Transportation Asset Management Case Studies

Presented by

U.S. Department of Transportation
Federal Highway Administration

ECONOMICS IN ASSET MANAGEMENT

The New York Experience

Note From the Director

The Federal Highway Administration's Office of Asset Management is promoting aggressively a different way for transportation agencies to distribute their resources among alternative investment options. This new way of doing business, referred to as "Asset Management," is a strategic approach to maximizing the benefits resulting from the expenditure of agency resources.

For any transportation agency, the progression toward Asset Management will involve a myriad of activities. These endeavors will differ from State to State. For example, some agencies will pursue a data integration strategy in order to ensure comparable data for the evaluation of investment alternatives across asset classes. Others will move to deploy economic analysis tools to generate fact-based information for decision makers. Still others will want to integrate new inventory assessment methods into their decision-making processes.

Much can be learned from those who are readying their organizations for Asset Management. To spark the exchange of information, we are initiating a series of case studies focused on agencies that are leading the way. In this, the inaugural year of the series, we established four tracks: data integration, economics in Asset Management, the Highway Economic Requirements System–State Version, and life-cycle cost analysis. In upcoming years we will add new State reports to each of the tracks and will create new tracks addressing additional facets of Asset Management such as change management and performance measurement.

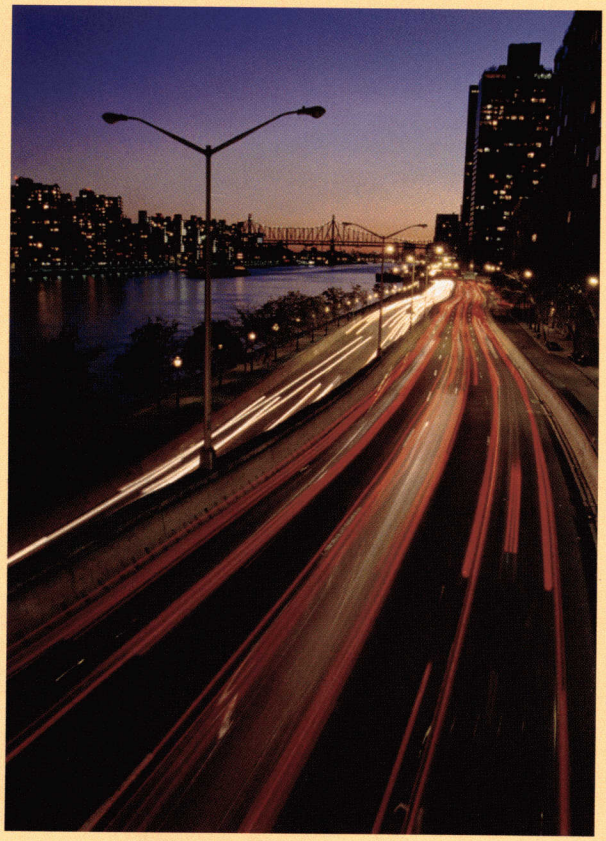
On behalf of the Office of Asset Management, I am pleased to introduce this new series. We believe the case studies will help agencies meet the challenges of implementing Asset Management programs.

David R. Geiger

David R. Geiger
Director, Office of Asset Management

Note to the Reader

The Transportation Asset Management Case Study Series is the result of a partnership between State departments of transportation and the Federal Highway Administration's (FHWA's) Office of Asset Management. FHWA provides the forum from which to share information, and the individual States provide the details of their experiences. For each case study report, State transportation staff were interviewed by FHWA, and the resulting material was approved by the State. As such, the case study reports rely on the agencies' own assessment of their experience. Readers should note that the reported results may or may not be reproducible in other organizations.



Executive Summary

The Transportation Asset Management Tradeoff Model will help NYSDOT target agency resources more productively among its pavement, bridge, safety, and mobility goal areas.

