



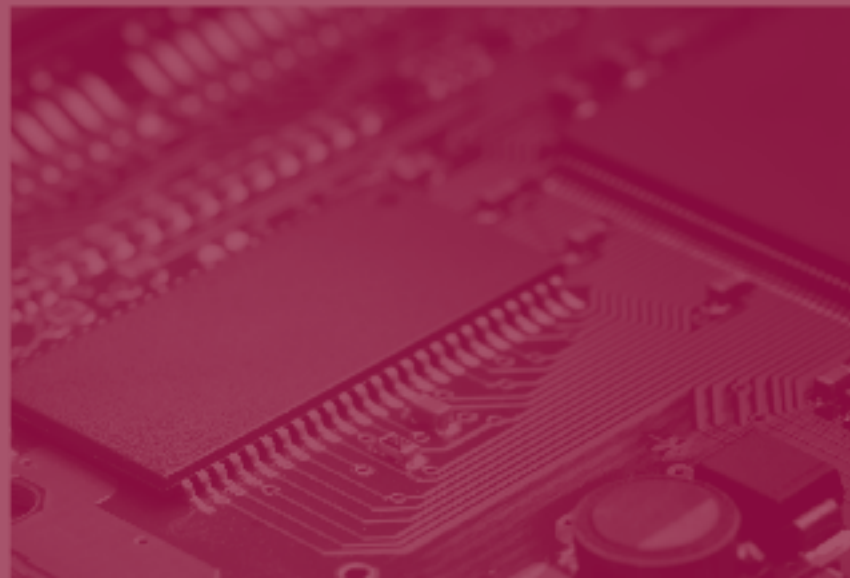
May 2017

Infrastructure management: current practices and future trends





**Infrastructure
management:
current practices
and future trends**



Report for RICS

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Preface

RICS promotes and enforces the highest professional qualifications and standards in the development and management of infrastructure. The name promises the consistent delivery of standards – bringing confidence to the markets that RICS serves. RICS accredits 125,000 professionals; an individual or firm registered with RICS is subject to quality assurance.

Their expertise covers property valuation and management, the costing and leadership of construction projects, the development of infrastructure and the management of natural resources, such as mining, farms and woodland. From environmental assessments and building controls to negotiating land rights in an emerging economy; if members are involved the same professional standards and ethics apply.

With offices covering the major global financial and political centers of the world, RICS can influence policy and embed standards at a national level. RICS also works at a cross-governmental level, delivering international standards that will support a safe and vibrant marketplace in land, real estate, construction and infrastructure, for the benefit of all.

Primary public infrastructure asset groups

Transportation	Ground, air, waterways, rail, transit and pipeline.
Water and waste water	Water supply, structures, agricultural, sewers and storm water.
Waste management	Solid waste, hazardous and nuclear.
Utilities and energy production and distribution	Electric, gas, oil, nuclear and renewable.
Buildings and structures	Public buildings (government), social (schools, hospitals), recreational, communications and information technology assets.

Foreword by RICS

RICS members serve as leaders in the design, construction, operations, management and valuation of infrastructure around the world. These esteemed professionals generate value through their strategic approach to these markets and their collaborative approaches across the industry. These approaches inform their decisions daily so that they can work together to improve the vital infrastructure that supports North America.

RICS raises the professionalism of our qualified professionals and those they support through the provision of guidance and training. RICS issues guidelines on asset management endorsed by government departments and agencies around the world. We are key partners in the delivery of ongoing International Property Measurement Standards, International Ethics Standards and International Construction Measurement Standards.

Foreword by The Building People

Physical infrastructure is a fundamental component of societal and economic development. Throughout the course of human history, scientific advances in engineering and management practices have directly correlated to elevations in living standards, economic development and social transformation. Infrastructure is central to economic, environmental and human sustainability, whether it is the distribution of resources for daily life or the construction and operation of complex structures, transportation systems and communication networks. As urban environments continue to grow across North America, the demand for smarter infrastructure investments and services increases. With the advent of the sharing economy, internet of things (IoT) and machine learning, the industry must adapt and prepare for the future. These adaptations must also consider continued urbanization and human vulnerability to natural disasters. With roughly 85% of populations living in cities across North America, the impact of disruption increases significantly.

For these reasons a strategic vision for infrastructure across North America is crucial to propel the economy forward. These investments improve economic output by upwards of 400% over their lifecycle because they attract business investments, jobs and advantages over other economies. However, across G7 nations the quality of infrastructure is in steep decline and demand continues to rise. Why is infrastructure investment failing to meet the demand if it is proven to boost economic growth? Moreover, what can be done about it? This insight represents RICS' commitment to support infrastructure professionals by facilitating dialogue and advancing solutions that help to address these important questions.



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Foreword by RICS President

Infrastructure dominates headlines all over the world. With a \$57tn infrastructure gap having been identified through to 2030, this is an exciting time to be thinking about infrastructure management within the North American market. Understanding current practices to help better predict and manage future trends is essential for those seeking to positively impact infrastructure outcomes to enable the best economic benefit.

This report has been produced jointly by RICS and The Building People to help inform those in infrastructure within the North American market. Decisive actions taken today will impact the outcomes for future generations. Ensuring that investment, public and private, is best aligned to prioritise delivery is an essential starting point for these mega-projects. They have long delivery and operational asset lifecycles.

Infrastructure management is core to getting this right, at both the federal and local level. If innovations around technology, data and automation are embedded now, we can secure future longevity. We also need to consider the workforce, skills and production methods that both capitalise on, and advance, best practice standards.

Infrastructure assets have a long-life expectancy. This means that the ripple effect of infrastructure, in terms of creating social value and supporting cities, will impact generations of North Americans well into the future.

This report provides a unique perspective gathered from leaders across North America, helping to shape a better future for infrastructure. I was delighted to provide my support in chairing these roundtables. I recommend the steps given in this report to help us all take the right actions today to benefit tomorrow's citizens.

Amanda Clack FRICS

RICS President 2016/17



Biography

Amanda Clack FRICS took office as RICS President on 27 June 2016. Amanda joined EY as a Partner in August 2015 as the Head of Infrastructure (Advisory) for the UK and Ireland. Prior to this she was a partner at another of the Big Four.

Qualifying as a quantity surveyor and in project management, Amanda is a Fellow of RICS, the Association for Project Management, the Royal Society of Arts, the Institute of Consulting and the Institute of Management. She is also a Companion of the Institute of Management, is a Certified Management Consultant and an Affiliate of the Institute of Accountants for England and Wales.



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Executive summary

Stakeholders in North American infrastructure must take decisive actions to reform the policies, processes and practices that helped to create its decline over the past quarter century. It is too soon to classify this decline as a crisis; however, it is never too soon to encourage and coordinate efforts over the next decade to alter this trajectory towards renewal, resiliency, sustainability and innovation. The infrastructure boom that followed World War II helped to ignite the economy for over 25 years, but efforts to maintain and enhance these structures and systems have weakened. Public infrastructure investments have not kept pace with major advances in architecture, scientific engineering, communications and urbanization. Today, there is an opportunity to act. This opportunity is empowered by significant efforts underway in Canada and increased attention at the highest levels of the US government. With built asset wealth in Canada and the United States amounting to US\$42tn, more than twice nominal GDP, there is too much at stake to discount these challenges any further.

Leadership is required to influence changes across infrastructure finance, asset lifecycle practices, technology innovations, training and educational outreach. Professionals and political bodies must work closer, at the federal and local levels, to create investment opportunities and new revenue streams directed at building and renewing these important economic pillars. Innovators in asset management and operations must promote practices that maintain the asset lifecycle more efficiently and avoid the immense backlog of deferred maintenance that has accumulated among public owned assets. More work is necessary to coordinate outreach with educational institutions to promote and develop the training and skills that are urgently needed to backfill retirees while taking the opportunity to introduce new skills that will help to advance innovative technology throughout the industry. Many are already acting, but to achieve these objectives the industry must engage in a coordinated strategy together.

A coordinated effort has the potential to make a significant improvement to the current environment. This insight is a call to action that delivers insights from industry leaders on the current environment, while offering guidance on how to influence and restore this central pillar of economic growth. Many infrastructure leaders embrace these challenges and are helping policy makers to recognize the path to restore, innovate and deliver 21st century infrastructure across North America, but need more support from industry professionals. For this reason, RICS looks to support these efforts by advancing innovative ideas, best practices and standards that strengthen the industry and help society advance.

Objective

This paper seeks to:

- Establish synergies between infrastructure operations professionals by raising awareness for professional standards and best practices.
- Identify and establish clear priorities across the industry in terms of governmental and social needs.
- Provide insight and guidance on how to address challenges throughout the lifecycle of infrastructure projects.
- Identify the types of professional training necessary to support continued development in the sector.
- Recognize innovation and best practice across core areas of infrastructure asset management, at both the federal and local level.

Audience

Critical to the success of these dialogues is the involvement of public and private sector leaders working across the various infrastructure sectors. The outcome of this collaborative effort will deliver a timely knowledge resource for both public and private sector leaders to further professionalize and optimize their infrastructure portfolios while maintaining a high level of public service and commitment to creating a better world.

Focus:

- To engage senior government infrastructure executives and managers and private sector service providers supporting infrastructure development in key cities across North America.
- To organize a network of infrastructure professionals that contribute their knowledge and experience to enhance their profession and contribute to societal good.
- To use this knowledge resource to engage stakeholders and encourage them to take action and promote awareness across their area of influence.

Scope

This report began with a series of three half-day roundtable sessions in Toronto, New York City and Washington DC. Professionals from public and private sectors gathered at each session to engage and share their experiences on a series of relevant infrastructure management topics. To develop the report, RICS captured these dialogues and utilized them by integrating them alongside complementary traditional research methods. Our aim is to engage leaders across a broad range of infrastructure communities to help them collaborate and share their knowledge, experiences, successes and challenges—past, present or future. In the report, we will examine practices and opinions across the infrastructure community to establish a dialogue that can inform policy makers, public sector leaders and private sector companies who seek solutions to improve the overall state of infrastructure across North America. The research will explore a wide range of topics across infrastructure asset management to include:

- design
- construction
- operations and maintenance
- security
- risk management
- resilience
- disposal
- finance
- public-private partnerships (PPP, P3)
- management systems
- organizational management
- standards
- public policy
- sustainability
- energy strategy
- system integration
- automation and smart technology
- cyber security
- life-cycle analysis
- quality controls.



Structure

This insight begins by examining demand for infrastructure improvements and provides context on how the current North American infrastructure environment came about. Once this background is established, the report engages in a five-part discussion that integrates expertise from the RICS roundtable participants with the latest research on public infrastructure management.

- **2.0: 21st century infrastructure challenges:** the report will explore the current state of infrastructure across five core sectors and identify the challenges, priorities and roadblocks that need to be addressed.
- **3.0: Infrastructure management:** focuses on issues that need to be addressed in finance, asset management, organizational management and quality control.
- **4.0: Technology, data and automation:** explores how trends in these areas impact the industry and what executive managers must do today to ensure they are ready for the future.
- **5.0: Workforce:** discusses how to address the skills gaps, attract talent and adopt strategies to develop the next generation of infrastructure professionals.
- **6.0: Conclusions:** concludes with practical steps on how RICS can work with industry leaders to advance high priority best practices and cross-sector policy issues that require the attention of executives and policy makers.

Terminology and definitions

Infrastructure is a term that can be broadly interpreted and used to describe a plethora of social, professional and financial concepts. Fifty years ago, the term infrastructure was rarely used to describe assets within the built environment; however, over the past few decades it has become highly utilized. Given our objectives, this report will use infrastructure to refer to a group of physical systems or facilities that provide essential public services across the areas of transportation, water, waste, utilities, government and society and to include the workforce associated with their development and maintenance. These sectors are comprehensive in scale; however, this report will focus on the common principles and challenges that public infrastructure management professionals share.

Infrastructure management is the systematic, coordinated planning and programming of investments, design, construction, maintenance, operations, evaluation, integration and a multidisciplinary set of strategies to sustain public infrastructure assets. Asset management specifically organizes and implements these strategies with the fundamental goal of preserving and extending the service life of infrastructure assets, vital to maintaining and increasing the quality of life in society and spurring economic growth.

Our purpose is to identify the primary public infrastructure asset groups rather than tackle the whole of infrastructure in the built environment and to carve out a broad, yet manageable, set of asset groups that share systemic practices within the public sphere of infrastructure management.



1.0 Introduction



Demand for global infrastructure investment is massive, with estimates between US\$60-80tn over the next 15 years; the US and Canada account for US\$12-16tn of this figure. Across emerging economies, infrastructure demand is driven by urbanization, population growth and economic expansion, while developed economies are spurred by aged assets, deferred maintenance backlogs, supply chain demand, energy and sustainability practices, urban development and technological innovations. Roadblocks to accessing resources to meet these demands include:

- government policies
- disagreements over priorities
- workforce skills gaps
- budget shortfalls
- communication failures
- risk distribution structures.

If current infrastructure investment levels continue in the US and Canada over the next 15 years, there will be a US\$3.5-4.5tn shortfall and the current trajectory will continue. To achieve these infrastructure investment goals, current investments must increase significantly or become more efficient to fill this gap. However, before we explore the path forward, let's examine how we got here.

Comprehensive infrastructure development across North America began in the 18th century and focused on ports, roads and bridges. By the 19th century, investments were linked to economic growth and continental expansion. During this period, North America's population increased rapidly from 7-8m in 1800 to over 80m by the end of the century. During this rapid expansion, engineers developed new infrastructure methods and products that were more robust and weather resistant while railways continued to link cities throughout the continent. Urban areas developed water supply systems and by the early part of the 20th century electricity and communications infrastructure advanced across the continent. With the advent of mobile cranes and massive earth moving machines infrastructure

development took on immense proportions and by the 1930s, projects like the Hoover Dam, The Empire State Building and Lions Gate Bridge demonstrated major advances in design, engineering, technology and construction, all despite deep economic depression.

