

Driving Transportation Performance through Data Management and Analytics

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Transportation agencies, such as state departments of transportation (DOTs) and municipal planning organizations (MPOs), face the daunting challenge of allocating limited revenue to service the transportation needs of large and diverse populations. In an era when funding is stagnant, the process for choosing where and how to invest in the transportation system is of paramount importance. Yet agencies frequently lack the tools to amass and harness the right information to make informed decisions for sound, long-term transportation investments that optimize performance.

***The good news is:* there are tools available to gather and analyze data in order to improve decision-making, empowering agencies to get even better return on their investment.**

HISTORICAL CONTEXT

Transportation agencies on every level of government support and serve the nation's population locally, regionally, and nationally. How well the transportation systems work is of fundamental value to the people, the economy, and to national security. According to the 2013 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance report, all levels of government spent \$203.5 billion on highway-related purposes and another \$54.3 billion on transit-related services in 2010.¹ To maintain highways and bridges at the 2010 conditions through 2030 is projected to cost as much as \$86.3 billion per year. The nation should not underestimate the enormity of managing these systems within the fiscal constraints.



Historically, agencies base maintenance decisions on a “worst first” approach. Sections of roads, bridges, or mass transit systems showing the greatest detriment received the first dollars. Complicating the allocation of transportation revenue, programs (such as safety, roads, bridges, etc.) didn’t always communicate and share information, making insight into the comprehensive transportation system a challenge. System performance measures and targets were not required of programs, leading to spotty and inconsistent adoption.

On a very pragmatic level, determining what projects needed to be completed required a physical visit to get “eyes on” the stretch of road, bridge, or rails. To ascertain the conditions of a road in the past required driving the full length of the section in question. Allocating the hours and personnel to such tasks has been the model for decades.

ISSUES AND PAIN POINTS

Historically, deciding how to best deploy agency resources has been a challenging process, fettered with numerous complications. Funding is limited and the transportation systems are commonly complex and vast. The ability to acquire information across multiple systems, and the length of time required to see the results of an investment are all complicating factors. More specifically, each of the following issues affects an agency’s ability to make sound decisions with their limited dollars:

- 1) Asset Condition and Performance Data.** Obtaining, interpreting, and using data to inform how to best deploy agency resources has come with a myriad obstacles. Most relevant is the ability to acquire data on the existing conditions. This requires “eyes on” the road, rails, or bridges. As such, obtaining the data is expensive and often has to be outsourced, creating an additional burden of oversight to ensure the data is valid and useful for the purpose for which it is intended. Furthermore, the data must be deemed reliable: the right information was collected and is current enough to serve as the foundation for decisions. When multiple programs are involved, the types of data to be collected are necessarily different, creating disconnected data “silos.” When all the data is decentralized (or that data is unreliable, outdated, or incomplete), making a sound “big picture” decision is impossible. Without a clear, data-driven link between investment and performance, agencies invariably choose sub-optimal investments.
- 2) Unclear Link Between Investment and Performance.** It often takes close to a decade to see the true performance of an investment in a given project. This lag time poses a challenge to future project selection due to the lack of ready information. Transportation agencies are charged with managing risk and uncertainty in allocating today’s funds to future projects. That’s why timely, reliable information is vital to the effort. Uncertainties may be related to volatile project cost estimates, available revenue in future years, the inability to predict performance, and variability in project formulation processes in general. The ability to set effective targets takes specific data and analysis in order to avoid chronic malinvestment, project delays, and generally bad performance.
- 3) Process.** Many agencies lack a comprehensive, well-defined process for project selection that considers the full life cycle of transportation assets. Limited visibility regarding the impacts of candidate investment options causes frustration and protracted effort. Competition for funds increases as each program vies for limited dollars and diminishes collaboration across programs. In a highly complex system, one in which programs affect one another (e.g. pavement condition affects safety and congestion), lack of a comprehensive, data-driven process to analyze tradeoffs between programs can be a challenge to sound decision-making.