Several decades ago, New York was among the first States to automate its highway information systems and to apply economic analysis in considering highway investments. Through the 1980s and 1990s, the New York State Department of Transportation (NYSDOT) endeavored to upgrade and strengthen its analytical abilities. It initiated management reforms that established clear lines of management responsibility, implemented goal-oriented programming, improved its management systems, and integrated the agency's information systems. These efforts created a solid foundation for the implementation of a Transportation Asset Management (TAM) system.

In 1997, NYSDOT created an internal task force to prepare a blueprint for advancing the implementation of TAM. An important finding of the task force was that the ability to conduct economic tradeoff analysis among investment candidates is central to realizing the full potential of TAM.

NYSDOT has since developed a prototype TAM Tradeoff Model that employs economic tradeoff analysis to compare the dollar value of customer benefits to investment costs among competing investment candidates. The model ranks the candidate projects by rate of return on investment. When it is fully operational, the model will assist NYSDOT at the program level in targeting agency resources more productively among its pavement, bridge, safety, and mobility goal areas.

NYSDOT continues to improve the prototype TAM Tradeoff Model as well as the separate management systems that feed data into it. The department is exploring ways to incorporate additional life-cycle cost and benefit data into the model equations and taking steps to ensure that economic comparisons among projects use consistent values for benefit and cost elements. Simultaneously, NYSDOT continues to improve its project-level economic applications.

In May 2003, NYSDOT announced that it would formally implement a TAM program as the department's transportation infrastructure management strategy. Economic, engineering, and mathematical analysis will constitute the core of this program. ■

INTRODUCTION

Economic analysis plays a critical role in Transportation Asset Management, providing information that allows planners and engineers to identify the most beneficial of competing investment alternatives.

Transportation Asset Management (TAM) is a strategic approach to maximize the benefits from resources used to operate, expand, and preserve the transportation infrastructure. It takes a long-term perspective of infrastructure performance and cost, and considers investment options in a comprehensive and informed way. TAM integrates the various disciplines related to infrastructure management, including planning, engineering, economics, and budgeting. It is systematic and fact based, and therefore dependent on good information and analytical capabilities. Economic analysis plays a critical role in TAM by facilitating tradeoff analysis, in which the net benefits of competing investment options are compared in terms of their "dollars and cents" impact on the public. Information from the analysis feeds back to planners and engineers, allowing them to identify the most beneficial investments.

New York State has long recognized the need for a comprehensive approach to infrastructure management that incorporates economic principles. The State has used economic analysis methods in some form for more than 40 years. More recently, the New York State Department of Transportation (NYSDOT) developed the foundations for a TAM system, including a prototype model to assess program-level tradeoffs among its pavements, bridges, safety, and mobility goal areas.

Accordingly, the Federal Highway Administration's (FHWA's) Office of Asset Management has selected NYSDOT as a case study for applications of economic tradeoff analysis in transportation decision making. NYSDOT personnel represent an important national resource of expertise and practical experience in this area. They have also produced significant documentation of NYSDOT's progress in developing economic analysis tools. The following case study summarizes this experience, highlighting both the challenges and the promise of the successful implementation of economic analysis methods in TAM.

AGENCY FACTS

NYSDOT is headquartered in Albany and has 11 regional offices and 68 county maintenance facilities. NYSDOT employs approximately 10,000 persons statewide.

New York State's transportation network is unique among the 50 States in the diversity of its assets and the user demand for them. The system includes these facilities:

- A State and local highway system that encompasses more than 110,000 highway miles and 17,000 bridges and handles over 133 billion vehicle miles of travel annually
- A rail network of 5,000 miles of track over which 42 million tons of equipment, raw materials, manufactured goods, and produce are shipped each year
- 456 public and private aviation facilities through which more than 31 million people travel each year
- More than 130 public transit operators, serving over 5.2 million passengers each day—equal to one-third of all public transportation passengers nationwide
- 12 major public and private ports that collectively handle more than 110 million tons of freight annually

The mission of NYSDOT is to ensure that its customers—those who move themselves, other people, or products to, from, through, or within New York State—have a safe, efficient, balanced, and environmentally sound transportation system.