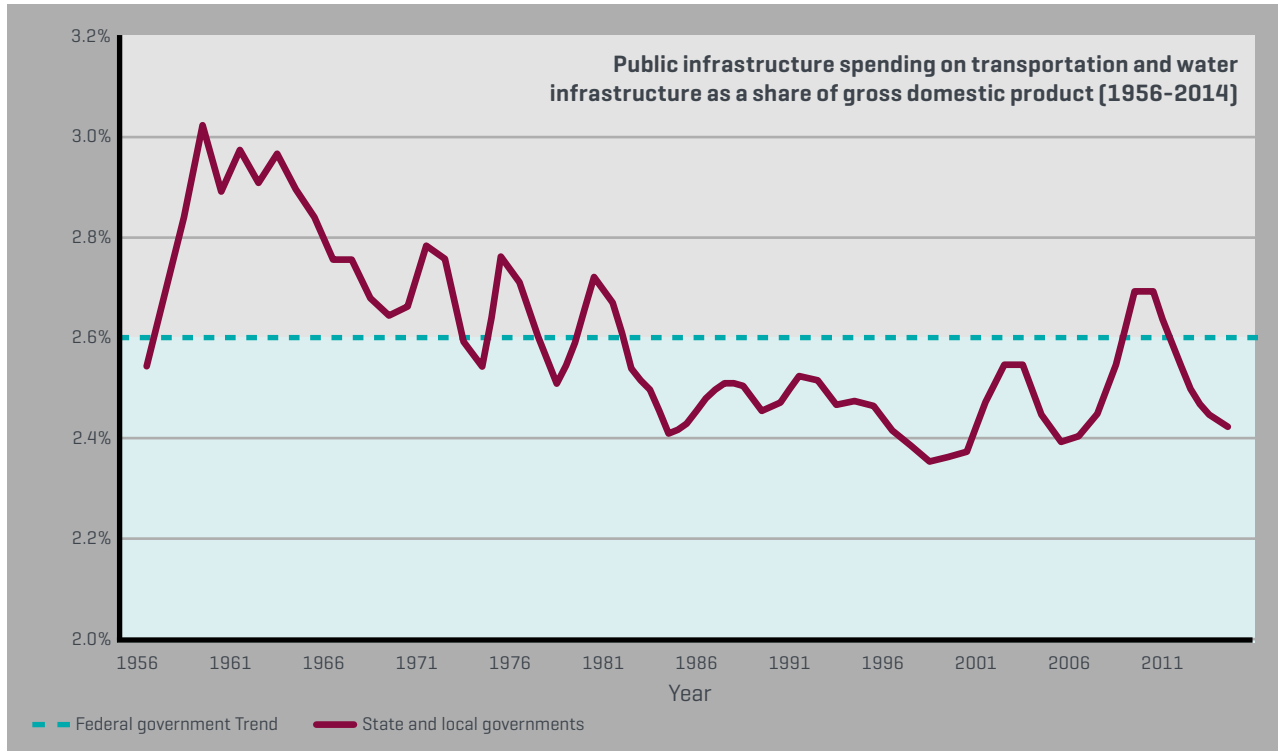
Following World War II, infrastructure projects increased as established agencies gave birth to new institutions to oversee these assets. In the United States, these establishments included the General Services Administration (GSA), Department of Housing and Urban Development (HUD), Department of Transportation (DoT), Federal Aviation Administration (FAA) and the US National Aeronautics and Space Administration (NASA). During the two decades that followed the war, infrastructure investments rose steadily with the largest increase from 1960-1977 before they returned to 1950s levels and have remained there for the past 30 years. The structures of these investments during this period are particularly interesting.

Over the 50-year period between 1958 to 2008, the source of transportation and water infrastructure investments shifted dramatically. From 1958-2014 infrastructure investments at the state level increased by 250%, while federal increases went up by only 80% (see figures 1 and 2). During this same period the US population increased by approximately 77% (see figure 4). There are two significant takeaways from this information:

1. public infrastructure investments took on a less centralized control structure at the federal level
2. as states invested more in infrastructure, federal investments did not keep pace.

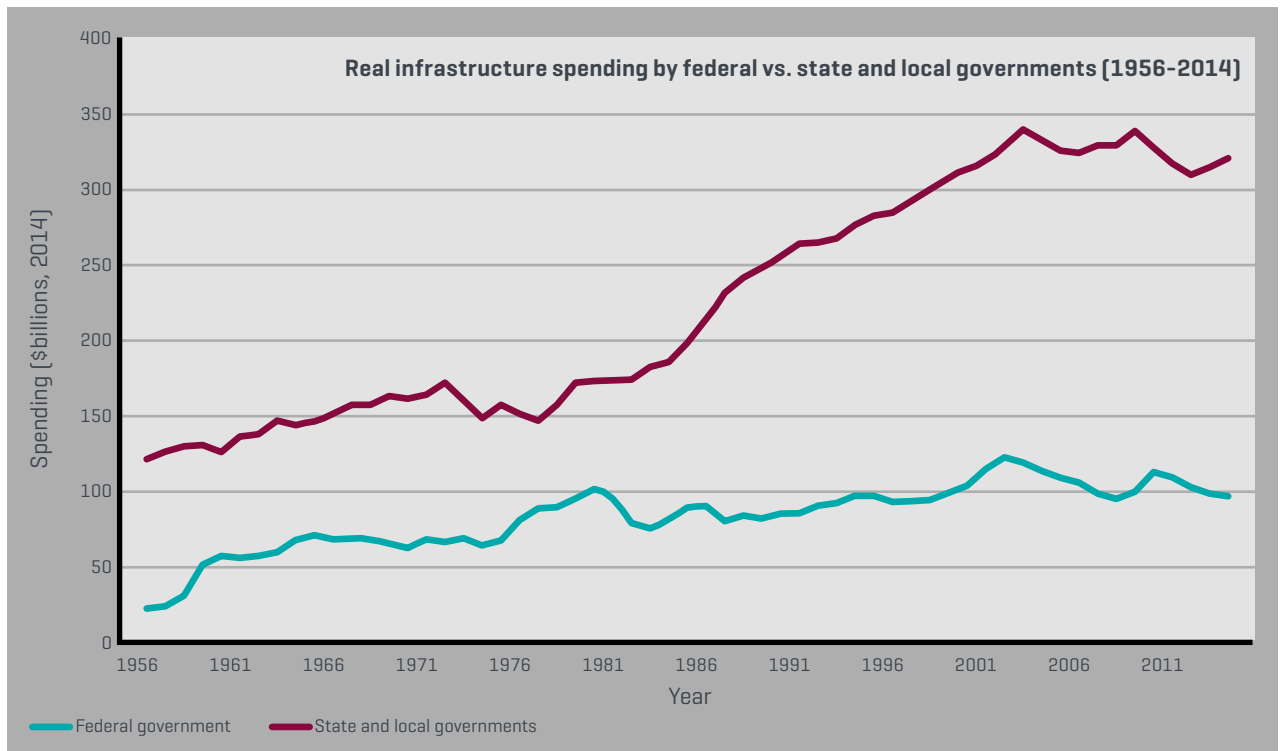
Sparking curiosity and debate are the sustained increases in infrastructure investment at a rate outpacing population growth and increases at the state level at a 3:1 margin (see figure 3). Given the significant rise in spending, why does the [American Society of Civil Engineers \(ASCE\)](#) grade US infrastructure with a D+? It appears there are far more variables to successful infrastructure lifecycles than mere funding.

Figure 1: US Congressional Budget Office, total federal spending for infrastructure, 1956-2014.



Source: US public spending on transportation and water infrastructure, 1956 to 2014. Washington, DC: Congressional Budget Office, 2015.

Figure 2: US Congressional Budget Office, state and local spending for infrastructure.



Source: US public spending on transportation and water infrastructure, 1956 to 2014. Washington, DC: Congressional Budget Office, 2015.

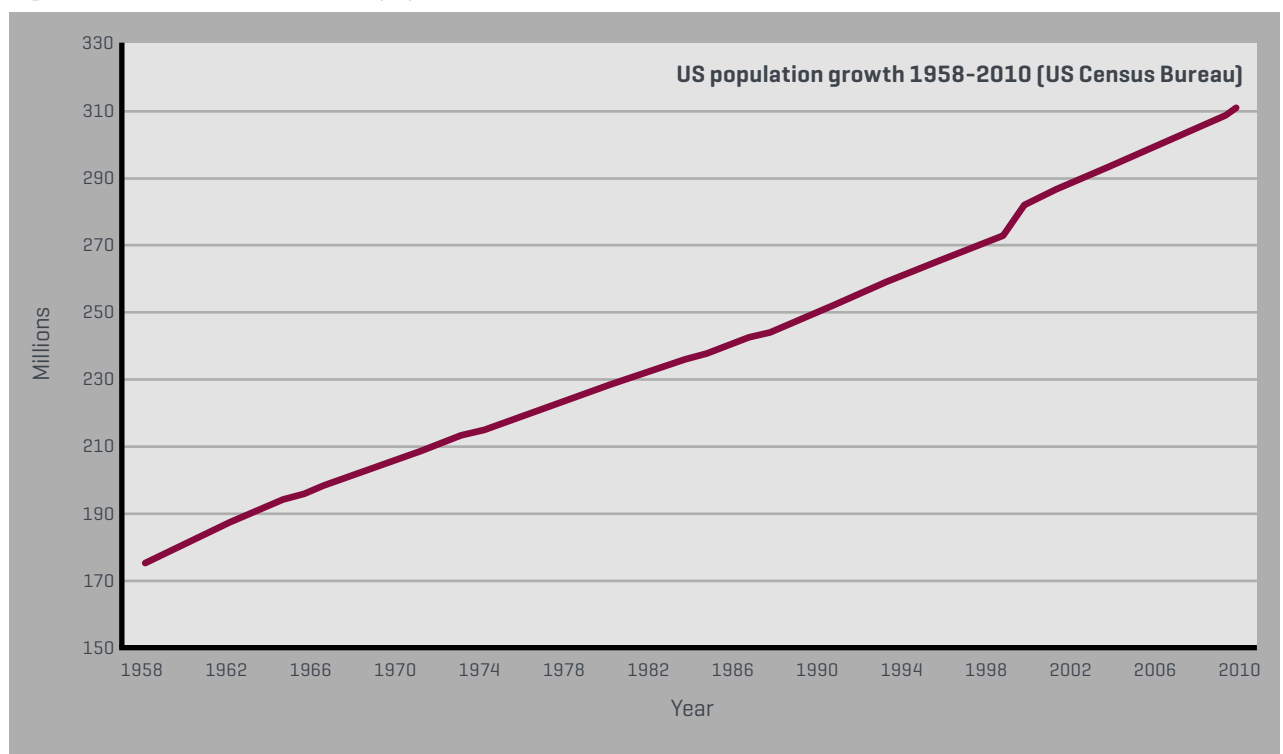
The picture in Canada over the past 20 years varies from the US. In Canada, a steep spike in infrastructure investments over just the past ten years along with a comprehensive asset management plan has reduced the average age of public infrastructure in a significant way. Over a ten-year period from 2003 to 2013, Canada reduced the average age of infrastructure from 17.5 to 14.7 years of age (-2.8 years). This was done by investing approximately 1.7% of annual GDP into infrastructure. In the United States, estimates of infrastructure investment across similar areas amount to roughly 2.5-3% of annual GDP, yet the average age of infrastructure continues to get worse (see figure 4). There are many variables that go into explaining these discrepancies; however, one of the easiest to see is the significant difference in how Canada utilizes P3 to supplement investments through [PPP Canada](#).

Today, many people look to the federal government to take the lead in addressing infrastructure challenges, yet for 30 years federal investments in infrastructure have remained steady. Though funding is a factor, of greater concern is the lack of a comprehensive systematic strategy to manage the vast array of new infrastructure

projects and already built assets. Filling the infrastructure gap will require local and national coordinated efforts to include both public and private sector leaders. These efforts will need professionals who understand the major issues to address. This paper aims to contribute to these efforts encouraging collaborative and comprehensive strategies toward improved infrastructure management.

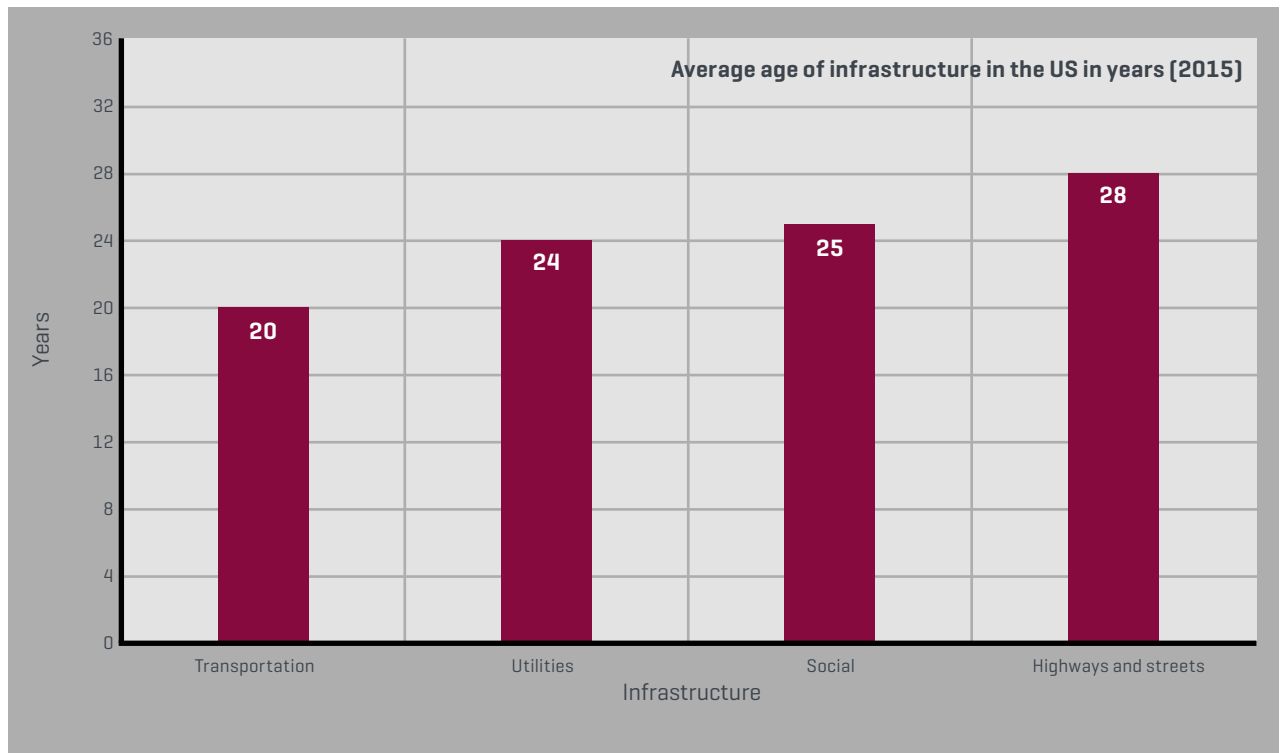
RICS continues to lead efforts supporting the infrastructure management community to foster solutions that address immediate and long-term issues impacting the industry. This paper is a step towards igniting the conversation among leaders in North America and across the various infrastructure sectors. These insights attempt to capture 12 hours of conversations among public and private sector professionals working as developers, surveyors, engineers, financial planners, government executives and operations experts. What follows is a broad landscape of issues that should resonate with professionals who deliver public works infrastructure projects.

