.e., which method(s) to use and under what conditions. In this short paper, I provide such analysis briefly.

Keywords – Project evaluation methods, Transport projects, Comparative analysis, Multi-criteria analysis, Social welfare analysis.

Background

Considering the complexity of transportation systems (Rouhani et al., 2016a) and travel behavior (Daher et al., 2018) and the fact that transportation projects are generally large size and very costly (NSTIFC, 2009; Rouhani, 2012; Rouhani et al., 2014), it is of extreme importance to develop theoretically-strong transportation project evaluation methods. Another reason to analyze such methods is that even a small improvement in our transportation systems could offer substantial travel time and energy savings and environmental improvements (Rouhani et al., 2013a), or even the opposite considering Braess' Paradox (Frank, 1983).

The question is then how to choose public projects (Poorzahedy and Rouhani, 2007). Advanced project evaluation methods examine a variety of projects' impacts, including project finance (Rouhani and Niemeier, 2011; Rouhani 2016; Rouhani and Gao, 2016), project delivery (Rouhani et al., 2015a; Rouhani et al., 2018), system-wide traffic flows (Do et al., 2021), external costs (Rouhani et al, 2015b; Rouhani, 2018a; Beheshtian et al., 2020), environmental implications (Booth and Schulz, 2004; Rouhani and Beheshtian, 2013; Rouhani et al., 2015b), and life-cycle asset management (Lin et al., 2009; Jones et al., 2018). The key goal of such methods, however, is to provide insights to policy makers in order to choose the most useful projects to be implemented, both as ex-ante and ex-post evaluations.

With the increasing interests in considering non-monetary costs and benefits, policy makers seek new evaluation methods that could include such cost/benefits. In fact, both policy makers and the general public have become more aware of the importance of air quality implications (Rouhani and Gao, 2014; Daher et al., 2018), climate change impacts (Rouhani, 2013), network impacts (Rouhani and Niemeier, 2014b), community cohesion (Litman, 2017), energy consumption (Rouhani and Zarei, 2014), equitable distribution of resources (Van Wee, 2012; Madani et al., 2014), safety implications (Lord and Persaud, 2004), resiliency (Beheshtian et al., 2016; Beheshtian et al., 2017), economic development (Do et al., 2020), sustainability (Rouhani, 2013; Rouhani, 2018b), autonomous vehicles' impacts (Do et al., 2019) etc.

In a previous study (Rouhani, 2019), I reviewed common methods/procedures for a proper transportation project appraisal. In this paper, I briefly compare these key methods with each other.

A Short Review of Project Evaluation Approaches

I begin with a short review of the most-commonly-used project evaluation approaches. For more information regarding the below methods, I refer the readers to Rouhani (2019). Note that I excluded Monte Carlo simulation (Pohl and Mihaljek, 1992) and cost-effective analysis (Nocera et al., 2015) from my discussion in this paper since those methods could not provide neither a comprehensive analysis of projects' impacts nor a unified score including a variety of impacts. Those methods, however, could be combined and used along with financial CBA, social CBA, MCA, and SWA.

Financial Cost Benefit Analysis (CBA)

Commonly-used by the private sector, financial CBA examines only the *direct monetary* costs and benefits. After determining the cost/benefit items in each time period, one could use one of the methods such as benefit cost ratio, net present values, annual worth, and/or rate of return in order to choose among the possible projects (Rouhani and Beheshtian, 2016):

Social/Economic Cost-Benefit Analysis (CBA)

In contrast to a financial CBA, a social cost-benefit analysis measures the economic and social impacts of a project, on a broader level than the financial analysis (Policy-EU guide, 2008). To include projects' broader impacts on society as a whole, a social CBA considers changes in consumer surplus, social opportunity costs instead of observed distorted prices (e.g., the social cost of Carbon versus its market price) and the markets that aren't available or they don't reflect true prices (e.g., health-related impacts of air pollution) (Rouhani et al., 2013b; Rouhani et al., 2016b).

Using a social CBA, all the costs and benefits associated with a project are monetised, to express the overall impact of a projects as a social rate of return or, usually, as a social benefit/cost ratio (Weisbrod and Weisbrod, 1997).

Multi-Criteria Analysis (MCA)

When using a social CBA, it might be impossible to monetize an impact (a criterion) (e.g., the value of life for an endangered species). Using an MCA, we can include all types of projects' impacts (Macharis et al. 2009; Madani et al., 2011). MCA assigns weights on various impacts (criteria) based solely on decision makers'/experts' judgements via surveys

The MCA provides a ranking of various alternative projects. In order to determine weights of each criterion (impact), the method makes use of interviews with stakeholders (Saaty and Shang, 2011). As a result, MCA can take into account any criterion, regardless of its unit of measurement.

Social Welfare Analysis (SWA)

The most appropriate evaluation criterion is the overall social welfare impacts of projects (Rouhani, 2016). A social welfare analysis (SWA) provides a unified criterion that can measure the overall impact of each project. SWA reduces various dimensions of projects to welfare units or net social benefits.