Tradeoff analysis compares the net benefits of competing investment options in terms of their "dollars and cents" impact on the public. Information from the analysis allows planners and engineers to identify the most beneficial investments.

SETTING THE STAGE

What Did NYSDOT Have?

Since its establishment, NYSDOT has been committed to the sound management of New York's transportation system. In the 1960s, with the advent of mainframe computers, NYSDOT (and its predecessor agency) began to develop automated systems for processing pavement, bridge, and safety data. These systems continued to be upgraded as new technologies led to better data and processing capabilities. NYSDOT simultaneously promoted the use of economic analysis at the project level to evaluate the costs and benefits of transportation infrastructure.

Consistent application of economic methods, however, was handicapped within NYSDOT by the highly decentralized structure of the agency. During the 1980s, fiscal shortages and deteriorating highways, bridges, and other transportation assets caused NYSDOT to review the efficacy of its decision-making procedures.

What Did NYSDOT Want?

NYSDOT's upper management concluded in the latter part of the 1980s that structural and management reforms were needed to encourage more accountable and informed decision making. It began by clarifying regional and main office roles for infrastructure management: responsibility for infrastructure project selection and delivery was assigned to regional offices and responsibility for policy and quality assurance to program offices in the main office.

To strengthen further its management process, NYSDOT implemented a formal business structure for decision making called the Program Update Process. The Process is goal driven and provides a quality assurance system necessary to monitor regional compliance with department policies. During the implementation phase of the Program Update Process, NYSDOT developed formal goals and performance measures for pavements, bridges, safety and mobility. These goals continue to shape the department's program development process.

> The mission of NYSDOT is to ensure that its customers have a safe, efficient, balanced, and environmentally sound transportation system.

Provisions contained in the Intermodal Surface Transportation Effi-

ciency Act of 1991 reinforced NYSDOT's efforts to refine network-level management systems for individual classes of assets such as pavements and bridges. These "stovepipe" systems, which contain cost and condition data on all elements within an asset class, are discussed in more detail in the next section of this case study. At the individual project level, NYSDOT improved its economic analysis methods for project scoping and evaluating alternative solutions to identified problems. For example, alternative pavement treatments are now evaluated using life-cycle cost analysis (LCCA).

Early in the effort to improve its decision-making process, NYSDOT recognized a critical need to integrate data on programs and projects from the stovepipe management systems, the financial information system, and other agency databases. Consequently, in 1990, the department began development of the Project and Program Management Information System (P/PMIS) to link together information from these multiple sources. The major modules of this integrated data system are now in place, and the system is the single financial management tool for both the Program Update Process and the day-to-day management of NYSDOT's capital programs—for which $1.3 billion of construction obligations are planned for fiscal year 2003. The P/PMIS contains planning, finance, and project information as it tracks each project from initial development to construction completion and final payment.

At the project level, NYSDOT improved its economic analysis methods for project scoping and for evaluating alternative solutions to identified problems. Alternative pavement treatments are now evaluated using life-cycle cost analysis.

Thus, by the late 1990s, NYSDOT had established most of the essential components needed for a TAM system. It had developed well-defined internal controls and tools to ensure responsible decisions whenever project scope, cost, or schedule changes required program adjustments. NYSDOT did not have, however, a program-level, economic tradeoff tool that could compare investment candidates selected by one stovepipe management system to those selected by others. Such a tool is important for allocating resources to appropriate goal areas so as to maximize benefits to the public.

HOW DID NYSDOT BUILD TRADEOFF ANALYSIS CAPABILITIES?