Figure 3: US Census Bureau, 'US population tables'



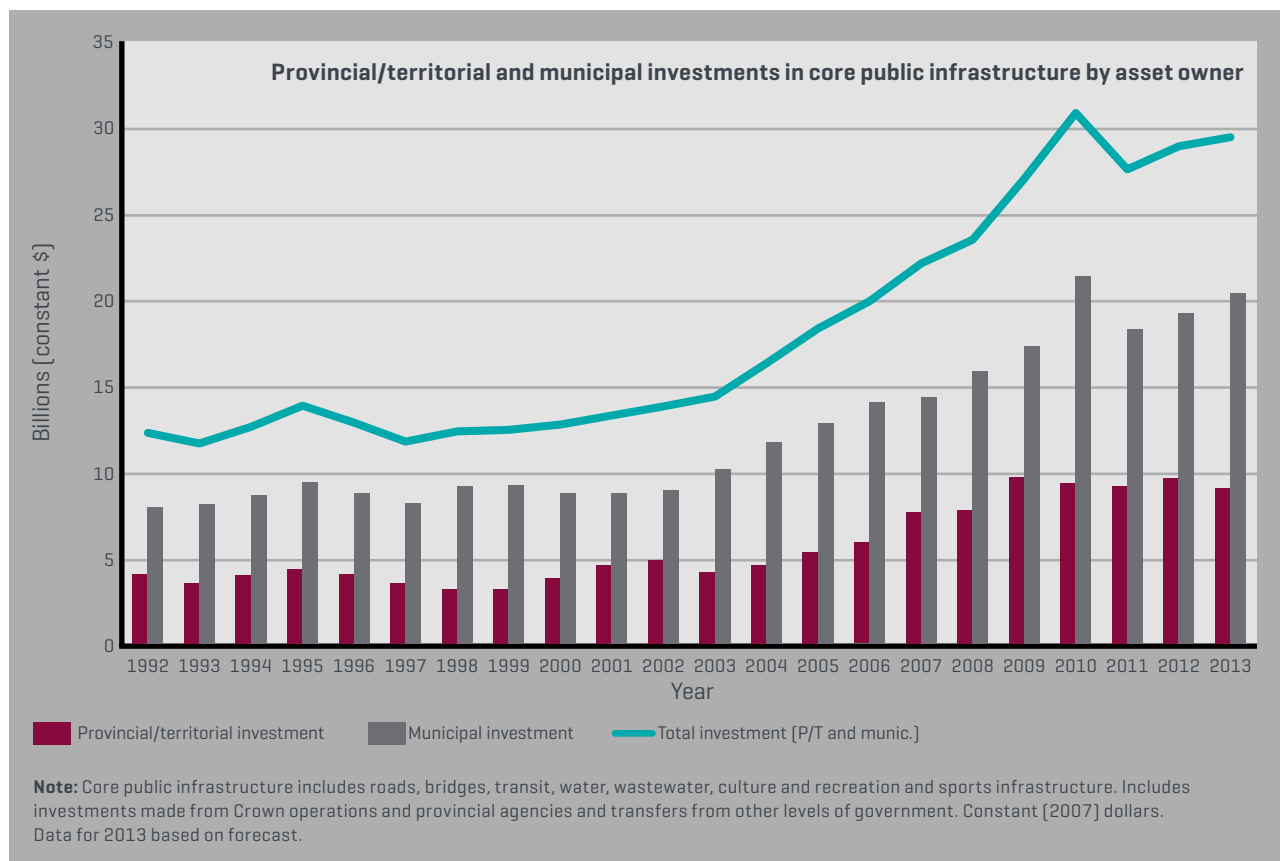
Source: Accessed 20 March, 2017, www2.census.gov/programs-surveys/popest/datasets/

Figure 4: Statista, 'Average age of infrastructure in the US in 2015, by type,' 2017.



Source: Accessed 20 March, 2017, www2.census.gov/programs-surveys/popest/datasets/

Figure 5: Denis Lebel, P.C., M.P., 'Infrastructure Canada: Report on Plans and Priorities 2015-2016,' Ottawa: Infrastructure Canada, 2015, pg 7.



Source: Statistics Canada, National Economic Accounts Division. Chart and data calculation: Infrastructure Canada



2.0 21st century infrastructure challenges

[Annual core infrastructure investments](#) by Canada's government are approximately \$30bn (=1.68% GDP 2014 current US\$) and in the United States approximately \$500bn (=2.87% GDP 2014 current US\$). These projects are financed through various models; however, Canada is far more open to leveraging P3 finance models. Experts in infrastructure investment, construction and operations overwhelmingly agree that infrastructure projects have become overly complicated and require excessive upfront planning to estimate the risk involved in pricing and to develop accurate payback models. One of our roundtable professionals put it best when they said, 'Conducting infrastructure projects across the United States is like trying to do business across 50 different countries.' There is a need for simplified structures for these investments that will attract companies and investors by reducing uncertainty through developing transparent processes that facilitate accurate pricing, realistic returns, public value and balanced risk assessments.



President Trump has made infrastructure investment one of the priorities of the new administration to help address the backlog of necessary repairs while promoting economic growth for the future. Efforts seek to modernize aging roads, rails, airports, energy grid, land ports and other structures. The President and the legislature will face challenges around the governance process and finance. The investment being suggested is an additional \$1tn, yet it is still unclear where this funding will come from. The finance strategy will need public support along with a prioritization plan that aligns with the direction of the economy over the next half century. '[Shovel ready projects](#)' are not a strategy. The opinions and ideas shared in this report provide an introduction for making substantial changes to government infrastructure strategies in addition to actions the private sector can address to support this transformation. It will outline an array of immediate tasks with an emphasis on long-term policy reforms and strategies to reduce deferred maintenance, restore critical structures and produce a proactive strategy for sustainable infrastructure that delivers value for the public good.

Figure 6: ASCE 2017 Infrastructure report card

ASCE report card	
Category	2017
Aviation	D
Bridges	C+
Dams	D
Drinking water	D
Energy	D+
Hazardous waste	D+
Inland waterways	D
Levees	D
Ports	C+
Public parks and recreation	D+
Rail	B
Roads	D
Schools	D+
Solid waste	C+
Transit	D-
Wastewater	D+
GPA	D+
Cost to improve**	\$4.59tn

“Conducting infrastructure projects across the United States is like trying to do business across 50 different countries.”

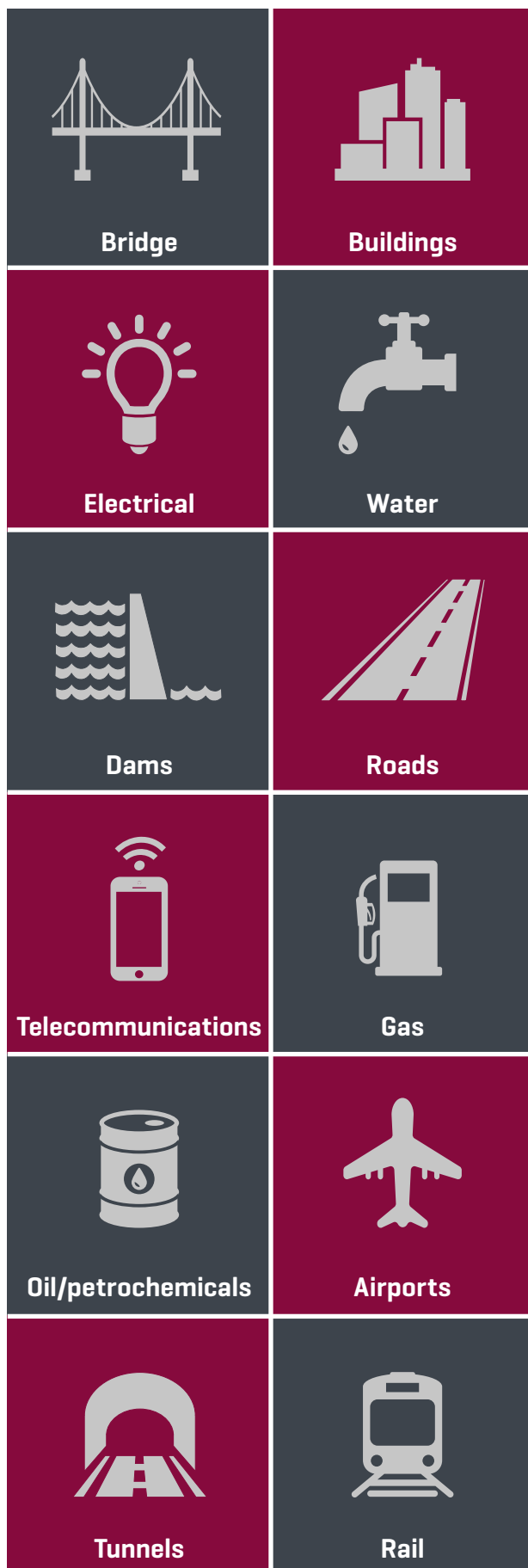
New York City roundtable

Much of the conversation around infrastructure revolves around politicians wrangling over federal funds for their districts rather than a comprehensive strategy to address national infrastructure needs. One of the challenges aggravating these issues relates to how infrastructure spending is framed and communicated. The clear majority of infrastructure spending should be understood as an investment because these assets generate value that can be measured in financial as well as social terms. Citizens are mostly unaware of the costs that they bear because of neglected infrastructure. These costs get embedded in auto-related expenses, rising consumer costs, rising utility costs and delivery charges. It is the task of infrastructure professionals across the sectors, from both the public and private arenas, to communicate the value these projects deliver to the economy and overall social wellbeing. This includes raising awareness for necessary improvements to jails and energy infrastructure instead of easier-to-promote initiatives such as transit, stadiums and hospitals that are more highly visible to the public.

Communication efforts run up against social concerns that may be health and safety or expense related. These issues focus on short-term change management struggles rather than long-term outcomes. For example, people scoff at the notion of paying a toll for a road that they did not pay for in the past. What goes unnoticed are the charges that fund the road that are embedded in tax structures at the local, state or federal level. The road needs funding to be repaired, so either the citizen will incur increases in their taxes based on income or special tax set aside (examples: gas tax, property tax, sales tax), funding will be taken from other infrastructure projects, or the project will be funded by fees paid by those who use the asset (tolls).

While there are valid debates over the funding structures for these projects, the person who does not want to pay the toll will pay in some other manner. What gets lost in these discussions are the long-term incentives to building better assets with longer lifecycles and the best financial mechanisms to deliver these results. Additionally, there must be transparency regarding the jobs that are created by these investments, but also visibility around where the revenue generated by these projects goes over the life of the asset. There is a tendency to deliver and move on, rather than deliver, monitor, assess and reinvest revenue back into the asset itself. Leaders look for the exciting, highly visible new projects to move onto rather than maintaining the previous projects in need of repair. Nowhere is this more evident than in the deferred maintenance backlogs across state and federal infrastructure.

Stakeholders recognize that there are limits to keeping up with demand for new infrastructure, but there are also those who approach the challenge strategically and address how to get ahead, rather than how to keep up. Strategic leaders and investors view infrastructure as a method that attracts people to an area to increase tax revenue, promote social development and encourage economic growth.



Rural and urban areas have distinctly different interests when it comes to which projects to fund. Rural areas may need better roads, communications or waterways, while urban areas may prefer new schools, metro rail or hospitals. But no matter where these needs reside, the question is always what to invest in. As we see in Canada, and are beginning to see in the US, there is renewed attention being given to infrastructure funding. What leaders would like to see is more conversation about how to fund and execute these projects responsibly. The unfortunate outcome for the past century has not changed; the taxpayer ultimately pays the bill. Things will need to change if we are to move away from chasing the need and towards getting out in front of it. Identifying practices that hinder progress is part of the necessary change process.

One of the major strategic challenges are the mega-projects. These are the lifeblood projects that help countries become competitive in the global market. Politicians want these initiatives in time for the next election cycle, but to do them efficiently and to reduce lifecycle costs requires patience. This is the 'ribbon cutting syndrome', where it is more important to have the visibility of a ribbon cutting ceremony than to deliver a quality and well-coordinated strategy that ensures stakeholder engagement and all of the correct input before breaking ground. Every mega-project should be attached to a 30-year development plan that encompasses the big picture and is able to communicate the importance of the long-term view when it comes to strategic asset management. Too often these projects begin with hurried bids awarded without due diligence for accuracy in terms of cost or risk. Motives for this can stem from public sector executives who know they are better equipped to ask for additional funds once the project is underway than if they request an accurate, but much higher initial investment up front. These practices make the process less transparent, while putting contractors in the precarious position of continuously rewriting scopes and project plans throughout the process. The best projects are those initiated by leaders who understand that they may be out of office before the ribbon cutting, but recognize the value in delivering a quality project to their constituents.

Operations and maintenance (O&M) professionals are typically left out of the planning, design and construction phase of most projects. This must change. The divide that exists between engineers and architects that design, the construction experts that build and the operations professionals that operate and manage are vast. A quality project will have representatives from each of these areas involved early in the process to deliver an asset that will produce a long lifecycle. Across the industry, asset operators must often deal with the consequences of poor design that could have been addressed at the outset of a design build.

3.0 Infrastructure management

Infrastructure management is the systematic coordinated planning, financing, programming of investments, design, construction, maintenance, operations, evaluation, integration and multidisciplinary set of strategies to sustain public infrastructure assets. Asset management organizes and implements these strategies with the fundamental goal of preserving and extending the service life of infrastructure vital to maintaining and increasing the quality of life in society and spurring economic growth. Over the course of the RICS roundtable sessions two categories dominated the conversations:

- Introduction to infrastructure finance, covering:
 - planning
 - risk
 - P3 structures
 - return on investment (ROI)
- Asset and organizational management, examining issues surrounding:
 - planning
 - design
 - construction management
 - operations and maintenance
 - measures of success
 - asset management systems
 - life cycle planning strategies
 - quality control
 - communications
 - organizational structures
 - resource allocation.