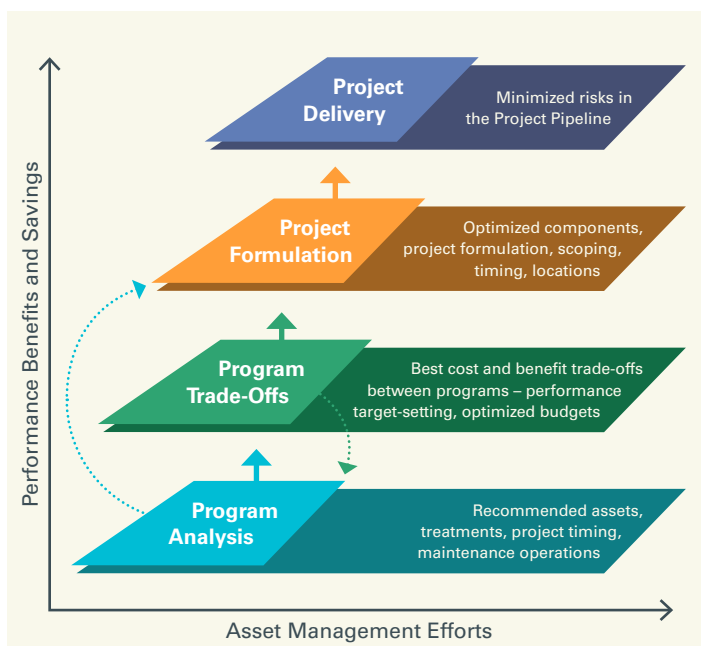
The complexity of transportation systems poses a significant challenge to budget allocation decisions. Many agencies lack a clearly defined process for selecting projects. Reliable data is often difficult and expensive to obtain. The interval of time to truly assess performance compounds the challenge further. Adding to the challenge is the on-going problem of “brain drain” related to the retirement of knowledgeable people. Tremendous decision-making capabilities are leaving transportation agencies with these experienced individuals.

SOLUTIONS AND LESSONS LEARNED

Despite the myriad challenges to project selection, there are solutions and practices to aid in the process. This makes it easier for agencies to improve and, thereby, better optimize their fund usage.

Decision-Support Tools

Decision-support tools and asset management systems can be valuable for planning for performance. Today’s tools can demonstrate the tradeoffs between selecting one project versus another, and making the selection based on a quantifiable decision. Asset management systems, both comprehensive and asset-specific systems such as pavement, bridge, or maintenance systems, support agencies in managing the life cycle of their assets through visualization, analysis capabilities, and even geo-spatial rendering.



This diagram demonstrates where a comprehensive Transportation Asset Management (TAM) approach can support decision-making.

Data Collection, Storage, and Analysis

The advents of Wi-Fi, cloud storage, and advancing technology have inducted the golden age of data. Obtaining, storing, and analyzing data has never been simpler or more affordable.

- a) **Data collection.** Obtaining data is the first step. What previously required a multitude of man-hours, or expensive in-field detection systems such as in-field detectors, pavement loops, or microwave or wireless sensors, can now be achieved through the likes of probe detection on commercial fleet tracking systems, smartphones, or GPS/in-car navigation systems, and drones. While each of these has implicit costs, they substantially reduce the fiscal commitment.
- b) **Storage.** Once accumulated, data has to be stored to be available for later analysis and use. Not long ago, this required owning numerous servers or outsourcing that storage elsewhere. Today, cloud storage is an affordable and—more importantly—reliable solution.
- c) **Analysis.** Data is only useful when it is analyzed and understood. Cambridge Systematics, Inc. recently developed a pilot Transportation Asset Management Information System tool for Alaska Department of Transportation and Public Facilities. The tool integrates asset information including pavement and bridges with crash, traffic volume and other system metrics along with programmed projects to support improved decision-making and project prioritization.

Today and in the future, data will prove to be the single most effective method for better serving the populace. Through data, agencies will have a keener understanding of the existing transportation conditions and usage. It will offer a sound basis for establishing goals and tracking progress made toward them. In an economic climate of stagnant and decreasing funds, data can and will provide the necessary insight to deploy those funds in the most expeditious manner.

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Return on Investment

Acquiring and maintaining asset management systems is an investment—one that improves transparency and aids in making the case for additional funding. That is because it establishes the link between dollars invested in a particular program and the resulting change in performance. The following areas will reflect the return on investment in an asset management system:

a) Better predictions of cost and performance on different program areas (pavement, bridges, safety, mobility).