Overall Approach

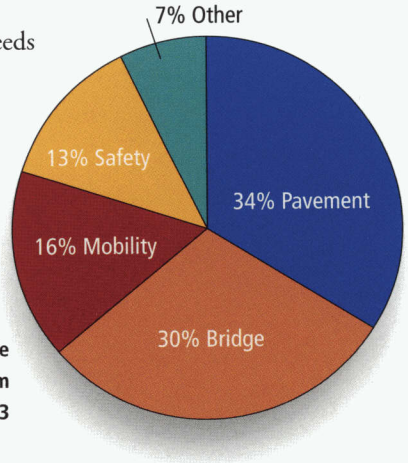
In 1997, NYSDOT created an internal task force to prepare a concept plan for advancing the formal implementation of TAM principles within the department. The task force prepared a document called "A Blueprint for Developing and Implementing an Asset Management System," which was released in April 1998. This nationally recognized blueprint strongly emphasized the need to use economic tradeoff analysis in developing a TAM program. In the document, the task force observed that "most transportation agencies are managing individual assets without taking a comprehensive view among these assets and evaluating all tradeoffs that must be made to ensure a program of projects results in the most benefit to the customer. Quantification of these tradeoffs is at the heart of Asset Management methodology."

In 2001, NYSDOT began development of an analysis tool that will provide a technical platform for making tradeoffs at the program level. Four pre-existing management systems that support the department's goal areas—pavements, bridges, safety, and mobility—provide input to this new tool, the TAM Tradeoff Model.

Stovepipe Management Systems

Basic, network-level, transportation management systems were established at NYSDOT as early as the 1960s. Each system is staff-developed and is unique to New York. Over time, improvements continued to be made, including the use of more sophisticated database management technology and the addition of economic analysis into asset class-level and project-level evaluation of investment candidates. NYSDOT's current transportation management systems apply to the following goal areas:

- *Pavement Management:* NYSDOT uses automation applications for its pavement inventory, inspection, and condition-needs forecasting. These applications were significantly refined in 1981, 1991, and 2001. The department provides project-level technical guidance to field offices on LCCA to enable more detailed evaluation of actions identified by the network-level system.
- *Bridge Management:* NYSDOT maintains a bridge management database and a network-level condition-needs forecasting application. The department employs formal least-cost analysis procedures in assessing bridge treatment alternatives, such as rehabilitation versus replacement.
- *Safety Management:* NYSDOT's Highway Safety Improvement Program uses crash data to identify statistically high accident locations for all State highways. High accident locations are investigated, and alternative countermeasures analyzed. The alternative with the highest benefit-cost ratio is programmed, either as a standalone project or as part of an infrastructure preservation project.
- *Mobility:* NYSDOT's Congestion Needs Assessment Model (CNAM) is used to identify and forecast the times, locations, and magnitudes of vehicular congestion on the State highway system. The model calculates "excess user cost" of recurring and incident-related delay



for both automobiles and freight carriers. CNAM also contains a project-level, benefit-cost analysis module to evaluate strategies such as travel demand management actions and transportation system management activities.

The four goal areas shown in the pie chart on page 9 constitute 93 percent of the $1.3 billion State Transportation Improvement Program for 2003 for highways operated by NYSDOT.

TAM Tradeoff Model

The effort to develop the TAM Tradeoff Model resulted in an operational prototype by the end of 2002. This model draws available economic and performance data from almost 2,000 investment candidates identified by the separate management systems. The tradeoff model ranks these projects both within and among program areas based on benefit-cost ratios. Implementing projects with the highest benefit-cost ratios maximizes benefits to highway users.

The common measure of benefits in the TAM Tradeoff Model is "excess user cost." Excess user cost is defined as the cost to travelers that exceeds a level (or threshold) deemed to be reasonable by NYSDOT. For instance, travel time at level of service D or better would be deemed reasonable—but extra travel time associated with anything worse than level of service D would be excessive. In the model, the annualized benefit of a project is equal to the dollar value of the excess user cost the project eliminates in its first year of implementation. The cost of the project is the agency's investment cost, annualized based on the expected service life of the project and the discount rate specified by NYSDOT.