3.1 Introduction to infrastructure finance

Finance is the most critical component for infrastructure projects as it determines their success before they begin. Infrastructure finance differs from more common lending practices. In a standard loan structure, financiers lend based on the value of the borrower's assets and income. If the borrower fails to repay, the financier will seize the borrower's assets to pay back the loan. When dealing with infrastructure finance, cashflow-based lending applies. Loan approval is determined by the anticipated cashflow from the asset and payback is based on the capital generated by the asset. This creates a shared risk structure where both parties invest in the successful outcome of the project. For example, an infrastructure

loan to finance a mining operation is built on the forecasted output and pricing of the materials the mine can generate. The financier loses money if the asset fails to deliver in line with the forecast. This model can take various forms, but provides a general framework for the financial component of infrastructure development. These models are common across the private sector but less so for public infrastructure projects.

P3 finance structures

P3 projects offer the public many of the benefits of private sector infrastructure finance by capitalizing on the efficiency of private enterprise while they enjoy a lower risk profile and capital costs associated with government sponsored projects. The structure of these deals varies and tends to fall within one of three categories known as Greenfield, Brownfield or a hybrid of the two structures.

Greenfield projects center on a design-build (DB) service, design-build-operate-maintain (DBOM) or design-build-finance-operate-maintain (DBFOM) and combine these services with a single fixed-fee contract. Finance and O&M can remain the responsibility of the public entity or be transferred to either entity depending on which model is selected.

Brownfield projects, which also include a DB component, are existing projects where the public sector outsources O&M or other services. Responsibility is transferred from the public to the private entity to improve performance or upgrade systems and can be structured on a fixed-fee basis or as an incentive contract with well-defined performance targets built in. These are the most popular models across government today.

In recent years, there has been further P3 innovation with the popularity of Energy Savings Companies (ESCO) and Energy Savings Performance Contracts (ESPC). These are off-balance sheet services that provide a service funded by the savings they generate for public entities. Fees to the public never exceed the savings they produce through efficiency programs; however, there are still questions regarding how beneficial these models are over the long-term (US Government Accountability Office 2005).

Because public infrastructure provides benefits to a wide cross-section of society, planning and financing these projects can conflict with public policy concerns that go beyond the interests of private companies and investors. Disputes over the decisions on which investments to make require detailed analysis and business casing to achieve. The initial challenge to start these projects is how to finance them. In the US, most projects use debt finance, with a smaller portion executed as public-private partnerships (P3s). In Canada, P3s are more common and innovative with fewer legal roadblocks. The US has an opportunity to learn from the experience of Canada and other nations around the world where P3s have become the dominant vehicle for infrastructure finance.

Canada's approach to P3 has been positive and establishes it as a leader in this arena. It has earned this reputation through commitment to value, competition and transparency throughout the procurement process. The Canadian model set itself on a sustainable foundation by gaining public support at both the federal and provincial levels, evident in the coordinated procurement programs that continue to meet the needs in an austere economic environment. Canada did not establish its success overnight, but invested time and effort in managing key stakeholders to accomplish the kind of program structures that deliver best value to the taxpayers. Canada's national and provincial governments have had the prudence to sustain investments in infrastructure projects beyond the typical surges that many politicians fund to spurt short-term economic growth and jobs. They have adopted a lifecycle approach to project development that recognizes sustainable funding over a long-term cycle is necessary. At present, there are more than 200 P3 projects being developed and operated.

“The federal government can play an important role in supporting, promoting, and expanding opportunities for public and private partners to work together on developing and financing infrastructure in a way that facilitates appropriate and competitive solutions that benefit the public interest.”

Secretary Jack Lew

Department of the Treasury

The challenges to achieving P3 success in Canada are not unique. They had to establish centers of excellence, consistent public relations and a high level of cooperation among municipal, provincial and national government bodies. However, despite these ongoing struggles, Canada is a model that the US can learn a great deal from.

In the US P3s are sparsely used. Even when they are, they often fall short of their full potential. Today, there is broad consensus that P3s can add value when executed with discipline. We can see this at the state and local level where more than [30 US states](#) have adopted P3 enabling legislation to create a secure legal and institutional framework needed to attract investment for numerous infrastructure services. Traction at the federal level include recent efforts like the *Fixing America's Surface Transportation Act* (FAST Act), and expansion of public activity bonds (PABs) to encourage the creation of Qualified Public Infrastructure Bonds (QUIBs). The goal is to leverage federal funds by attracting substantial private and other non-federal coinvestment in critical improvements to the [nation's surface transportation system](#). While these efforts are a good sign of the commitment to grow the financial options available, there needs to be more action. Research participants shared their thoughts on why there is an apprehension to get involved in P3 projects. For starters, the lack of enthusiasm for P3 projects results from the lack of structures needed to support evaluation, procurement and execution in a consistent and coordinated fashion across the country.

Among experts, there are concerns the US market is not yet the mature P3 market that will attract the investment community to the marketplace. However, investors are encouraged by agency heads at the US Treasury Department and US Department of Transportation who mention P3 efforts in their reports to Congress. A comprehensive effort in Congress is necessary to establish a P3 marketplace that goes well beyond road infrastructure. The construction community patiently waits to see if any traction for P3 will grow around social infrastructure projects that use tax exempt private activity bonds (PABs). Projects permitted under new legislation would legalize subsidies for social PAB on projects that Congress qualifies based on whether they meet certain social benefit criteria. These projects could include waste management facilities, airports and utilities. Currently, there are no provisions for PABs for regular use public buildings and social infrastructure that meet the same requirements for private activity. However, there are alternatives that could be on the horizon.

The first is a safe harbor for private business that allows long-term operations contracts of 25-30 years, if qualified under congressional provisions, to take advantage of government use bond financing. House Bill HR960 provides a path to those who cannot fit into the safe harbor for private business use:

“To amend the Internal Revenue Code of 1986 to provide for the tax-exempt financing of certain government-owned buildings.”

It allows tax-exempt PABs for qualified government facilities which would include schools, colleges, libraries, courts, hospitals and government office buildings. Despite certain exclusions, this would open significant opportunities to help the government reduce asset management expenses and help them diminish deferred maintenance. There is still a long path ahead, but it could transform how these assets are managed for the next century.

Factors for P3 success

Integrating P3 into government acquisition strategies must address key concepts to be successful. Success should influence public investment with private financial support to develop results that neither the public nor private entity can achieve on their own. These key concepts must be adopted to achieve success:

- **Governance:** inform and engage with legislative bodies to ensure they understand the structure of these contracts and participate in understanding the process and risks.
- **Reliability:** there must be a consistent systematic process that all parties understand across every phase of project finance and acquisition.
- **Transparency:** ensure that stakeholders understand the rules and requirements on both sides of the deal and engage them early in the process. Be open and recognize that both parties must benefit or profit from the engagement.
- **Communication:** implement the communications strategy early and reinforce the benefits to all parties involved, including the public. Ensure timelines are clear, factsheets are consistent and stakeholders are communicating the same message.
- **Controls:** ensure strong leadership and organizational support that is knowledgeable, innovative and flexible enough to adapt to the unique requirements of the public sector needs while maintaining control over the risk to projects.

Within the community there are discussions on how crowdfunding can apply to specific infrastructure projects. The attraction would be for industries that benefit most from these projects but cannot authorize them without significant government involvement. They could gain political traction by opening a portion of the investment to the public. These would be anything from schools, utilities, community centers or transportation. If the asset is used by the public, it would receive the green light. An example of this approach is the state of Virginia’s [P3 Public-Private Partnerships Pipeline](#) report:

“Crowdfunding concept (agency wide; statewide) – The Jumpstart Our Business Startups (JOBS) Act in 2012 has led to a rapidly changing legislative and regulatory environment, which provides for the ability of new ventures to raise money. Virginia now allows companies to raise money from equity investors through crowdfunding. This new form of investment has been successfully used in real estate development and can offer an opportunity to smaller investors to invest in P3 projects. This enhanced method can provide another level of competition for those who wish to invest in P3 projects at equity level, open the door for public involvement, especially local communities as an equity partner in the P3 model, and create opportunities for risk sharing, idea exchange, additional transparency, and enhanced public engagement.”

For many small businesses, getting into the government marketplace is daunting. Those on the outside often have a perception that the request for proposal (RFP) process is rigged against them in favor of specific service providers. This understanding is stronger for foreign companies that see risk in spending limited resources on a bid when they feel their chances of winning are slim. Government leaders taking part in our roundtable sessions raised these issues and strive to prevent such activities, but understand more can be done to achieve transparency and fairness throughout the process. The government wants to attract competition and provide opportunities to businesses new to the market. Businesses that become successful within the government contracting arena will often enter by partnering with other businesses familiar with the process. There is a learning curve that these relationships help newcomers navigate.

3.2 Planning

Traverse across infrastructure sectors and you will find many of the same issues during the planning process that contribute to overruns, misinformation and poor returns affecting all stakeholders. Changes from concept to build are where many of these overruns befall government managed projects. These problems often continue to mount and build on each other; due in part to the political drive to get projects started quickly rather than focusing on deliberate and thorough estimates and cost models. Pressure to publish figures for public consumption contributes to poor estimates and does not allow sufficient time to properly assess projects. Poor estimates extend the time a project takes as they lead to incremental adjustments to the design that add unforeseen activities and cost. Project managers can avoid these pitfalls by ensuring the right amount of time goes in the initial estimates and prior to the start of construction.

A contributing factor to these inaccurate estimates comes from political considerations. Some officials are not interested in accurate cost measurements. They latch onto the lowest figure because it is more appealing to the public, making the legislation more popular. Politicians often have no compunction about using an older project plan with an outdated estimate that does not factor in many recent industry and environmental changes. Practices like this are counterproductive and opaque. They place the private sector in a precarious position by making it appear that public projects routinely overrun budgets and schedules. In truth, officials are less concerned with the quality of initial cost estimates because it's often easier for the politicians to request additional funding for project completion than it is to fully fund a project at its outset.

On the other end of the spectrum, there is the expectation for contractors to identify every possible negative issue while under pressure to meet a quick bidding process. This results in excess contingency planning that increases bid values. Professionals want to strike a balance between reasonable contingency planning and a fair timeline to prepare reliable bids. Certainty comes with time, while government procurement processes rely on short cycles.

How to determine which projects to fund is briefly covered in figure 7. However, infrastructure failures have a way of escalating issues to the forefront of the public's attention that is both beneficial and detrimental to the big picture. Recent bridge collapses and the Flint water crisis grab national attention and motivate people to think about how infrastructure affects their daily lives. High profile infrastructure failures such as these provide visibility for the significance of infrastructure and provide important, if costly, lessons. As these conversations develop, it is important to draw attention to the projects that impact people's lives, but are difficult to understand.

Renovations to LaGuardia Airport are difficult to rationalize to people living in Detroit, yet its benefits will be felt throughout the economy. Public officials and professionals alike need to explain infrastructure needs as part of a much larger system that has an impact on every consumer of goods and services across the continent. For long standing public officials, there is a tendency to shy away from these difficult conversations because they highlight years of neglect that happened on their watch and additional funding needs that no one wishes to address.

How infrastructure is funded

Presenting viable options to fund infrastructure projects is a challenge, but the more complex task is to coordinate the project approval and to reduce costs. Progressive financing sources also drive investment opportunities and risks. The legal structures for these bond offerings are also important to prevent over-reliance on volatile revenue sources. Current finance options for infrastructure include:

- **Income tax:** federal, state local income or property tax revenue allocated by elected officials during the budget process.
- **Sales tax:** taxes levied for specific items that are earmarked for infrastructure investments. These are popular for transportation and utility funding through special taxes based on the consumption of these items.
- **Fees:** these fees are tacked onto services that the government provides, or get embedded into licenses and permits.
- **Value capture:** value capture assumes that a new infrastructure project will bring economic growth to an area, such as a metro rail system or new highway. It is a way to capture revenue on the back end of a project to repay the funds borrowed at the front end.
- **Tolls for use:** technology has made tolls less disruptive and instituted fee-for-use models that are popular for P3 transportation projects. Tolls often fluctuate based on demand to reflect standard supply and demand economic principles.
- **Public-private partnership (P3):** contractual partnerships between public and private sector to design, build, finance or operate and maintain an asset. Allows for private investment for public works projects. (P3 is detailed in section 3.0 of this report.)

