

# The Evaluation of Transportation Investment Projects

Joseph Berechman



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# **The Evaluation of Transportation Investment Projects**

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Investment Projects**

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*I dedicate this book to my newborn grandson, Ely.  
May his world be just and peaceful.*



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# Preface

I keep six honest serving-men  
(They taught me all I knew);  
Their names are What and Why and When  
And How and Where and Who.  
I send them over land and sea,  
I send them east and west;  
But after they have worked for me,  
I give them all a rest.

I let them rest from nine till five,  
For I am busy then,  
As well as breakfast, lunch, and tea,  
For they are hungry men.  
But different folk have different views.  
I know a person small—  
She keeps ten million serving-men,  
Who get no rest at all!

She sends'em abroad on her own affairs,  
From the second she opens her eyes—  
One million Hows, two million Wheres,  
And seven million Whys!

—Rudyard Kipling  
From "*The Elephant's Child*"

In a previous book written by Prof. David Banister and myself, we raised the question of whether transportation investment projects generate economic growth benefits and, if so, what is their nature and how significant are they (Banister and Berechman, 2000). Our motivation in exploring these questions grew from our concern that in many cases, when transportation investment projects cannot be fully or even partly justified on the basis of their direct transportation benefits, their advocates tend to argue that the project

will nonetheless engender substantial economic benefits. We showed that, by and large, for a given transportation investment, economic development benefits are difficult to establish and substantiate. In general, the economic development benefits growing out of such investments are poorly defined, with attempts to appraise them often double-counting the benefits. Rationalization of projects mainly on the basis of economic development benefits is consequently erroneous and likely to conclude in the implementation of inferior projects.

In recent years I have been engaged in several studies designed to analyze and evaluate transportation investment projects. In one recent major study, the objective was to prioritize a set of large-scale rail and transit hub investments in New York for the purpose of recommending which should be carried out (Berechman and Paaswell, 2005). In the course of carrying out this study, the most striking observation was the tenuous evaluation process that key stakeholders used to rationalize their positions on the various projects. These stakeholders neither saw the need for a systematic and well-founded evaluation procedure nor worried much about the modest value of the anticipated transportation benefits. Ambiguous catch phrases such as “the project’s potential for urban development,” “promoting regional needs,” “strengthening the vitality of the city’s economy,” or “the critical importance of rapid transit services to business and economic development” were used *prima facie* to justify their favorite project. Yet, from transportation, economic, and even social perspectives, these projects made little sense. As a transportation economist and planner, I was deeply troubled by the staggering capital costs of these projects—running into billions of dollars—which could have been invested in public infrastructure either in transportation or in other domains, such as the environment, health, and education.

This situation, however, is not unique to New York City or, for that matter, to any specific urban area or country. A growing body of literature has documented the colossal failure of many transportation mega-projects worldwide to meet projected budgets, travel volumes, and timetables (Flyvbjerg et al., 2003; Winston and Maheshri, 2007). The absence of a well-founded, comprehensive, and ongoing evaluation process at a core stage in decision making is commonly cited as one of the main causes of the failures (US Government Accountability Office, 2005).

Explanations for this phenomenon encompass a wide range of reasons. They include the politics of public infrastructure decision making; state and federal capital subsidization of local projects, which encourage non-systematic project evaluation; or the downplay of transportation impacts by placing excessive weight on claims that the investment will automatically engender regional economic growth. Not less glaring, however, is the impression that many transportation professionals are not well acquainted with the literature on transportation project evaluation, and especially of its recent developments. This might be due to the fact that no currently available topical book on the subject is sufficiently comprehensive to cover

all the relevant aspects of transportation investment decision making, or adequately up-to-date to offer the most recent analytical and empirical advances in the germane areas.

To be sure, most countries use some formal transportation project evaluation procedures. Yet, these are, by and large, partial, ad hoc, and applied only at the initial phases of the planning process, when vital information (mainly, cost and demand projections) is largely missing. Many of these procedures neglect to consider key issues such as project risks, methods of capital funding, latent demand, market imperfections, and incompatibilities between trip rates, travel costs, and activity location. As a result, projects that would not have been accepted had a comprehensive and effective evaluation process been applied are judged viable under deficient and sometimes faulty evaluation schemes.

This state of affairs motivated the writing of this book. Its main objective: to present a comprehensive and methodical transportation investment evaluation scheme. To be viable, such a scheme should rest on four major principles: well-established theoretical principles; comprehensiveness with respect to all the relevant evaluation issues; applicability to a wide range of transportation investment projects; and amenability to sensitivity analysis relative to decision-making preferences and future scenarios.