The power of the TAM Tradeoff Model is its ability to assess the cost-effectiveness of treating groups of assets taken together, such as facilities in a corridor. It is used as a first cut in program development. However, the TAM Tradeoff Model is intended only to provide a network- or program-level assessment of investment priorities, cutting across stovepipe system results.

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MOVING AHEAD

Network-Level TAM Tradeoff Model

The TAM Tradeoff Model is currently operating as a prototype. NYSDOT is considering several potential revisions and improvements to the model:

- The threshold values of condition and performance at which unit user costs are judged to be excessive are under review. For example, International Roughness Index values greater than 101 inches per mile on flexible pavement and 136 inches per mile on rigid pavement generate excess user costs in the prototype model. If these thresholds are too high relative to thresholds for other asset classes, pavement investments will be less attractive.

The benefits of properly timed infrastructure preventative and corrective maintenance, as contrasted with postponing needed work, should be considered in addition to saved user cost.

- The unit user costs for crashes, vehicle operating costs, and hours of travel time for moving people and goods need to be standardized across all program- and project-level tools that have a direct relationship to the tradeoff model. The same is true for other values such as treatment service life and the discount rate.
- The benefits of properly timed infrastructure preventative and corrective maintenance, as contrasted with postponing needed work, should be considered in addition to saved user cost. This could be implemented by an "avoided agency costs" logic that reflects the increasing cost of work required to restore infrastructure to a state of good repair as more and more deterioration takes its toll. These costs would be discounted to an equivalent present worth amount and then annualized to be applicable to the prototype tradeoff model logic.
- Policy makers need the capability to conduct sensitivity analysis on tradeoffs among the various program areas by varying economic values.
- Demographic and economic impact data from files such as the Census will be added to the system.

Project-Level Economic Analysis

The TAM model provides program level assessments of investment priorities. Detailed benefit-cost analysis, based on site-specific data, is required for reliable project-level economic evaluations.

To accommodate the need for project-level evaluations, NYSDOT continues to improve its economic tools. It will replace its current pavement LCCA tools with a customized version of RealCost, FHWA's project-level, computerized spreadsheet for LCCA. NYSDOT also is carefully evaluating use of the National Cooperative Highway Research Program Report 483 bridge LCCA software as a part of bridge project scoping. These methods emphasize the evaluation of alternative construction delivery methods; maintenance and protection of traffic alternatives; and project scoping alternatives.

WAS IT WORTH IT?

Over the last decade, NYSDOT has made important strides in improving the condition and efficiency of its infrastructure. For instance:

- Pavements rated in good or excellent condition were 68 percent in 2002, up from 54 percent in 1990. Less than 6 percent were categorized in poor condition in 2002, compared to more than 12 percent in 1990.
- Deficient bridges have decreased from 37 percent in 1990 to 27 percent in 2003.
- Fatal crashes have fallen from 1.4 per 100 million vehicle miles of travel in 1990 to 1.0 per 100 million vehicle miles of travel in 2003.
- Annual vehicle hours of delay for recurring and incident congestion on State highways fell from 225 million in 1991 to 197 million in 2000, even though vehicle miles traveled increased by 22 percent during the same period.

NYSDOT has not, however, completed a formal study of the specific contribution attributable to economic analysis techniques to this improved performance. The application of economic analysis to infrastructure investment decisions has developed gradually over time, making it difficult to define a before-and-after case study. In addition, it is problematical to separate the impact of economic analysis from important managerial and process reforms and higher funding levels introduced during the last 15 years. Finally, a significant innovation made by NYSDOT—the TAM Tradeoff Model—has not yet been incorporated into the decision-making process.

There is recognition within NYSDOT, however, that economic analysis is contributing to a more dynamic and accountable decision-making process. In May 2003, five years after the development of its "Blueprint," NYSDOT announced the adoption of TAM as the framework for managing all infrastructure

Economic analysis is contributing to a more dynamic and accountable decision-making process within NYSDOT. At the program and project levels, economic methods will play an essential and larger role within the TAM framework.

investments. Economic methods at both the program and project levels will play an essential and larger role in this framework.