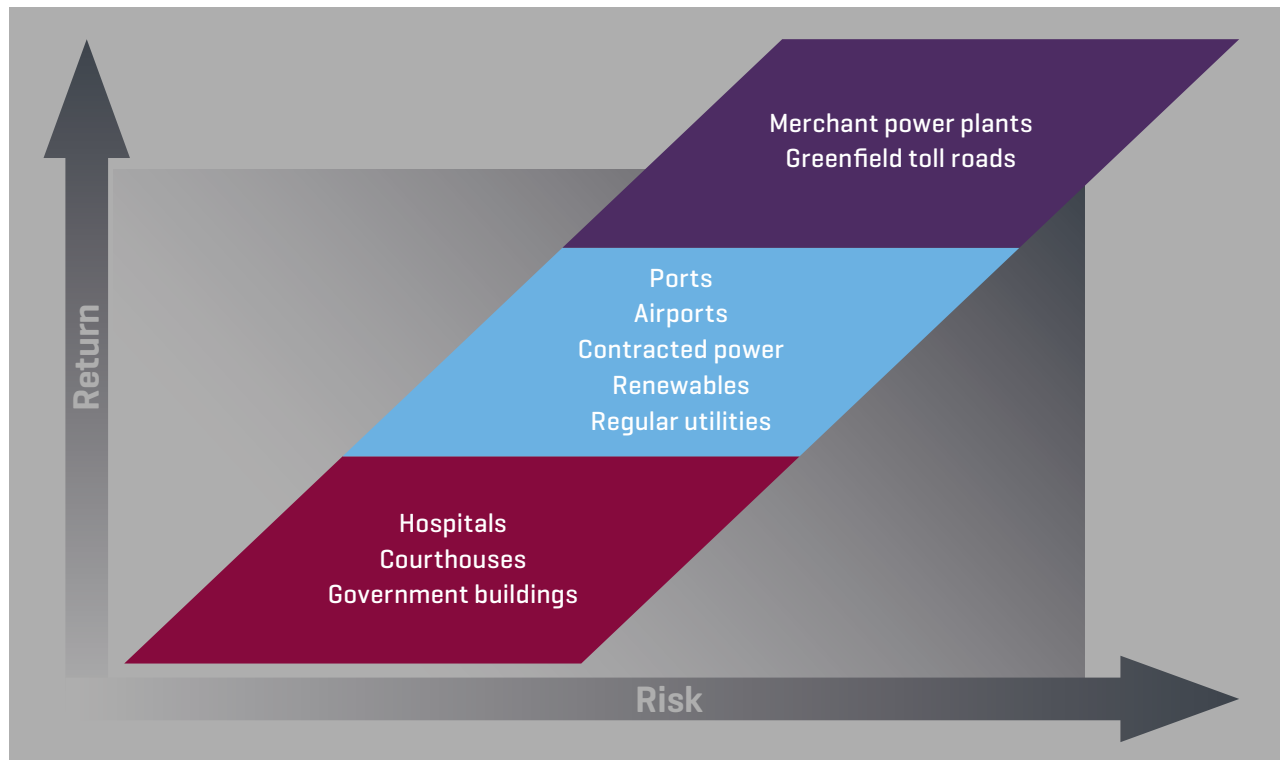
As previously suggested, a lack of transparency and mismanagement within government expectations can derail projects. When government-run projects go over budget, often for good reason, there is little uproar among government agencies or officials. However, with P3 there is far more risk involved because the private sector is not always in the best position to manage the risk. It can take only one bad project for a business to go under, which does not help anyone involved, including public stakeholders. The fundamental principle behind the success of P3 is that risk be allocated to the party best able to manage it. Transparency requires standards and open processes to certify models that validate that estimates are comparing like for like. These models should start at the national level and work through regional structures that interact with the states and local entities to help them put models in place the market can understand and adopt.

3.3 Creating regional structures for P3 investments

There are opportunities for the US to learn from the world when it comes to P3 investments. Endeavors in P3 at the state and local level have demonstrated some success, but to attract more of these investments the federal government will need to facilitate cooperation and policy guidance. Complications with state and local projects stem from a lack of uniformity in their structure. The private sector risks significant resources just to bid these projects and there are significant costs that accrue when dealing with 50 different states as the legal, risk and cost variables are similar in scope to doing business with 50 different countries.

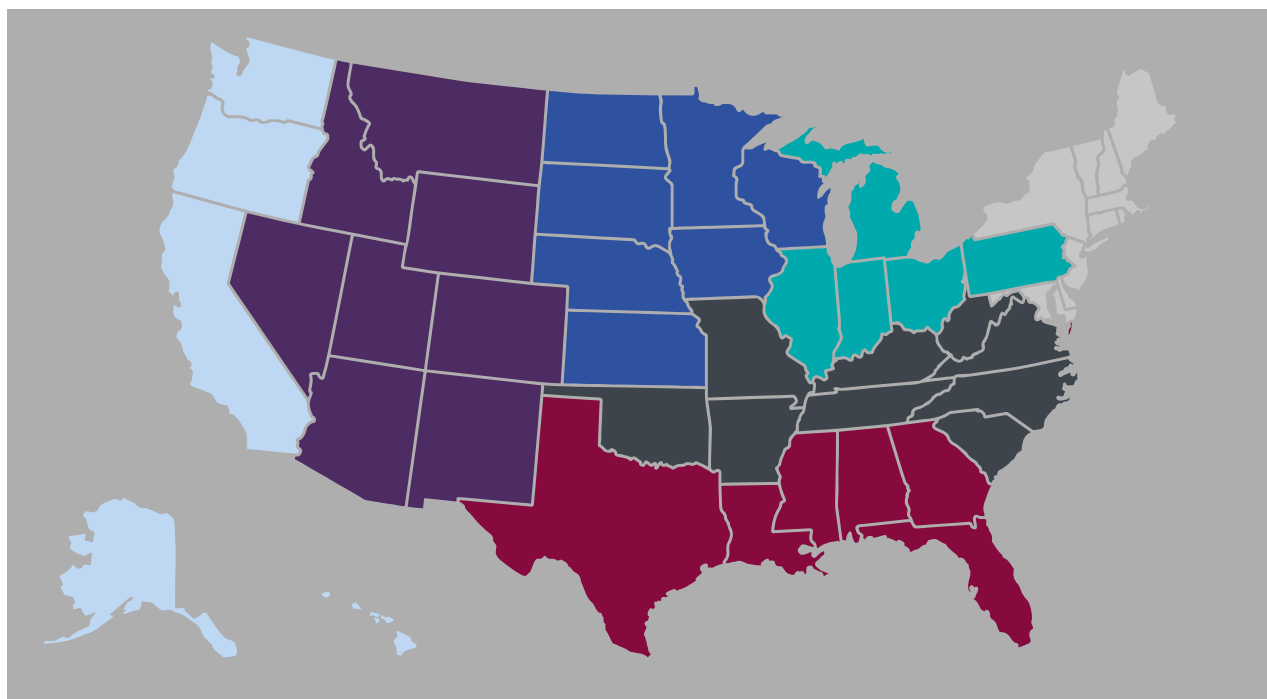
The federal government can partner with the private sector and local officials to create social value through regional structures that bundle projects, design uniform P3 structures, work to make processes transparent and help to deliver effective projects (see figure 8). Examples from around the world show that P3s will attract more investors to the process if structured to generate value for everyone involved.

Figure 7: Example infrastructure prioritization: risk vs. return model



Source: OECD 'Pension Fund Investment in Infrastructure', OECD Working Papers on Insurance and Private Pensions, No. 32, [OECD 2009]

Figure 8: Example regional jurisdictions



Following the Canadian P3 model (see figure 9) as a guide, regional jurisdictions provide much broader policy boundaries to help structure these investments. They encourage states to coordinate projects, and reduce the complications around infrastructure that crosses state boundaries. Regional jurisdictions work with states to develop standard P3 contracts for members to establish contractual clauses and provisions consistent within each state. Introducing standards to this process would help identify inconsistency around non-compete clauses, revenue sharing agreements, teaming agreements, and acceptability of unsolicited proposals, along with a host of other legal risks.

Regional jurisdictions could examine performance based contracts. These are of increased concern for O&M agreements due to deferred maintenance backlogs. The ability to enter longer-term contracts for 20-30 years for O&M agreements could balance risks related to asset condition by incentivizing vendors to conduct preventative maintenance and building condition assessment standards into the contracts. A vendor is more invested in the long-term success if they know they are there for 30 years rather than only 5-10. Encouraging vendors to have a stake in the lifecycle management process will motivate them to be more proactive throughout the lifecycle of

these structures; this is a good start toward remediating systemic deferred maintenance backlogs. P3 regions will offer technical help to agencies and private sector entities seeking to get involved in these projects. Regions should also partner with well-established industry best practice organizations and review projects to report factors for success and opportunities for improvement or standards.

Example: Strategic objectives for the P3 regional jurisdictions

1. Develop standards for participation in infrastructure programs, partnerships, project delivery and investments.
2. Foster infrastructure development, finance opportunities and O&M practices.
3. Assess asset lifecycles, sustainability and investment decisions.
4. Offer expertise, technical assistance and advise agencies on P3 participation.
5. Promote innovation by providing expertise across various infrastructure sectors.
6. Evaluate innovative financing models.
7. Provide visibility to the pipeline of projects to attract capital investment.

Figure 9: Example of regional P3 governance



3.4 Asset and organizational management

Asset and organizational management comprise the long-term activities of the infrastructure lifecycle (see figure 10). As discussed in Section 2.0, the current crisis in the United States results from years of underinvestment and poor asset management planning. In 2009, the History Channel ran a special titled *Crumbling of America*, the same year the *American Recovery and Reinvestment Act* (ARRA) was signed. The summary of the show stated:

“America’s infrastructure is collapsing. Tens of thousands of bridges are structurally deficient or functionally obsolete. A third of the nation’s highways are in poor or mediocre shape. Massively leaking water and sewage systems are creating health hazards and contaminating rivers and streams. Weakened and under-maintained levees and dams tower over communities and schools. And the power grid is increasingly maxed out, disrupting millions of lives and putting entire cities in the dark.”

This dramatic description echoes [ASCE’s report cards](#) from the past eight years with the United States, which assessed an average grade of D+ for 2017 (up from a D since 2009). Most of the criticism emphasizes lack of investment; however, professionals understand there is more to the equation. The efforts underway in Canada provide a good framework for advancement in infrastructure asset management. Canada has raised and is sustaining infrastructure investments, while instituting comprehensive long-term asset management plans. In the US, agencies have a pattern of reporting on the status of infrastructure with basic 3-5 year plans in hand. These narrow perspectives must grow to 20-30 year cycles to address the current crisis in a serious manner.

3.4.1 Understanding the issues

A strategic infrastructure operations and asset management practice implements rational maintenance, preservation and renovation programs over 20-30 year lifecycles for buildings, and in some cases 50-200 year cycles for dams and utility infrastructure. Despite commitments by the current US administration to invest in these assets, scarcity of resources to operate and maintain them will continue. Demand in other areas of the budget like healthcare, national defense and social security will continue to take precedent. These operational realities make asset and organizational management a primary path to reducing the infrastructure gap.

Figure 10: Asset and organizational management structure



Source: Geneva, Switzerland: International Organization for Standards, 2014

3.4.2 Maximum value

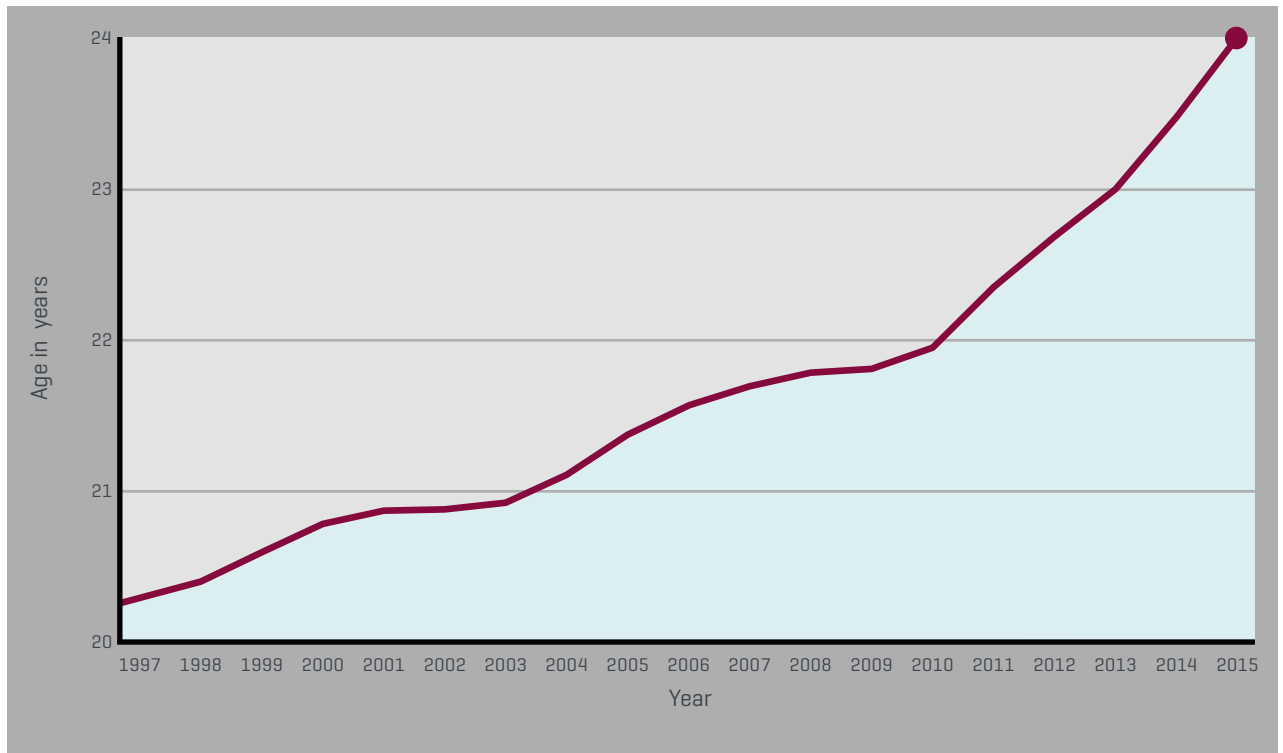
Organizations struggle to maintain maximum value at the lowest cost. Lack of coordination among the various disciplines that comprise the organization can account for much of these losses. For this discussion, an organization comprises members of a single enterprise or various teams that assemble from different entities to accomplish a project together. In the public sector, this is typically a teaming model managed by a government project management office (PMO). Within the context of infrastructure asset management, we think about these teams in terms of project phases (planning, design, construction, O&M) and emphasize handoff as projects are commissioned and handed off to O&M. Practices like these develop into silos that continue to impede our understanding of infrastructure management and how to improve longterm outcomes.

Over the course of our roundtable discussions, professionals identified common issues in this struggle. The first is a need to control the lifecycle costs and risks. This is of particular importance in the surveys so there is transparency and respect for all parties. Organizations need to assemble formal networks with representatives from the various stages/teams that have responsibility for the asset being managed. These networks should

engage to frame the problems as a team so they can provide visibility to those involved at other stages of the asset management cycle. Markers of a successful project are when the client gets what they want, the private companies make money and activities stay on target in terms of cost and timing over the lifecycle of the asset. Assembling these networks reinforces the long-term 20-30 year lifecycle perspective to ensure insights are shared across disciplines. As seen in figure 11, the combined average age of infrastructure in the US is at the end of the 20-30 year lifecycle. This indicates that many of these assets require significant renewal and a better strategy going forward to reduce this lifecycle measure to a more sustainable average age of 15 years.