The first principle is embedded in normative theories and models of micro and welfare economics, financial and risk analysis, transportation planning and traffic flow, and urban activity location. Compliance with the second principle is accomplished through the use of a public policy analysis approach based on detailed definition of planning objectives and design alternatives, the identification of stakeholders and their preferences, and specification of germane decision criteria. The third principle is the result of the development, as presented in this book, of operational measures and methods that can be used to evaluate a broad range of transportation investment projects. Application of these methods to several real-world case studies will demonstrate their effectiveness as evaluation tools. Finally, the decision framework developed in this book allows realization of the fourth principle: the explicit expression of stakeholders' preferences at the project selection and choice phases of the evaluation in addition to the testing of alternative planning and economic scenarios.

A well-established body of knowledge containing normative models and rules for transportation cost-benefit assessment and project evaluation is already in place. Yet, this knowledge is not well organized, nor readily accessible to economists and planners having only basic knowledge of transportation economics, transportation planning, and quantitative methods. This observation applies to students as well as practitioners. As a result, the book's potential audiences are graduate students in the areas of transportation and urban economics, geography, urban planning, and transportation engineering. Professionals such as traffic engineers, transportation planners, urban planners, practicing economists, and consultants directly involved

with the evaluation of transportation infrastructure investments will also find it useful.

While this is not a book on policy analysis, it nevertheless devotes considerable space to the role of policymaking in influencing project evaluation and selection. Western democracies are marked by complex public decision-making institutions that are predisposed to interest group pressure, conflicting concerns over major social and economic issues, opposing ideologies, and, at times, even unethical behavior. Thus, understanding the motivations of decision makers and how they think about public investments is an important ingredient in constructing a decision-making paradigm conducive to rational transportation infrastructure investment and development.

In sum, my basic objective in writing this book is to help inform present and future generations of transportation specialists on the tools available for carrying out project evaluation, the theoretical foundations of those tools, and how they should be applied. The book will hopefully prove valuable to those intent on improving transportation investment evaluation and rationalization.

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Joseph Berechman  
New York, April 2009



# 1 Objectives, Scope, and Structure

Not everything in the world that can be counted counts,  
and not everything that counts can be counted.

—Albert Einstein

## 1. PERSPECTIVE

Countries across the globe routinely invest massive resources in transportation infrastructure in the form of new facilities, expansion of existing ones, or maintenance and repair of the network in place. What is common to all of these investments is that they are products of public sector decision making at the local, regional, national, and, at times, international level. Despite their strong technical and economic dimensions, transportation investments represent partial political statements regarding objectives, funding priorities, and targeted service recipients. Viewed from this perspective, transportation investments are similar to other public sector projects. Given this reality, the key questions that this book sets out to explore are normative in nature: What should the objectives and purposes of transportation investments cover? What should their scope be relative to population and space? How should they be analyzed in terms of available analytical tools and the attendant decision making?

Of these, the first question is often the most problematic. The difficulty arises from the fact that like the case of beauty as an objective of art, the purpose of a transportation investment is in the eye of the beholder. Some will argue for transportation-related objectives such as reducing congestion, increasing accessibility, or improving highway safety. Others may argue that equity concerns related to job market access, improved reachability of rural areas, and general spatial mobility should be a project's leading objectives. Still other arguments pertain to the mitigation of environmental externalities, the impact on urban structure, and the generation of economic growth. Only rarely are political motives cited as the underlying *raison d'être* for a specific project, although these may very often be the true incentives impelling

## 2 *The Evaluation of Transportation Investment Projects*

political decision makers to allocate huge amounts of financial resources to projects that might not have been constructed otherwise. According to this somewhat cynical view, the costs of a project are in effect political benefits to be distributed among constituents, supporters, and functionaries.<sup>1</sup>

Policy analysts using the tools of their trade might study transportation projects in terms of the key players, their social and economic viewpoints and political agendas, including coalition-building and distributive goals. They might also investigate other stakeholders, such as rent seekers, the administrative bureaucracy, and relationships with other political institutions (e.g., local and federal governments).

