



NETWORK-LEVEL ANALYSIS

An Inclusive and Data-Rich Approach
to Infrastructure Development

BY ISRAR AHMAD AND JOHN MURRAY

The state of a community's capital infrastructure is inextricably linked with its quality of life. Strategic asset management has become a critical agenda item for most developed and stable economies around the world. As the relationship between infrastructure and economics becomes better understood, the prioritization framework for infrastructure projects is changing from an exclusive focus on financial cost-benefit analysis to one that relies on a variety of community and organizational key performance indicators, economic output metrics, environmental indicators and other socio-economic drivers. Infrastructure appraisals and project prioritization have shifted from emphasizing individual, asset-level studies to a holistic, network-level analysis, with the goal of more accurately quantifying the true socio-economic value of all infrastructure projects.

A cross-disciplinary, long-term approach such as this requires robust data on not just capital assets and their networks, but also on the organization itself and the environment in which it exists. Technology is needed to improve speed and efficiency whenever possible. Lastly, high-level guidance is needed to unify technology and data in an effective way.

Network-level analysis relies on collaboration among multiple departments, including senior management; department heads from finance, engineering, and public works; and elected leadership. Time and effort are also needed, as such an approach involves building an asset management practice from the ground up and generally spans two years, including development and implementation. There will be pivotal short-term victories, including better understanding of the organization's existing capacity and a more comprehensive dataset on the state of existing infrastructure. The rewards to the entire organization in return for the time and intellectual capital invested can be substantial. Exhibit 1 explains the value of adopting network-level analysis of a government's infrastructure investment.

INFRASTRUCTURE CHALLENGES

In Canada, local governments own 60 to 70 percent of all public infrastructure, yet collect only 8 percent tax revenues,

according to the Federation of Canadian Municipalities. This imbalance severely impedes fiscal pragmatism at the municipal level. Most municipalities lack the financial capacity to ensure that infrastructure growth requirements and service enhancements are accounted for and long-term replacement needs are met. Instead, they aim to fund their annual operating costs. Providing levels of service that do not reflect fiscal capacity is a serious risk to municipal financial sustainability, and infrastructure lifecycle costs can be a big part of that. As a result, municipal decision makers need to make an effort to go beyond minimal infrastructure funding levels and work toward achieving incremental improvements in sustainability.

Some local governments are able to set aside funding to counter inflation and meet renewal requirements, which helps extend the useful life of capital assets, reducing both current costs and the burden on future generations of residents. However, most municipalities struggle to meet even day-to-day tactical investment needs related to infrastructure, let alone being able to attempt a strategic makeover.

Investment in infrastructure depends on a number of elements, including political considerations and risk tolerance in individual municipalities. Because there are no industry standards for target investment rates, the most influential of these factors is the amount of funding available—and there is a severe lack of it, in both

Canada and the United States.

The Canadian Infrastructure Report Card, an annual survey-based analysis of Canada's infrastructure, suggests that 12 percent of the country's infrastructure (valued at approximately C\$141 billion) is in very poor or poor condition. Further, according to the same study, seven of the eight categories of infrastructure covered will decline in condition based on current reinvestment rates (i.e., the percentage of an asset's replacement value budgeted annually for the purpose of rehabilitating, reconstructing, or meeting replacement needs).¹ The situation in the United States is no different; \$3.6 trillion in infrastructure investment

A cross-disciplinary, long-term approach requires robust data on not just capital assets and their networks, but also on the organization itself and the environment in which it exists.