In today's marketplace, more time is being spent on the management of the transportation system than the construction of it. Under the Moving Ahead for Progress in the 21st Century Act (MAP-21), agencies are now required to set targets for the performance of their investments in the system, to better understand how safety, asset condition, and mobility are affected.² Asset management systems offer a means of looking at the transportation system as a whole. They facilitate plans to preserve and maintain the system in the most cost-effective way since performance of a bridge, for example, is measured differently than a road. Most agencies aren't skilled in such cross-program investment analysis, yet such analysis is vital to the health of the overall system. Asset management systems make it easy for managers to look at multiple sets of data together to facilitate the best decisions possible, in turn resulting in a more effective and economically sound project pipeline.

b) Better understanding of risks to agency and program areas. Risk is increasingly both an issue and an opportunity. In addition, there are multiple types of risk that a transportation agency faces. These include hazards out on the road, as well as uncertainties related to managing performance and setting effective targets. Herein

lies the boon of the convergence of data, asset, and performance management. Having data on site-specific issues (e.g. landslides) facilitates better allocation of resources because funds aren't distributed merely habitually but equitably based on risk and performance. When legislators inquire about increased performance resulting from increased funding, the answers can be substantiated by data.

c) Better projections of available revenue. Data accumulated in an asset management system enable performance prediction and investment projection analysis. When the same information is evaluated in retrospect, managers have the ability to assess whether the projections were valid and translate that learning forward. No longer are transportation agencies functioning as construction agencies; declining (or stagnant) funds require agencies to know better what monies are available now and in the future so they can smooth the flow of projects accordingly.

d) Compliance. MAP-21 requires state DOTs to develop asset management plans. Agencies are restricted in how funds can be allocated. With a systematic, data-driven approach, agencies can demonstrate to legislators why a particular set of projects makes sense. Having targets and knowing the condition of the assets empower agencies to make the case for that set of projects.

The systems that power asset management have declined in price substantially. There will always be costs associated with data, performance, and asset management, but the systems ensure tight budgets go further by empowering agencies to answer the question of how to optimize their funds. Despite the complicated, multidimensional nature of the task, asset management systems harness the power of data to clarify the link between investment and performance.

Agencies that seek to capture some of the benefits of having a better-defined process and data analysis will want to conduct a gap assessment to identify ways to improve fund usage. Important questions to ask include:

1. How are we currently obtaining our data?
2. What questions can that data answer?
3. What questions does the data need to answer?
4. What actions can we take to strengthen the data?



The benefits of Transportation Asset Management outweigh the costs.

Arie de Geus, strategic planner for Royal Dutch Shell, asserts “The only sustainable advantage an organization has is in its ability to learn.”

Many transportation agencies today are taking a deep dive into their data to answer these questions and identify gaps using a Capability Maturity Model assessment. Cambridge Systematics introduced this in-depth assessment technique in a National Cooperative Highway Research Program (NCHRP) project.³ It was adapted from the software industry and involves self-assessment of data management with seven levels of maturity (ad Hoc, Aware, Planning, Defined, Management, Integrated or Continuous Improvement) across three dimensions (Technology/Tools, People/Awareness, and Institutional/Governance).

Once gaps have been identified, taking steps to close them will yield improved performance on investments. Tapping into the nexus of asset management, performance management, and data management will be of great benefit. Arie de Geus, strategic planner for Royal Dutch Shell, asserts “The only sustainable advantage an organization has is in its ability to learn.” This reality provides a compelling incentive for both public and private organizations to increase demand for meaningful sources of data and analysis capabilities.

CONCLUSION

In a climate of increasing financial constraint, transportation agencies want to invest their funds for the maximum benefit of the population they serve. Knowing what investments will yield the greatest performance proves vital to that effort. Data, when analyzed with today's advancing technologies, empowers transportation agencies to wisely manage programs and projects within existing budgetary constraints, and set the right targets for performance. Furthermore, accountability and transparency are both improved with the clarity data brings, in turn making communication with the public and legislation simpler and more effective. Having a strategic approach improves the usage of fiscal resources for the agencies, which ultimately results in better serving the population's needs.

About the Authors

Lawrence (Larry) Redd brings more than 20 years of experience providing risk management and mitigation expertise, strategic planning, prioritization, investment analysis, and asset management support to state DOTs and international organizations.



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