While this may be a valid approach to the understanding of how public decision making is conducted, it does not provide a genuine guide—in a normative sense—to which transportation investment alternatives best enhance social welfare. Moreover, several transportation projects are often considered concurrently and under budget constraints that require rationalization, prioritization, and selection. To that end, transportation planning and economic literature provides a set of models and techniques for the analysis of transportation investment projects. The common denominator underlying all of these tools is their goal: ascertaining which alternative investment will yield the highest social return, defined as a combination of transportation, economic, environmental, and social benefits. In following this course, this book regards the enhancement of social welfare, broadly defined, as the prime objective that should guide transportation infrastructure investments policies. (An economically based working definition of social welfare is given in Chapter 3.)

A key distinction should be made here between the concepts *project evaluation* and *project assessment*. The former refers to the *overall process* by which investment alternatives are conceptualized, generated, assessed, ranked, and finally chosen, with economic and noneconomic criteria employed in decision making. The latter concept, (i.e., project assessment), refers to the structured procedure by which the transportation-economic worthiness of each planning alternative is determined. Such assessments are indeed part of project evaluation, which also refers to investment policy together with other decision-making components. While a significant part of this book is devoted to the transportation-economic underpinnings of project assessment, it should be clearly understood that this facet is not an end in itself. Rather, we consider the overall process of project evaluation to be the crucial mechanism for selecting a project, sources of funding, and final implementation (Chapter 2 formally examines these issues). Furthermore, since we vigorously believe in transparency and accountability as inherent features of public decision making, we also maintain that the entire process of project evaluation should be based on acceptable rational, systematic, and justifiable principles. These issues are dealt with in Part E of the book.

Returning to project assessment, this book takes the view that the objective of social welfare maximization is best served by the selection of the

“best” project from an array of possible transportation investment alternatives. A related tenet is that an assessment’s results should be conveyed to decision makers by highlighting the fundamental issue of optimal allocation of scarce societal resources, namely, the opportunity costs associated with the forgone investment alternatives. Therefore, with respect to project assessment, the book’s focus is on methods, techniques, and their underlying theories, all aimed at identifying the project that will yield the greatest welfare contribution.

As to project evaluation, the perspective taken in this book states that decisions on the selection and implementation of transportation investment projects are ultimately based on myriad considerations, including economic, planning, engineering, social, environmental, legal, institutional, and political interests. While each of these factors is important in itself and requires a focused analysis, as is the case when deciding other policy matters, the “whole is more than the sum of its parts”. Hence, it would be wrong to assume that project choice decisions are based only on one or a subset of these key considerations. We argue here that all these factors should enter the overall decision process, subject to the fundamental requirement that they be transparent. The structure of decision making, which represents a crucial part of the overall evaluation process, should therefore be transparent as well.

## **2. APPROACHES TO TRANSPORTATION PROJECT EVALUATION**

We can study the process of infrastructure project evaluation from several alternative viewpoints. For instance, the process can be examined from a “positive” perspective, implying that we study how the process actually unfolds. Alternatively, we can study it from a “normative” perspective, where theoretically derived rules are utilized to establish how the process should be carried out. Still another approach entails employment of “policy analysis” tools in order to portray the decision-making process that led to a specific project’s selection.

The distinction between positive and normative analysis, two seemingly polar approaches, is somewhat contrived. A normative analysis aimed at developing guiding principles for project assessment cannot be carried out independently of the parameters set by a positive analysis. That is, a project’s spatial and institutional boundaries provide the framework for its normative analysis regarding the range and distribution of its transportation and nontransportation impacts. Similarly, the required discount rate, the value of time-by-trip type, or the time span of a particular project’s implementation provides inputs for the normative analysis. Alternatively, a positive analysis must employ methodologies that are based on theoretical assumptions guiding the users’ behavior and objectives (e.g., utility

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maximization) and market structure (e.g., equilibrium market share of various travel modes).

The policy analysis approach is applied to project evaluation in order to characterize the decision making behind project prioritization. To do so, various inputs must be obtained from positive and normative analyses: benefit-to-cost ratios, sources of funding, and the distribution of benefits and costs among socioeconomic groups. A corollary to this observation states that a positive or normative analysis cannot provide relevant information if it does not consider elements of policy analysis such as the weights that various stakeholders and decision makers attach to each type of project impact.

Recognizing these critical interdependencies, this book delves into the key elements from the three major approaches. Part B therefore provides a normative welfare-maximization approach to project assessment. Parts B, C, and D employ a mix of positive and normative approaches to examine assessment principles and techniques of transportation investment projects. Based on these results, Part E develops a policy analysis evaluation approach to the ranking and selection of projects from a large set of alternatives.