Exhibit I: Top Value Propositions for Network-Level Analysis

How a contemporary, multi-year approach to asset management appeals to key decision-makers

Value for City Managers and Chief Administrative Officers	Value for Directors of Finance	Value for Directors of Engineering and Public Works
<ul style="list-style-type: none"> ■ Helps align long-term budget projections from the budget staff with the long-term infrastructure needs determined by the public works staff. ■ Creates more realistic funding targets. 	<ul style="list-style-type: none"> ■ Quantifies costs accurately and allows decision makers to track assets and costs for both operational and management purposes. ■ Creates a best practice-based methodology that allows public works officials to collect and communicate asset data to finance executives. 	<ul style="list-style-type: none"> ■ Establishes capital management best practices over the lifecycle of the infrastructure and identifies alternate technologies that can significantly reduce the cost of capital and maintenance programs. ■ Improves the accuracy of asset reporting, which enables better decision making.
<ul style="list-style-type: none"> ■ Creates organizational awareness and flexibility, which allows municipalities to respond swiftly and systematically to government grants, and maximize expenditures within the established parameters. 	<ul style="list-style-type: none"> ■ Determines the financial requirements of infrastructure, based on life-cycle costs. Tightens budget forecasts because requirements are based on real field information. ■ Keeps annual requirements from being either overstated or understated. ■ Strategically allocates revenue to particular asset classes, based on organizational priorities. 	<ul style="list-style-type: none"> ■ Develops a more efficient allocation of resources (e.g., needs of field staff needs over the medium to long term), allowing department heads to schedule and prioritize crew activities more effectively.
<ul style="list-style-type: none"> ■ Provides a review of existing infrastructure management practices and policies so they can be better aligned with key objectives in a community's strategic plan. 	<ul style="list-style-type: none"> ■ Helps analyze a municipality's financial capacity (e.g., its ability to borrow or take on debt, use or increase reserves, and determine potential revenue possibilities and expenditure requirements). 	<ul style="list-style-type: none"> ■ Creates stability in the capital program by allowing public works staff to better forecast medium-term expenditures, leading to more strategic discussions with the finance department.

will be needed by 2020, according to the American Society of Civil Engineers.² Overall, the group gave U.S. infrastructure a D+ on its most recent “report card.”

As governments have increased their commitments to tackling infrastructure deficits, advances in asset management processes, technology, and knowledge have also provided a great deal of data that organizations can

use for decision making. A recent study by Public Sector Digest assessed the state of roads and bridges in 93 Ontario municipal-

ities by aggregating data on an asset-by-asset life-cycle and condition analysis.³ The study found that C\$5.1 billion is needed to replace roads and bridges in the sample jurisdictions, and an additional C\$462 million is needed annually to meet future replacement needs.

Technology is needed to improve speed and efficiency whenever possible.

However, the same study determined that deficit estimates may be overstated, given the lack of comprehensive field inspection data. In calculating accrued backlogs and annual funding shortfalls, the majority of municipalities in Canada rely on the age of assets as an approximation of their remaining useful lives. In Public Sector Digest’s analysis, remaining useful life based strictly on age was 23 to 29 points less than remaining useful life based on actual field inspections. Using age-based data therefore overstated the amount of tax increases that would be required to meet the related financial demands.

There will be pivotal short-term victories, including a better understanding of the organization’s existing capacity and a more comprehensive dataset on the state of existing infrastructure.

A SHIFT IN THINKING

When it comes to developing asset management plans for local governments, the discipline has seen a philosophical shift. It is no longer asset-centric. Instead, it places services and citizens at the center of all strategic analysis. This approach lends itself to more advanced and holistic appraisals of infrastructure projects, requiring a strategy and plan at the asset network level rather than the individual project or asset level.

This shift changes the magnitude of investment that municipalities, states, and federal governments make in an essential way, as assets and projects are no longer viewed in isolation from each other, from the community, or from the local and regional economy. Instead, they’re treated as elements of a dynamic, integrated network — literally and figuratively — and the fundamental question decision makers ask themselves changes from which project should take priority to why these projects were recommended in the first place.

Under this service- and citizen-centric model of asset management, capital maintenance is based on risk-to-service delivery. Further, serious consideration is given to the consequences of asset failure along multiple dimensions, including economic, financial, social, and environmental. Key questions municipalities must ask themselves as they develop their asset management plans and programs include the following:

- What are the organizational objectives?
- What assets are owned and what services do they provide?
- What is the asset’s value to the organization and to the community?
- What is the asset’s impact to service delivery (performance and risk)?
- What are the life cycle needs and the options available for meeting them?
- What are the work/budget prioritization processes?
- What are the financial strategies?
- What level of service is attainable?