WHAT HAS NYSDOT LEARNED?

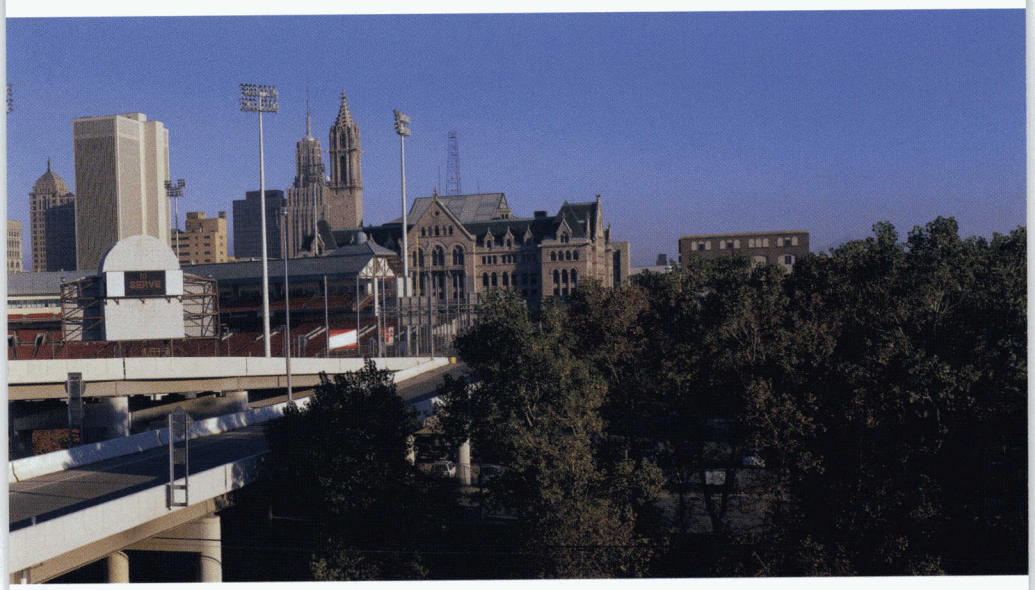
NYSDOT has made several important findings in its quest to implement Asset Management principles:

- The use of economic and other management tools is contingent on having clear lines of decision-making authority and accountability, particularly in a highly decentralized organization such as NYSDOT.
- There is a need to continuously improve economic tools and methods to take advantage of improved automation and information management technologies.
- Economic tradeoff analysis can play an important role in integrating the outputs of individual management systems.

WHAT'S NEXT?

In 2003, NYSDOT is undergoing a major transformation in how it measures and accounts for its performance. This transformation responds to three primary factors shaping the department's future: trade, technology, and traffic. The North American Free Trade Agreement and other international trade agreements have significantly increased the volume of goods traveling to and from the Northeast to all points of the globe. Similarly, the e-commerce and technology revolution is changing trading patterns by virtue of the information available in the supply chain. Finally, traffic continues to grow, fueled by trade, technology, and the general rise in economic well-being of the citizens of New York State.

To facilitate its renewed focus on performance and accountability, NYSDOT's executive management has directed that TAM principles will be used to guide all transportation infrastructure investment decisions. Results in five areas will be used to gauge the department's accountability to its customers: mobility and reliability, safety, economic sustainability, security, and environmental stewardship. The five areas will be reflected in future versions of NYSDOT's management and economic tools.



Closing Thoughts

NYSDOT's recent decision to implement TAM at the agency level will give renewed impetus to the development of improved economic methods. In the near term, NYSDOT intends to continue to improve its program- and project-level economic analysis tools to assist the regions in program development, as well as to provide more information to the TAM Tradeoff Model.

Further Information

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