### 3. TRANSPORTATION PROJECT EVALUATION: WHAT INTERESTS US?

The term “transportation project evaluation” is commonly used to describe a formal procedure for ascertaining the net societal welfare contribution found among several specific investment alternatives that may differ in nature (e.g., mode), goals, and incidence of benefits and costs. While societal welfare gains need to be formally defined (see Part B), here we will deal with the application of project evaluation at four levels of transportation planning.

#### *A. Comprehensive Transportation Plan*

Sometimes called “a transportation master plan,” its main function is to map the full range of transportation issues and needs located within a given geographical area and to subsequently propose a range of transportation developmental options. As such, this plan should be part of a larger comprehensive land-use plan that defines urban and regional objectives as well as articulates the planners’ and community’s views about the region’s future spatial structure. Both plans must be compatible with land-use and population policies as well as harmonized in a dynamic way so that the recommended transportation investments will support larger regional growth and social objectives. The land-use segment of the plan should also facilitate execution of the transportation plan with respect to eminent domain rights-of-way and generation of the critical demand necessary to rationalize the

transportation investment. In brief, the comprehensive transportation plan acts as a guidebook from which more specified plans could be derived.

Given the nature of the comprehensive transportation plan, the evaluation process focuses on its compatibility with the comprehensive land-use plan and how well the region's economic, social and environmental objectives are supported by the plan. From a normative perspective, comprehensive transportation plans should be rationalized and updated periodically even if not statutorily required. This recommendation is rarely complied with. In practice, the most appropriate time to do so is the period following a national census, when new population and travel data and trends can be extrapolated.

### ***B. Transportation Development Plan***

A transportation development plan's declared aim is to provide the legal, economic, and planning guidelines for implementing the transportation options derived from the comprehensive plan. Of special concern are statutory issues, planning components such as phasing and readiness for implementation, and acquisition of right-of-way. Evaluations of transportation development plans focus mainly on their ability to promote project implementation within 10–15 years time horizon.

### ***C. Transportation Investment Plan***

Also called a “strategic plan” or a “comprehensive investment plan,” it represents a package or set of projects that are likely to be implemented in the medium- to long-term. The key objective of a strategic plan is to provide a framework for measuring and prioritizing a set of specific transportation investment projects for the purpose of determining an adequate schedule or implementation sequence. Since transportation projects can be technically and spatially interdependent within a region, it is necessary to determine the optimal set of plans that will maximize social welfare given expected budget, statutory, and planning constraints. A strategic plan likewise needs to show the value of an alternative set of projects in light of strategic policy options as well as a range of future travel growth rates (Nash, 1993). Evaluations of such plans are suitable for only 4 to 5 years because beyond this period, key conditions—primarily financial resources availabilities—are likely to change.

### ***D. Specific Investment Projects***

The key objective of plan evaluation is to determine the welfare contribution of a specific project relative to a set of planning alternatives, including the so-called “do-nothing” or “do-minimum” alternative. Economic measures, such as benefit-to-cost ratios, are the key criteria applied to these

## 6 The Evaluation of Transportation Investment Projects

plans provided that statutory, planning, and right-of-way conditions will be met.

This book deals mainly with evaluation of specific transportation investment projects even though analyses of specific plans and strategic plans are highly related due to their common use of the “positive net social welfare” criterion as the key decision principle. Therefore, while issues related to the evaluation of comprehensive or transportation investment plans will be discussed, evaluation of specific investments and their selection from a set of planning alternatives will remain the focus of our attention.

### 4. STRUCTURE OF BOOK

The overall structure of the book is shown in Figure 1.1.

**Part A** of the book, *Objectives, Scope, and Policy Framework*, contains two chapters. Chapter 1 presents the book’s overall objectives and scope with respect to project evaluation and choice. Its fundamental canons begin with the view that decision making on transportation investments is, first and foremost, a political statement made within the political arena regarding the allocation of societal resources. The political arena is peopled by multiple interest groups and stakeholders, each with its own agendas, and each vying for the same public resources. Moreover, the decision-making process is carried out within the public sphere, a domain ruled by legal, institutional, bureaucratic, economic, environmental, social, and cultural factors.