ASSET MANAGEMENT ROADMAP

The most feasible way to develop an asset management program is to follow an incremental critical activities path, measuring progress using key milestones. This “roadmap” approach relies on dialogue between multiple stakeholders, including administration and its governing body. In these discovery sessions, department heads learn more about each other’s priorities and challenges and, ultimately, become more unified in their asset-management pursuits at the corporate level. This approach also allows decision makers to more



optimally allocate their resources toward asset management programs without increasing staff workload. The roadmap generally starts with assessing the current level of asset management maturity at the municipalities, concluding with a comprehensive asset management plan. Later stages of the roadmap involve monitoring, reviewing, and retooling as needed.

Most municipalities struggle to meet day-to-day tactical investment needs related to infrastructure, much less have the resources to attempt a strategic makeover.

Designing and implementing an inclusive roadmap approach instead of an asset-centric, siloed strategy requires broad consensus and appeal within the municipal organization. It is the only way to forge a more defensible link between infrastructure investment levels, the municipality's overarching strategic plan, and citizens' capacity to finance the investments. It is also critical in ensuring that communities can secure the maximum total value for their capital assets at the lowest life-cycle cost. The core component of this approach includes organizational cognizance, data as a foundation, condition assessment protocols, risk and criticality models, life-cycle management, a financial strategy, and levels of service framework.

Organizational Cognizance. Stability requires an asset-management policy that clearly states program objectives, roles, and responsibilities, and is vetted through senior management and endorsed by the jurisdiction's governing authority. The policy becomes a guideline for employees to follow in making decisions. It provides a framework for the delegation of decision making, eliminates misunderstandings, reduces uncertainties, and enables the organization to meet its goals and objectives.

Data as a Foundation. Valid and accurate data comprise the foundation of sound decision making. Jurisdictions need to collect complete and accurate data for all municipal infrastructure and to maintain this accuracy and currency over time. In addition, to avoid misuse of scarce resources, they must determine the optimal composition of the data set.

Condition Assessment Protocols. Municipalities need to fully understand the performance and condition of their assets. All management decisions regarding future expen-

ditures and field activities should be based on this knowledge. An incomplete understanding of an asset may lead to ill-timed failure or premature replacement. A robust condition assessment protocol will, over time, also dictate which assets receive field inspection resources based on the value they provide to the community.

Some benefits of holistic condition assessment programs within the over-

all asset management process include:

- Understanding how the overall network condition leads to better management practices.
- Preventing future failures and providing liability protection.
- Establishing proactive repair schedules and preventive maintenance and rehabilitation programs.
- Extending asset service life and thereby improving level of service.
- Enabling accurate asset reporting, which, in turn, enables better decision making.

Risk and Criticality Models. Using risk and criticality models and analysis are key elements of proper asset-management practices, and programs help an asset manager determine which infrastructure is critical to the organization. They can also be used to rank and rate the level of business risk associated with all of the infrastructure stock. This ranking can be achieved at the organizational level, the asset category level, the individual asset level, and the asset component level. It becomes invaluable when limited internal resources are being used to try to address a significant number of field needs or priorities. A robust risk model will assist with prioritization of available resources, including:

- Ensuring vital services are available.
- Prioritizing and streamlining inspection and condition assessment programs.
- Prioritizing and optimizing capital budget processes and program delivery.

- Ensuring that available money and resources are applied to the right asset at the right time.
- Establishing attainable levels of service.

Life-Cycle Management. Municipalities can establish truly optimized investment levels and make the best use of public funds by properly managing the life-cycle of infrastructure components, networks, and portfolios. Accomplishing this requires an understanding of the types of maintenance activities and cycles, preventative maintenance activities, timelines for application and rehabilitation activities, and timelines for application and replacement activities for each asset class. In addition, jurisdictions should document the cost for the activities and perform a cost-benefit analysis to determine which activities provide the best value for money.