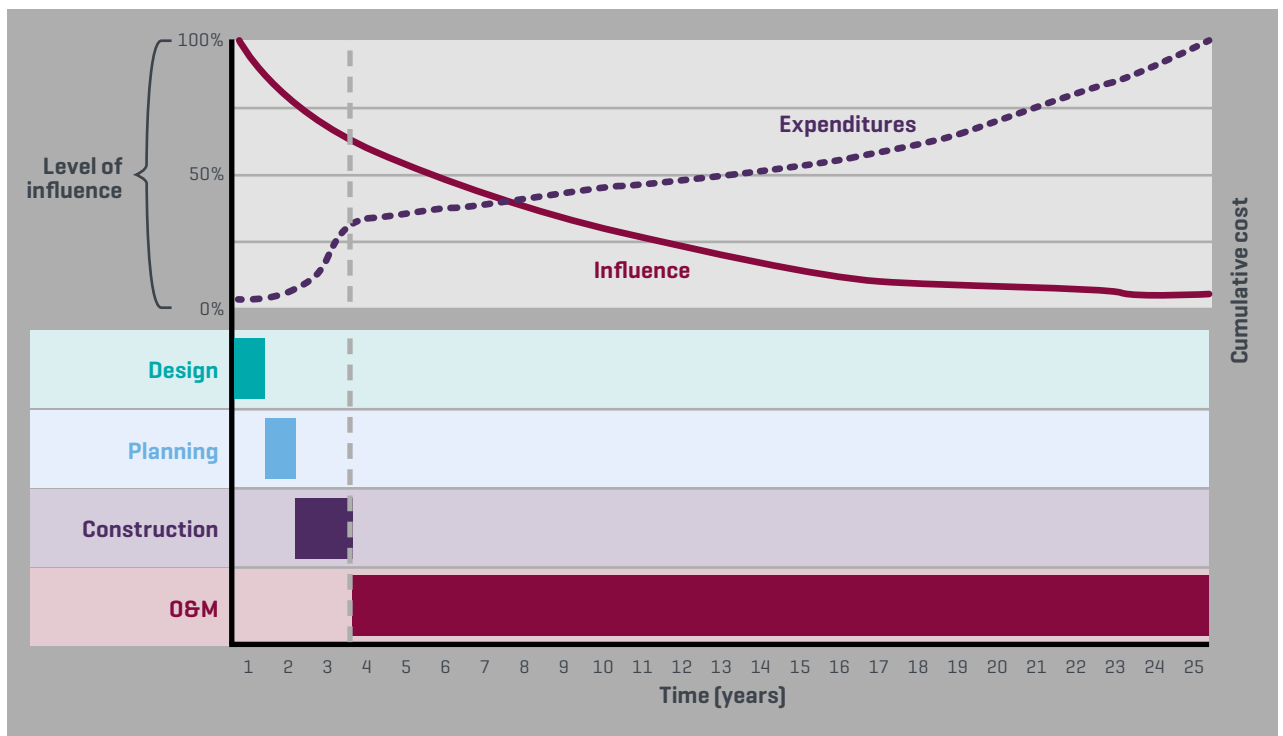
Capital investments set expectations based on well-managed, long-term maintenance practices. However, because these practices have not been well implemented, as operating budgets get cut outcomes shift to reactionary and corrective maintenance practices and increase costs while reducing useful life. Increases in operational spending can only correct this issue if they already have a preventive and predictive O&M strategy in place that is enforced and monitored (see figure 12). Additional funding by government will not correct this systemic issue; it will only buy time.

Figure 11: Average age of all US infrastructure, 2015



Source: Data Source US Bureau of Economic Analysis; American Society of Civil Engineers 2015

Figure 12: Influence and cost over the asset lifecycle



Source: Accessed 20 March, 2017, www2.census.gov/programs-surveys/popest/datasets/

3.4.3 Data collection and systems

Data collection is an immediate problem for government agencies. Discrepancies in condition, inventory and financial monitoring are inconsistent and lack standardization. Stakeholders do not have the necessary information to make knowledgeable decisions. An example of this is the variance between financial report estimates issued by agencies and those documented in the Federal Real Property Profile. Some of these estimates differ by as much as 300% (see figure 13).¹⁵ Best practice statements, like Government Accountability Standard Board 34 (GASB 34), should include an inventory of assets and condition assessments performed every three years.¹⁶ Many agencies comply with these requirements in terms of reporting, but do so without conducting thorough assessments. Old information is recycled and rereported or estimated without ever laying eyes on the assets.

Insufficient data makes it difficult for agency leaders to create businesses' cases for prioritizing operational improvements, especially under tight budgets. Instead of comprehensive strategic planning, executive budget departments determine the performance measures that drive business decisions and not the engineers, assessors and mechanical experts educated in these systems. The value in extending lifecycle and functionality are traded for short-term budget targets. These self-perpetuating cycles accumulate into crisis and system failures.

Agency leaders make efforts to integrate disparate systems into databases in order to pool information across departmental siloes. The challenge to integrating this information is the absence of standard naming conventions or unique asset identification numbers that

help users understand the difference between two data points. Standards are necessary to define asset levels (structure, land, facility, generator, control panel, etc.). Issues arise when simple data points like square footage appear in two different systems for the same asset, but present different values. The use of consistent, clear standards for categorization and measurement, such as International Property Measurement Standards (IPMS) and International Construction Measurement Standards (ICMS), which will be discussed in section 6.2, can play a role in providing greater clarity and consistency.

Data validation that ensures reliable information overwhelms analysts if a hierarchy of systems does not exist. For each data point in a database there must be some authoritative criteria that trumps other conflicting entries based on a system rank or time stamps. Criteria to help business lines cross-reference information are essential to maximize this data for intelligent decision processes. Simple steps begin with time-stamps or dropdowns that set parameters around data formats and units of measurement across systems. More comprehensive approaches use cross-departmental strategic design teams to consolidate systems in a way that integrates needs while meeting requirements across departmental workflows and services. These integrated work management systems (IWMS) can be difficult to implement; however, with the right strategy in place they streamline information flows, intelligence and transparency across an enterprise.

Figure 13: GAO analysis of agency financial reports and FRPP data [2012]

Selected agencies' deferred maintenance and repair backlog estimates, fiscal year 2012 [Dollars in billions]		
Agency	Financial report estimates	Federal Real Property Profile (FRPP) estimates
GSA	\$1.5	\$4.7
DOE	4.7	5.1
DHS	0.8-0.9 ^a	0.9
Interior ^b	13.8-20.2 ^a	14.4
VA	6.7	12.5

¹⁵ US Government Accountability Office, Report to Chairman, Committee on Homeland Security and Governmental Affairs, US Senate, *Improved Transparency Could Help Efforts to Manage Agencies' Maintenance and Repair Backlogs*, January 2014, pg 10

¹⁶ Waheed Uddin, W. Ronald Hudson, and Ralph Haas, *Public Infrastructure Asset Management*, 2nd ed., (New York: McGraw Hill, 2013), pg 40

3.4.4 Relationships

Clients rely on these assets to deliver their mission and often get left out of the strategic decision-making process. As managers of these assets, relationships with the client that develop a link between the asset management strategy and the clients mission are beneficial. For example, across the US and Canada, there are dozens of scientific agencies with missions to advance research around the world. Asset strategies need to engage these clients to ask where scientific research is headed in the next decade. What are they going to be looking for in 20 years? Are asset plans able to sustain and integrate services in a manner that helps these clients attain their objectives? Stakeholders want to know how to evolve these programs and policies to meet future needs. Many of these departments battle one another over the same funds to develop similar assets that could meet both of their needs if only they collaborated. Leaders in these areas examine needs and budget shortfalls from an activities perspective, rather than at the agency level.

3.4.5 Strategic asset planning

Developing relationships expands the narrow governmental strategic perspectives at both the local and national level. There are major developments across Europe to advance the 20-50 year strategic outlooks for asset planning, but in the US there is less progress. Current efforts examine assets from a size and utilization perspective and focus on short-term savings opportunities. They miss the long-term forecasts about where economic and agency activities are heading over the coming decades and how to prepare assets that support these activities.

These issues are rarely addressed within infrastructure asset management plans, yet have enormous potential to impact on them:

- How will automotive automation transform highway infrastructure?
- How will breakthroughs in renewable energy change utilities?
- How will robotics alter the labor force?
- How will drones transform distribution networks or disaster recovery?

The public sector is under pressure to increase utilization of their assets. In the US, two new pieces of legislation have been passed. One authorizes agencies to increase federal property disposal, and the other sets targets to increase asset utilization rates. These directives are used to measure performance by executive and congressional budget offices, but these perspectives create narrow viewpoints that ignore mission-driven performance. Many agencies are conducting security-related functions like border stations,

training facilities and airports. The asset management community is examining ways to link mission activities to infrastructure measures on performance, but it is a challenge. Maintaining asset conditions to a high standard is one aspect that links infrastructure directly to clients' missions. The challenge is to collect and manage this information in a consistent way that empowers authorities to make smart reinvestment decisions. Too often, asset and portfolio managers let the age of an asset determine what to fund instead of examining expected use life based on facility condition assessments for structure, mechanical, electrical and plumbing. To the surprise of many, some of the oldest infrastructure delivers greater efficiency in terms of equipment lifecycles, energy efficiency and tenant satisfaction than assets developed over the past few decades. Age is only one of many variables to consider when examining these important decisions.

3.4.6 Delivering value through partnerships

Partnerships are critical for success within the public works sector. The earlier and more transparent they are, the better they perform during a project. Whether teaming up with the PMO at an agency, or forming relationships with other vendors, it is vital to be forthcoming about estimates and risks. Lack of transparency among parties can often lead to unpleasant surprises mid-project. If professionals put a thorough case out on the table, regardless of fault, it is rare to run into these conflicts.

Project leaders cannot stress early engagement enough. Partnering relationships are often comprised of highly functional individuals who deliver exceptional work, but fail to develop the relationship skills and behaviors that make projects successful. Leaders establish relationships during the project development stage and build them throughout the work to communicate values and purpose and gain trust at the outset. These lessons also apply to the public sector leaders and elected officials when planning for new projects. There needs to be more transparency in the pipeline. Private sector partners have to strategize well in advance to assemble the right teams and talent profiles to deliver a quality outcome. The fact that construction managers are seeing significant demand for work followed by long dry spells impacts the public sector as well as the private sector. Public officials must recognize that there is a limited pool of qualified professionals to deliver the work. Being proactive with pipeline information will help the private entities to maintain a steady workstream for their staff and prepare for upticks in activity.

“Infrastructure from the post war era is now in need of major repair or replacement.”

Washington DC roundtable

3.4.7 Making the business case

Public managers have a difficult time making business cases for asset management decisions. They pursue a course of action they know will be more costly in the long run, yet as servants of the public they have a responsibility to carry out the wishes of elected officials. These officials are averse to long-term commitments that might save money, but require higher risk. For example, most energy procurement experts say real-time pricing will save significant amounts of money over the long-term while placing agencies at risk for spikes in some fiscal years. This is also the case for leased assets. Committing to 30-50 year fully serviced lease agreements will reduce the costs, but risks locking agencies into these agreements. Worries like these are understandable, but evidence points to leases being renewed multiple times for decades. Asset managers have a tough time approaching stakeholders to report the multiple options that balance the risk factors. The tendency is to create binary choices rather than balanced options. The choices are either the least expensive, or the highest risk without suggesting opportunities in between. Another side of these poor decisions lies in the attractiveness of new projects to politicians, when similar funding could repair multiple aged assets that would continue to deliver value across a far wider terrain.

3.4.8 Construction management (CM)

Good construction managers are highly valuable for organizations overseeing large construction programs. However, the workload can fluctuate and force these professionals to conduct other aspects of the business to stay productive. Cross-discipline experiences are encouraged, and finding ways to utilize talent across projects is particularly beneficial for government agencies where these resources are scarce. Managers like to hold onto their best talent and often hinder talent sharing practices that would benefit agencies or the government as a whole, but may prove costly to their own departments. To help stabilize the industry, government leaders must control the volume of construction projects in a region. Maintaining a consistently steady workload is beneficial for staffing and talent retention in both

the public and private sector. Long gaps contribute to staffing problems when projects pick up. The regional P3 structure, discussed earlier, would help to keep this steady state and commitment to construction rather than the peaks and valleys that disrupt the quality of the work.

Maintaining a big picture perspective is a theme that affects every aspect of infrastructure management. The industry is seeing projects planned and executed on a one by one basis without consideration of a broader strategy and scaled design process. The project pipelines are not systematic, but fractured. Causes emanate from the skill level of the engineers and the team members designing the work. They do not understand how to think or conceive of their projects as part of a larger system. To overcome these gaps, new P3 structures need to promote bundling services and encourage teaming agreements for various companies to deliver the various phases of these projects as one unit.

“Don’t rely on the policy to drive business decisions... make good business decisions to drive policy.”

Washington DC roundtable

Government procurement and planning practices are also part of this shortsightedness. Large projects are broken up into phases and each phase is marketed separately. In one way, the private sector benefits because they do not take on the risks of the entire project and there is more competition for small businesses willing to take on a smaller level of risk. However, conducting project cycles this way builds additional costs for the government due to inconsistent designs, interface issues and the added time and cost to onboard a new labor force. It would benefit the industry to examine ways to conduct long-term designs and place requirements within these contracts that mandate workshare across the phases of the project from design to O&M so that all parties are engaged from beginning to end. Not only would this reduce costs, but it will increase the level of success that these sizable projects entail.



Oversight agencies produce excellent reviews and audits that provide valuable insights and lessons learned from disputes, yet agencies and firms are continuing to make the same mistakes. Government PMOs and private sector CMs must be more transparent and work through issues proactively. It is too common to find PMOs squeezing the CM to benefit their bottom line. The contractor must stay profitable to survive, so they respond by hiding costs or embedding them into other line items. Most of these activities happen during the design phase when agency stakeholders provide their requirements and track them in the design documents. The requirements that get left out of these designs will force the builders to make determinations onsite to keep the project moving ahead. During build, there is a habit of clients entering the job site with requests to change the design. Changes mid-build can have significant impact on costs. These costs result from the limited requirements delivered to the construction team post design phase, yet blame and overrun tends to focus on the CM. Behaviors like these run against successful operational outcomes and hurt all parties involved.