The welfare effects of a project can be modelled by solving a general equilibrium model before and after its implementation, even for small/local projects (Diewert, 1983). Researchers have developed detailed models required to capture welfare improvements resulting from public projects, e.g., how to separate imp[acts on various stakeholders (Do et al., 2019), how to measure environmental/equity impacts in monetary terms (Rouhani and Niemeier, 2014a), what types of models required for the analysis, etc.

The change in welfare could be estimated according to the studied project's impacts on various stakeholder groups (users, residents, government, the private sector, employees, etc.), and the analysis can also examine the impacts for subgroups (different income level groups).

A Comparative Analysis

Returning to the key objective of this paper, I provide a comparative analysis on the key project evaluation methods in this section. Note that my focus is on the methods that provide a clear/robust answer on the project's (s') selection. In fact, I overview the methods that could provide a unified measurement of the overall score/ranking of projects, considering a variety of impacts altogether.

A financial CBA works mainly for the private sector. Any formal analysis from the public sector should avoid focusing only on direct monetary costs/benefits. A social CBA is more inclusive than a financial CBA, e.g., considering externalities. However, even social CBA is unable to take into account the impacts on various sectors of economy and various stakeholder groups. In fact, a social CBA usually considers primary impacts, not secondary impacts. In general, only SWA or MCA could include such missing impacts.

Almost all approaches that include a variety of projects' impacts are variations of SWA or MCA. Both approaches provide a unified measurement of the overall impact of projects; SWA in terms of welfare money and MCA in terms of a normalized score. Without an overall impact score, project evaluations could become subjective since projects usually offer trade-offs. For example, the projects that mitigate climate change impacts of travel the most could be the most expensive ones. Therefore, policy makers are unable to decide which project(s) to implement. My argument is that these two approaches could provide results that, in most cases, shows clearly the best project(s) from society's perspective. In the following, I mention the important limitations of each method.

On one hand, SWA suffers from a few fundamental limitations. First, it is less demanding, as well as less controversial, to quantify impacts in their own units, for example, assessing GHG emissions in tons rather than attempting to determine social costs of GHGs. In contrast to MCA, SWA requires extensive calculations to transform all impacts into welfare units. Second, some impacts are difficult to monetize, such as the value of an endangered species or the aesthetic value of a project. Therefore, SWA essentially suffers from incompleteness (Hickman and Dean, 2018). Given this fact, MCA should be preferred since it does not require the monetization of non-market goods/services. Third, SWA suffers from a number of practical limitations. For instance, it generally prioritizes projects that could produce significant benefits for a large number of people. These projects tend to be concentrated in economically vibrant urban areas rather than in socially and economically deprived areas, which serves to further perpetuate inequity (Hickman and Dean, 2018). Further more, SWA usually aggregates individual perceptions and assumes that society is willing to pay for the project's impacts. However, society is not monolithic, and individual perceptions vary widely from one person to the next (Ackerman and Heinzerling, 2004).

On the other hand, the first limitation of MCA is that such surveys might lead to subjective judgment; in contrast, SWA is able to provide a relatively objective assessment, as it estimates trade-offs in practice, based on real preferences of stakeholders. MCA's weights are based on surveys that could provide biased evaluations, e.g., a transportation safety expert generally values safety more than other criteria. Second, the importance (weight) assigned to each impact/criterion could change with time, region, or even projects' nature. MCA approach is unable to adapt to such changes. Third, MCA could produce questionable results when impacts are extremely small/large due to the normalization procedure (Saaty and Shang, 2011). Finally, misinformed responses or a general lack of knowledge on the part of the stakeholders could impact the weights (Rouhani et al., 2021).

Overall, if the SWA weights are robust, they should be preferred to the MCA weights, as they are less subjective. Very few studies, however, have compared the two approaches. In one prominent example, Tudela et al. (2006) compared the results of social CBA and MCA. Interestingly, public authorities selected the MCA-preferred option over the because it accounted for factors that were not considered in CBA, such as environmental and social impacts. However, the study ignored the fact that a social CBA could also take such factors into account by using a SWA. In addition, the study did not explore the key reasons behind the observed difference. No study has yet examined fundamental differences in both approaches.

Conclusions

In this paper, I overview and compare the key common approaches for evaluating transportation projects. First, it is almost impossible to choose among the projects without using evaluation methods that could provide a unified score. Only social CBA, SWA, or MCA reduce a variety of projects' impacts into single score. Second, social CBA is useful, but less comprehensive than SWA. Third, SWA is unable to determine welfare implications of some aspects, e.g., the aesthetic value of a project. Fourth, while MCA could theoretically include all impacts of projects, it provides a subjective assessment. Fifth, although the importance (weight) assigned to each impact/criterion could change with time, region, etc., MCA approach is unable to adapt to such changes. Overall, considering substantial social/economic/environmental impacts of transportation projects, I recommend a hybrid approach, i.e., employing more than one approach or at least taking the strengths/weaknesses of the selected approach into account. Furthermore, future studies should carefully examine fundamental differences in project evaluation approaches, using case studies.

Copyright Note

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