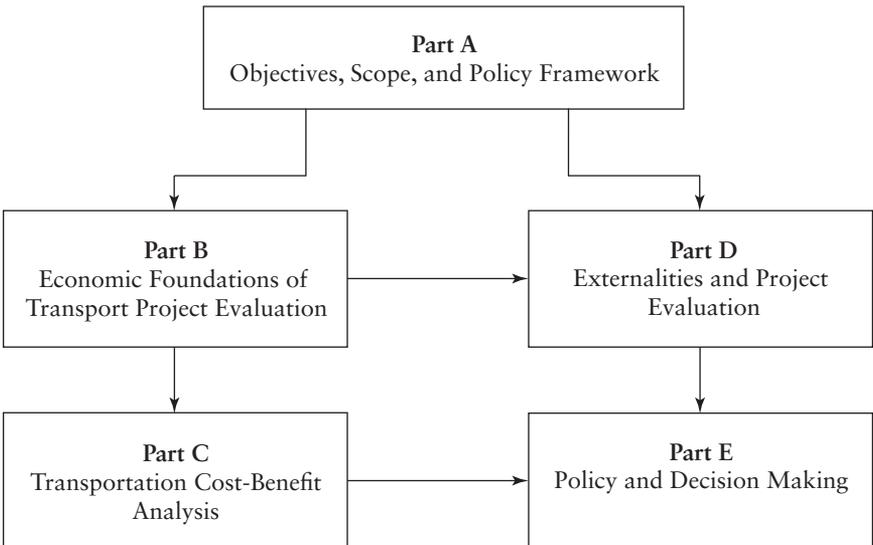


Figure 1.1 Structure of the book.

Notwithstanding these constraints, the second tenet states that since public decision making is about obtaining the “best” allocation of resources, the respective debate should necessarily center on the transportation-economic value of the specific project. Applying a term taken from the welfare economics lexicon, the issue is that of the investment’s *social rate of return*, relative to its alternatives. To arrive at this rate of return, a technical analysis of the benefits and costs of an investment and of its alternatives is required. While this kind of analysis is a necessary condition, it is certainly not a sufficient one for sound decision making. Chapter 2, therefore, examines the political economy framework of project evaluation, while emphasizing the use of rational and formal project evaluation tools. This approach advocates, in essence, the use of a normative approach to transportation planning and project assessment, while recognizing the grim reality of informal, inefficient, and unfounded evaluations that characterize transportation decision making in general and mega-projects in particular.

Subsequent to accepting the rational approach to project evaluation, **Part B** of the book focuses on the economic underpinnings of public project assessment. Chapter 3 examines the welfare foundations of public investment. Chapter 4 examines components of those users’ benefits engendered by transport supply improvements. Similarly, Chapter 5 analyzes the societal cost components involved in transportation infrastructure investments. Using the constructs developed in Chapters 3, 4, and 5 as inputs, Chapter 6 formally analyzes benefit-cost methods and measures.

In turning our attention to the specific attributes of transportation infrastructure investments, **Part C** focuses on four major features. Chapter 7 explores traffic flow and congestion conditions following capacity expansion. Chapter 8 then analyzes several key difficulties associated with the actual computation of benefits from a transportation investment under conditions of a fully loaded network with fixed demand and with capacity expansion-induced demand. Chapter 9 discusses the risk components of these investments, including financial risk, cost overruns, overestimation of benefits and the risk entailed in nonuniform distribution of benefits and costs. It further examines how risk can be included in project assessment. The issue of funding and its impact on transport project evaluation and ranking is examined in Chapter 10, which also discusses financing in public-private partnerships in addition to the related issue of risk sharing. Chapter 11 dwells on the equity issues raised by transportation investments especially when investments result in disproportionate accessibility to labor markets.

The subject of **Part D** is externalities, negative and positive, resulting from transportation investments and their impact on project appraisal. As indicated by Figure 1.1, the theoretical outcomes from Part B underlie the modeling and measurement of these impacts. Chapter 12 examines environmental externalities like noise and pollution as well as the safety consequences of transport improvements. Chapter 13 examines the issue

of transportation investment and economic growth with respect to their underlying causes, magnitude, spatial incidence, and land-use patterns.

**Part E** focuses on transportation investment policy and decision making. As indicated by Figure 1.1, we accept the argument that decision making recognizes transportation cost-benefit evaluations (Part C) as major inputs for such decisions. Chapter 14 thus examines alternative methods of project ranking and selection, such as goal achievement matrix, multicriteria analysis and performance measures. The chapter then compares evaluation regimes followed in different countries. Chapter 15 explores the question of why wasteful transportation investments are so often made. Several contentions are examined and applied to three mega-projects.

To summarize, this book examines transportation investment evaluation from normative and positive viewpoints. Its major proposition is that evaluation approaches need to be grounded in sound economic and planning theory and practice, while simultaneously considering political, social, environmental, and institutional issues. The structure of the book, outlined above, reflects this principle.