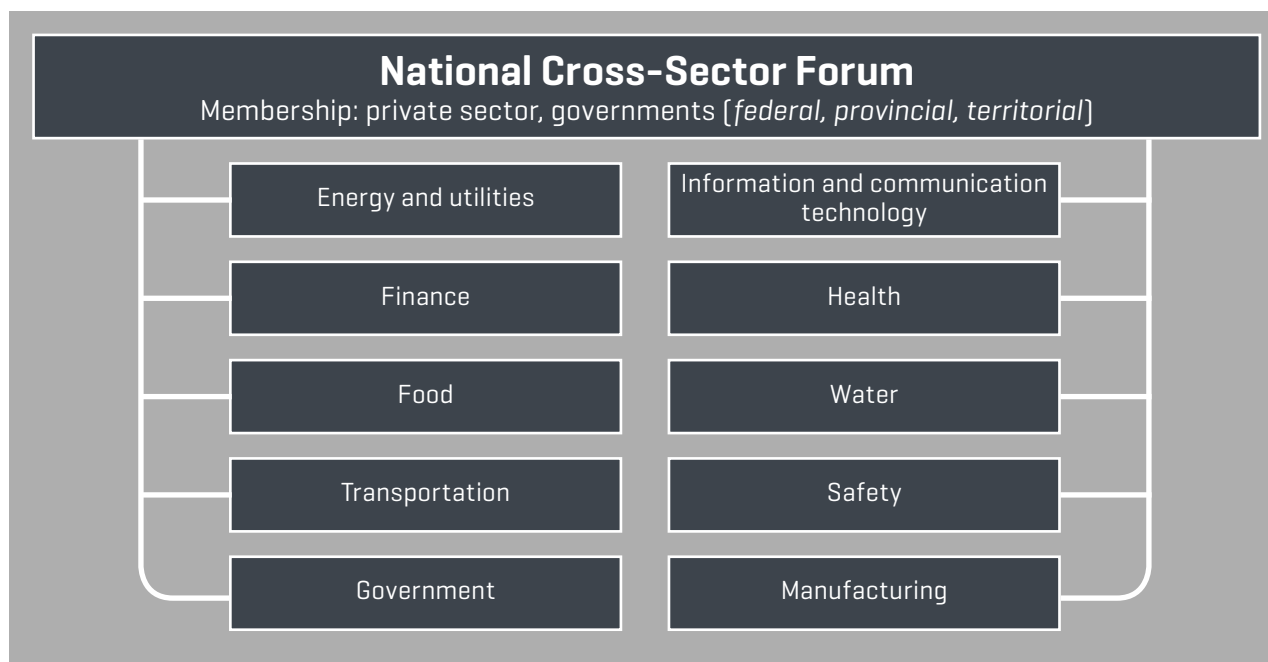
One way to help remediate some of these overruns is to build more flexibility in the contingency funds. Too much is being held back at the outset of a project and then does not resurface until the build is almost complete. Project managers spend the funds, but due to timing they go into items that are outside of scope or unnecessary when they would be more effective earlier in the project by driving down overall costs. Leaders in the industry are concerned that a significant number of PMs do not understand how to use project controls. Enhancements to training and measures around activities that run late could make a significant impact on these outputs.

Building consistency into the construction management role is important for the future of the industry. RICS has been part of a major coalition working to introduce an International Construction Measurement Standard (ICMS). The coalition aims to deliver a structure and format for consistent construction costs that provide transparency for private firms and governments around the world. Adoption of these standards will open the doors to compare, validate and benchmark costs to help project firms assess and identify issues in their pricing models. It will cover four levels of project or sub-project, cost category, cost group and cost sub-group. These standards work in conjunction with the International Property Measurement Standard (IPMS) that the coalition delivered in November 2015 to encourage consistent valuation.

Figure 14: US count of critical assets by sector

United States of America Count of critical assets by sector	
Sector	Assets
Government facilities	12,019
Emergency services	2,420
Nuclear power plants	178
Chemical/hazardous materials	2,963
Telecommunications	3,020
Water	3,842
Banking and finance	669
Transportation	6,141
Information technology	757
Agriculture and food	7,542
Dams	2,029
Energy	7,889
Postal and shipping	417
Public health	8,402
National monument and icons	224
Commercial assets	17,327
Defense industrial base	140
Not specified	290

Figure 15: Canadian structure of the National Cross-Sector Forum. Membership includes private sector and government (federal, provincial and territorial) representatives from each of the ten critical infrastructure sectors



3.4.9 Critical infrastructure and resiliency

Critical infrastructure refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of society and the continued function of government in the face of an emergency. These assets include the interconnected network of utilities, transportation, airports, oil and gas transmission pipelines, power plants, dams, channels, waterways and ports that society depends on for daily life (see figure 15). More than 80% of these assets are owned by the private sector, which makes planning and protecting them a joint effort with federal and local government to ensure resiliency in an emergency.

The guidelines that determine critical infrastructure are contentious; however, the primary factors are based on the catastrophic loss of life, adverse economic effects and significant harm to public confidence that results from these assets being nonfunctional. When evaluating infrastructure projects for the government, professionals must consider whether the project should be submitted for recommendation to the critical infrastructure list as it can have significant implications for investors. In the wake of disasters like the World Trade Center attack and Hurricane Katrina in New Orleans, resiliency has become a concern for infrastructure investors.

Both Canada and the United States have comprehensive plans and policies in place to safeguard these assets. Implementing these policies and best practices require communication strategies to relay critical information on potential threats or risks. Asset managers must educate their staff on the policies and additional practices required in preparation of an unforeseen event.

4.0 Technology, data and automation

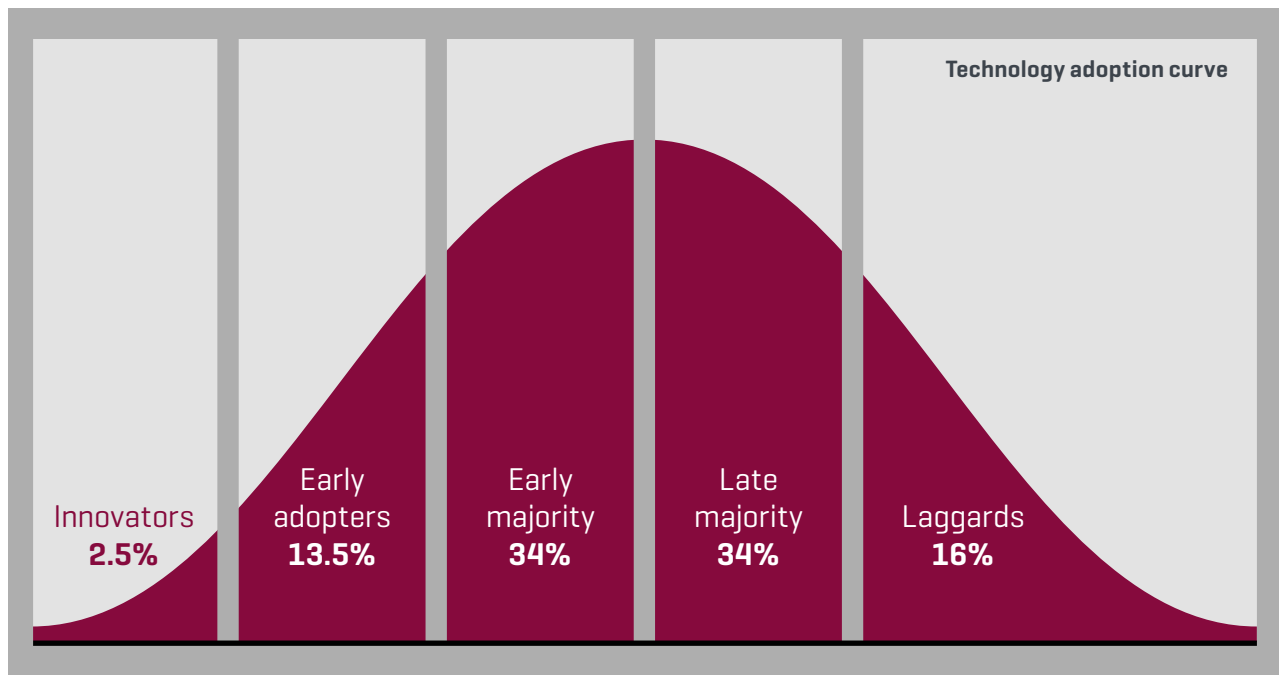
Industry professionals are getting excited and overwhelmed by the innovations and technological advances that surround us. Our challenge is finding the skills and time to assess these innovations to identify their functionality, value add and the human capital and financial investment required to complete the adoption curve (see figure 16). Our roundtable professionals offered insights on several topics like the Internet of Things (IoT), pre-fabricated construction and advanced simulation models. As these conversations progressed, uncertainty lingered around how to prepare for innovations that no one can predict.

The technologies transforming the infrastructure community impact industries around the world. Whether they be advances in wireless, simulation models (i.e. BIM), IoT, automation and robotics, big data and machine learning or artificial intelligence (AI), leaders are obligated to monitor developments and be ready with an implementation strategy when it is time for adoption. Too often organizations buy into a technology without the due diligence to test and prepare the change management process that will advance their workforce through the adoption curve.

Key principles for new technology adoption

- **Evaluate:** take the time to compare products and avoid proprietary systems when possible; establish a realistic value for ROI.
- **Communicate:** prepare the workforce ahead of time by building excitement and making them as familiar as possible with the changes to come.
- **Train:** prepare staff as a team and have a strategy in place for turnover and ongoing education.
- **Apply:** establish a problem statement and set the expectation for what the new technology will solve.
- **Monitor:** establish measures for successful adoption, ROI, and outputs.
- **Enhance:** use performance measures and adjust training to ensure the technology performs and meets value expectations.

Figure 16: Rogers' adoption curve



Concept source: Everett M. Rogers, *Diffusion of Innovations* 3rd Ed, [New York: The Free Press, 1983]

4.1 Resistance

Our roundtable professionals are often surprised by client resistance to new technology. Instances include proven solutions like advanced meters and sub-metering. It is unclear whether education is the main factor, or if there is anxiety to maintain these systems in the rare event they fail. Some of these fears stem from experience with large investments in which proprietary systems shackle enterprises to specific systems that are expensive or difficult to manage. Proprietary vendors often have little incentive to enhance systems and can leverage additional fees for enhancements. Meanwhile, non-proprietary vendors continuously compete with the advances in the marketplace and must update their products or services to maintain market share. Industry leaders have a responsibility to educate and create the demand for these innovations, but it requires a commitment to educate themselves on innovation, understand the risks and know the systems that are dependable and tested.

4.2 Big data

Data is booming, but is it reliable? More than ever before, information models are being used to forecast financial needs, predict equipment failures, calculate expected use life or model engineered systems using BIM and other techniques. New tools make it easier to create these models but do not guarantee their accuracy. Professionals put themselves in vulnerable positions when relying on some of these techniques without having a grasp of what data is being used to build the models they rely on. Questions need to be asked about the variables, the sample size and information selection.

“I love data! It is our life blood in quality assurance. The models are what matter; how do we capture old data and make it relevant to a particular job?”

Toronto roundtable

Organizations need to train valuers, engineers and analysts on how to scrutinize the data. The value of these tools can reduce the duration of planning and design phases while helping asset operators understand how new equipment or renovation designs impact the operation of a facility or structure. The industry will need to push for standards around common modeling techniques to maintain credibility and develop case studies that demonstrate their value to clients in a clear and transparent fashion.

“Across the spectrum there is a lack of cradle to grave mindset. Managers still do not understand how to transform data into knowledge to help them make long term decisions.”

New York roundtable

Organizations have massive amounts of financial information, yet struggle to make the connections on why project costs fluctuate. Roundtable participants offered examples of projects where they see mechanical costs coming down while other areas remain constant. They want to explain why this is the case; is it the specs, labor costs, equipment upgrades or something else? Making these connections helps planners by providing clients with options on how to lower project costs.

4.3 Pre-fabrication

In a different vein of innovation, pre-fabrication has become an option in the design world despite the slowness of its adoption. The challenge is to convince clients to move away from prescriptive design in general. Clients ask for specific changes throughout the design process. Convincing them to commit to pre-fabrication products takes away their autonomy despite reducing costs in significant ways. Another limitation of pre-fabrication is the location of a DB project. There are many places where the materials are too large to transport by road due to physical or legal restrictions. These limitations push pre-fabrication projects closer to coastal areas or nearby railways. Pre-fabrication saves on equipment costs and labor, but to increase its usage, the industry must overcome some of its other limitations.

4.4 Automation

The world of facilities has taken the largest strides towards automation. Building automation systems have been around for over a decade but smart buildings have taken these concepts to a new level. There is no standard definition to establish a smart building; however, smart buildings integrate building, technology and energy systems to include automation, life safety, telecommunications, user systems and facility management systems. They recognize and reflect the technological advancements and convergence of building systems the common elements of the systems, and the additional functionality that integrated systems provide; they also deliver actionable information about a building, its equipment, people or space and provide an interface for the owner or occupant to learn or manage aspects of its functionality.