Financial Strategy. To be effective, an asset management program has to be integrated with financial planning and long-term budgeting. Governments need to develop a comprehensive financial plan before they can identify the financial resources required for sustainable asset management based on existing asset inventories, desired levels of service, and projected growth requirements. The financial strategy should define the relationships between maintenance/capital requirements, debt strategy, reserve strategy, and annual revenue opportunities/strategies. The end result is a series of recommendations on the necessary near-term steps for managing the long-term budget requirements. At a high level, the financial strategy should include:

- An understanding of the costs associated with investing in assets (new, renewal, maintenance, and operations).
- An understanding of the various costs associated with accounting for assets (historical, replacement, and depreciated).
- Metrics for tracking assets and costs for both operational and management purposes.
- Asset management plan financial requirements that are based on replacement costs and desired levels of service.
- An analysis of the municipality's financial capacity.

Investment in infrastructure depends on a number of elements, including political considerations and risk tolerance in individual municipalities.

- Development of scenarios for consideration.

Level of Service Frameworks.

Finally, governments need to develop desired levels of service; these are high-level indicators comprising many factors that establish defined quality thresholds at which municipal services should be supplied to the community. They support the organization's strategic goals and are based on customer expectations, statutory requirements,

standards, and the municipality's financial capacity to deliver those levels of service. They typically involve a review of strategic and municipal goals, legislative requirements, expected asset performance, community expectations, and availability of finances. Customers will use the levels of service to understand the proposed type and level of service to be offered; to identify the costs and benefits of the services offered; to assess suitability, affordability and equity of the services offered; to measure the effectiveness of the asset management plan; and as a focus for the asset management strategies developed to deliver the required level of service.



Municipalities are embracing the cross-disciplinary long-term approach in defining their target investment levels and developing a well-rounded asset management program that can withstand shifts in politics. The financial strategy is one component of a multiyear approach, rather than the ultimate pursuit, of a well-designed asset management roadmap.

In the past, estimates of infrastructure deficits were sometimes overstated because they were derived from survey-based studies rather than a systematic asset-by-asset aggregation of data, or they relied on incomplete field inspection information. More precise data on the physical health of infrastructure, the establishment of long-term capital programs, and more refined business processes mitigate the challenge of infrastructure management and make it more manageable. Increased communication and alignment between the finance and public works/engineering departments is also needed to implement a more inclusive approach. In addition to technical expertise, elected officials also need to understand this challenge and be thoroughly involved in addressing it.

CONCLUSIONS

Most municipalities are lagging in all core elements of a modern and inclusive asset-management program. Many

As governments have increased their commitments to tackling their infrastructure deficits, advances in asset management processes, technology, and knowledge have also provided a great deal of data organizations can use for decision making.

have only a basic proficiency in organizational cognisance, financial strategy, and levels of service. With a new approach and a shift in philosophy that views asset management as an ongoing program and a critical component of corporate strategies, governments can elevate their asset management programs without overburdening staff and compromising other priorities. ■

Notes

1. The Canadian Infrastructure Report Card, 2016. (canadianinfrastructure.ca)
2. 2013 Report Card for America's Infrastructure, American Society of Civil Engineers.
3. "The State of Ontario's Roads and Bridges: An Analysis of 93 Municipalities," *Public Sector Digest*, 2015.

ISRAR AHMAD is senior project manager of asset management at the Public Sector Digest (PSD). In 2015, he served as lead analyst and author of the *State of Ontario's Roads and Bridges*, which provided Canada's first non-survey-based infrastructure deficit estimates. He serves as lead analyst and writer for PSD's municipal asset management plans. **JOHN MURRAY** chairs the Canadian Network of Asset Managers and serves as PSD's general manager of asset management. He is also project lead for PSD's Asset Management Roadmap initiative. Prior to joining PSD, Murray was manager of asset management at the City of Hamilton, Canada, as for nearly two decades.