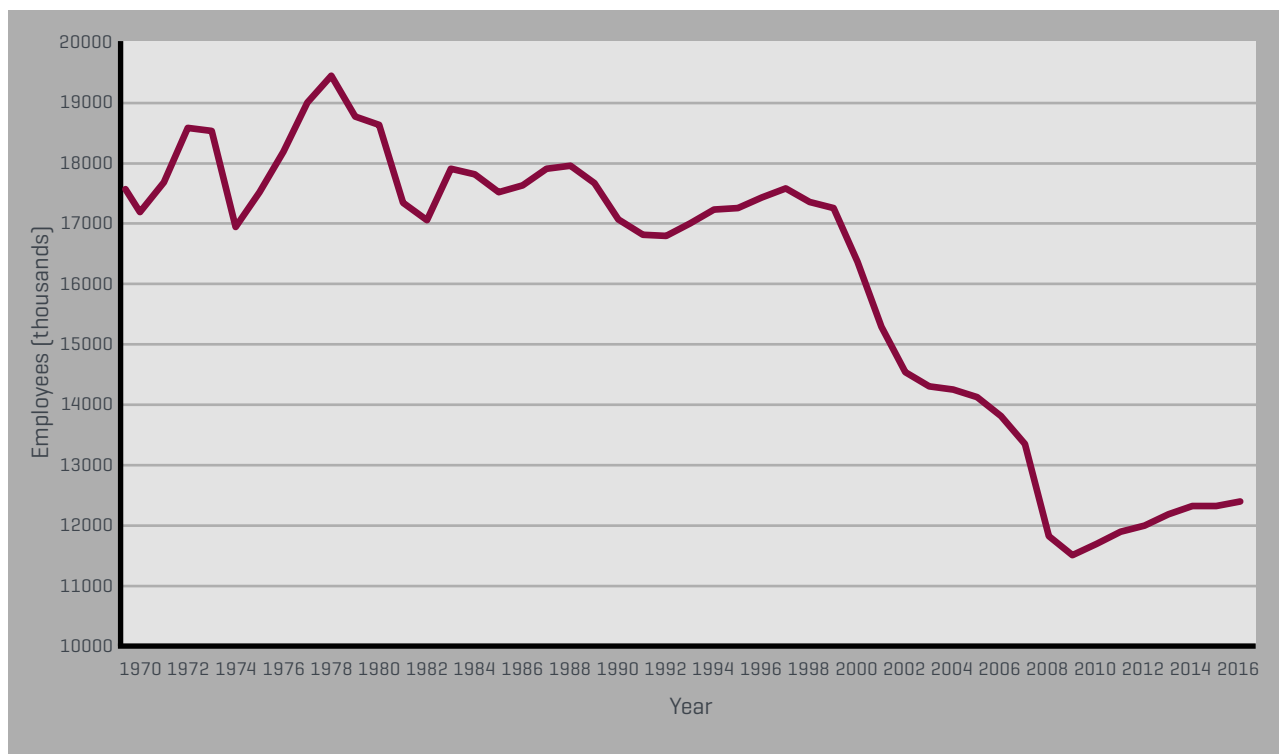
Some of the biggest misconceptions about smart buildings technology is that the primary output lies in energy savings. Utility conservation makes up about 15-20% of the overall savings potential that these facilities offer. The primary driver of cost reductions in the relationship between the O&M personnel and the fault detection interface. Through this relationship, the personnel and the machine build rules to respond to specific equipment and occupant behaviors in real-time. These components help to reduce the time technicians spend identifying the cause of equipment failures to resolve issues. As these systems are refined, portfolio managers can operate facilities remotely and be more efficient with their operations staff. These systems also reveal how the tenants are impacting the buildings performance. These data elements are used to work with the tenants to change behaviors that are beneficial to the operation of the facility. This can also work in the opposite direction, where tenants inform the facility of their needs through interfaces throughout the facility. Anything from a dirty restroom notice to a warm temperature in order to let operators know immediately if there are adjustments that need to be made.

4.5 Robotics

Robotics are taking automation to the next level. There are hospitals and warehouses experimenting with these technologies to deliver things like linens and medication while warehouse managers rely on these machines to retrieve products and fill orders. Schools have started to use industrial robots to conduct some of their routine floor cleaning and have saved districts thousands in custodial staff. These trends are certain to expand across the public sector.

There is some pushback against these technologies by labor unions as they have witnessed a dramatic decline in manufacturing over the past decade due to recession and less expensive offshore manufactured goods (see figure 17). This type of resistance will slow the adoption rate, but it will not prevent adoption of these technologies. Robotics and automation will help to solve some of the skills gaps that have already been discussed, but it will also eliminate some types of jobs.

Figure 17: Annual average number of manufacturing employees





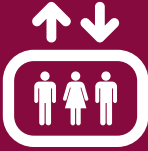



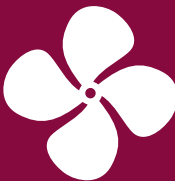



Source: Bureau of Labor and Statistics 2017, 'Manufacturing Employment, Hours, and Earnings from the Current Employment Statistics survey [National]'

If manufacturing returns to North America, the expectation to create jobs will run into the reality that automation will fill most of them. Robots are already onsite for many repair jobs like rebar and even other forms of steelwork. As this transpires, many of the health and safety issues that consume time and resources will become obsolete. As automation and machine learning continue to advance and merge with robotics, it will be the next big wave in innovation across the industry.

Over the past 25 years, advances in technology have been astonishing. In a short period, enterprises have gone from copper to wireless, from drawing to BIM and from calculators to data centers. Today, there is more computing power in a person's pocket than there was across an entire enterprise a short while ago. Despite these innovations, much of the industry remains fundamentally the same. The tools across trades have advanced, but the fundamentals and processes still follow similar frameworks.

Professionals adapt faster than many realize when they are faced with the possibility of elimination. However, these advances can exploit vulnerabilities in the workforce with skill gaps and the elimination of positions through increased automation and remote operational capabilities. Given that much of the existing infrastructure in the US and Canada is over 50 years old, and in many cases more than 100, how do organizations maintain the experience necessary to manage legacy systems while they prepare and advance new skillsets that will move the industry into the future?

 <p>Fire/life safety</p>	 <p>Security</p>	 <p>Access</p>	<p>Increase building efficiency</p> <ul style="list-style-type: none"> • Easier system coordination • Lower energy consumption • Reduced cost 
 <p>Elevators</p>	 <p>Lighting</p>	 <p>Energy</p>	
 <p>24/7 monitoring</p>	 <p>HVAC</p>	 <p>Comms</p>	

5.0 Workforce



Image source: 1 Sergei Butorin / Shutterstock.com



Anxiety grows around the industry as new technology requires new talent and workforce gaps accumulate as experienced professionals retire. According to [Pew](#), North America experiences over 10,000 members of the Baby Boomer generation retiring every day. However, matriculation is not the only driver of these changes. Industry leaders recognize they must engage with post-secondary institutions to ensure options on college campuses and to inform young people of the career paths that are available and in need of their talents.

Workplace culture also plays a role in attracting the next generation of professionals. Young people want to have a certain level of social interaction and a workplace driven by production and results, rather than how many hours one sits at a desk. What follows are insights on these topics along with questions the industry professionals will need to work out together.

“Experience can be shared, but it can’t be taught.”

Washington DC roundtable

5.1 The cultural change

The sharing economy can impact operational efficiency and workplace culture. Workplace culture is changing for a variety of reasons due to mobility, space utilization, telework and hot desks; yet there are still plenty of old style offices with cube farms and siloed workspaces. The mission of an organization can prevent or drive these changes depending on what type of work needs to get done and whether adopting these new attributes improves performance. Even among agencies conducting laboratory work, shared workspaces across departments and agencies are being implemented to achieve better utilization and cost reductions.

Across the government there is pressure to ‘reduce the footprint’ to achieve specific utilization targets. These targets make implementation complex due to the diverse mission within each agency. There are cases where shared workspaces and open concepts are being used to get employees to engage more in cross-discipline discussions yet result in employees sitting largely disconnected and engaging very little. The key is to understand the workplace that will attract the right people to an organization and to recognize it must function in a manner that helps people deliver their work. Building it without significant upfront thought and engagement will not create an attractive workplace culture, there must be an accompanying strategy that includes communication and input from the workforce.

5.2 Developing talent

Workplace culture includes best practices on how to develop people up through an organization. Leaders foster relationships and mentor younger staff to replace those transitioning to retirement. These practices are not as common as they once were. Recapturing these traditions requires organized efforts and new expectations.

Part of the decline is due to job transfers where the new generation stays in an organization for two to four years before moving on to another firm or agency. Organizations like RICS can foster these practices across multiple enterprises to help overcome the detriments of turnover that make knowledge transfer more challenging.

Today, fewer young workers are interested in being tradespeople and seek professions that offer gamification. According to the [Associated General Contractors of America](#), 53% of hiring managers said they were unable to hire supervisors, estimators and engineers due to a lack of knowledge. In the construction sector, there are substantial risks to the superintendent roles. Superintendents are the knowledge base during the construction phase. They take time to mould because their knowledge accumulates over years of solving construction and management issues and learning how to resolve conflicts that crop up on the job site. Project success relies on their ability to manage an immense responsibility. Hiring managers encounter young people who are risk averse and have no interest in taking on this level of responsibility. Construction leaders encounter too many CMs without the institutional knowledge necessary to run a construction project. If the industry does not find a way to implement technology into this work stream soon, the resource pool will run dry.

From a property management perspective, hard skills among the facility operations teams are at risk. Many of the new facility managers have no grasp of engineering or mechanical systems which are fundamental to understanding facilities. In 2010, the *Federal Building Personnel Training Act* was passed in the United States to require agencies to pursue fundamentals of facilities

management training for their staff, yet most agencies are in non-compliance. Organizational stovepipes have become a hindrance to overcoming these skills gaps. Some of the most valuable staff are those who move from one stovepipe to another. When asset managers attract talent from the design world and transition to operations, they create great value for the organization. Educational institutions do not produce these professionals which means to develop these skills organizations must move quality people across the various infrastructure departments. It is unclear in the public sector whether the older generation is genuinely preparing their replacements, but the industry will soon find out.

5.3 Selling the industry

A key component to bridging the skills gap is to develop a communications and public relations strategy. In this arena, personal skills are key. Staff must be able to explain what they do, how it fits into the larger picture of the organization and their client's mission. They must express their value to the process and why it's interesting.

"We don't promote our work outside of the industry... no one knows what we do."

Toronto roundtable

Infrastructure continues to be a headline in the news cycle and leaders take advantage of this to recruit and demonstrate the relevance of the industry as a career choice. Outreach to primary schools is important, whether participating in career days, or offering to conduct a workshop on the various career and educational paths within infrastructure. An additional component to these efforts requires outreach within the digital sector where there is a rich talent pool. Sending teams to digital conferences to promote the latest technological developments in the industry helps others see infrastructure as part of this space.



The industry is changing, and it is a good opportunity to examine how to alter job titles to reflect these changes. For example, *quantity surveyor* is not a term many people understand, while *construction strategist* or *capital projects consultant* may be a clearer way to communicate the activities implied in the role. Facilities management leaders are considering revisions to titles as many young people envision a low skilled technician rather than Niagra certified facility technology and automation experts.

“I did not realize surveying was such a male dominated field. After noticing I was the rare female, it became a strength because people remembered me and I used that to my advantage.”

Toronto roundtable

Another strategy to expand the talent pool is through increased outreach to women. There is a huge talent pool of women not being exposed to the opportunities and diverse career paths within the industry. There is a need to communicate the opportunities whether related to policy, procurement, or the complexities of packaging projects to enhance their value. These are all exciting and strategic aspects of what the profession offers. Getting this message out is about promoting the work and the pride professionals have in what they do. Professionals can promote the interesting aspects of what they do each day using hashtags (#) on social media or simply sharing their experiences with other young professionals to educate them about their options.

It will be up to the incoming generation to learn the profession and develop a comprehensive background beyond the engineering pieces to grasp why the financial models are important to the future. It is the role of leadership to coach and mentor the next generation workforce throughout the early part of their career. New professionals want to feel like they are being invested in. They want to do something they can be passionate about and are more interested in lifestyle and their future influence in an organization than salary. They look for ongoing educational opportunities to grow and adapt to the changing economic environment. If today's leaders can foster this culture among their programs they will attract quality people.

5.4 Education

The education systems that support the industry are ill-equipped for the future needs of the industry. The responsibility will fall on industry organizations to conduct outreach to colleges and trade schools to help develop the curriculum across the industry sectors and disciplines. Additionally, organizations like RICS can work to develop post-secondary education systems to produce certifications that validate the right skillsets. In the United Kingdom, infrastructure leaders work with education policy makers to conceptualize a school for the built environment and how it might look. The message must change from narrow and specialized to the big picture: these professionals create and operate structures that transform people's lives.

The foundational curriculum for students headed into infrastructure consists of basic literacy in the following skills:

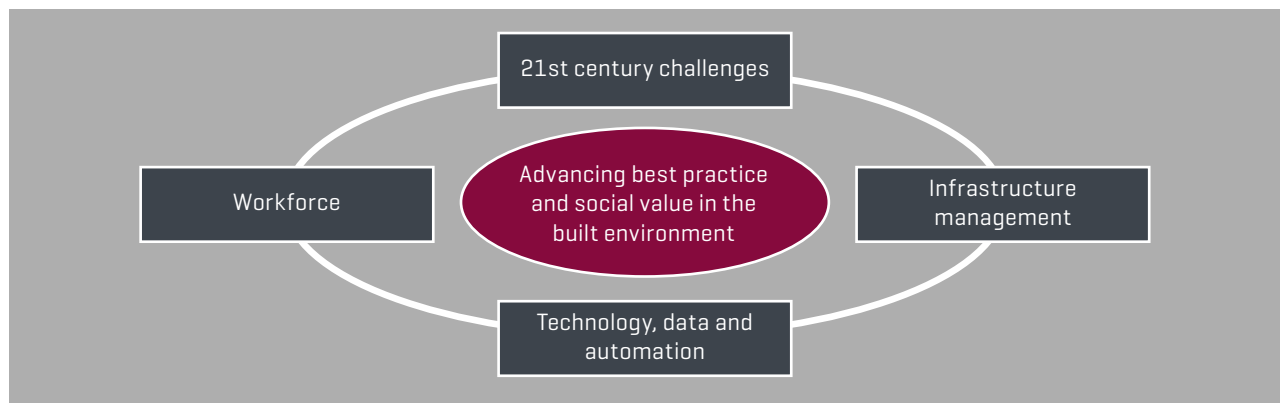
- finance
- planning
- design
- construction
- operations.

Pursuit of these core disciplines, and how they relate, will help secure the foundation of excellence to build on. To support these efforts, developers and asset management organizations are rebranding what they do within the area of technology. Some companies are conducting hackathons or innovation challenges with significant scholarships or monetary awards to students who can solve complex technology related problems facing their organization or sector. These leaders are working together to drive change.

“We should be developing programs with post-secondary institutions to produce employable graduates, rather than stand by while graduates pursue degrees where the economy has no demand.”

New York roundtable

6.0 Conclusions



Infrastructure leaders should embrace the path ahead to restore, innovate and deliver 21st century infrastructure across North America. RICS works for the benefit of the public good by supporting these leaders to build market confidence, trust and relationships that advance best practices and standards around the world. This insight captures the essence of this vision and seeks to build on the topics raised in this report over the coming years through outreach and continued research. To advance best practice and social value across the built environment, RICS is committed to promoting awareness and solutions around the current practices, challenges and the road ahead.

Following are the main conclusions that should be used to drive conversation and engagement across the industry over the coming years. RICS will continue to build on these insights through ongoing research efforts, training programs and the development and promotion of industry standards.

6.1 21st century challenges

Consensus across the spectrum of disciplines is that new infrastructure investments are necessary to replenish post WWII era assets and to build 21st century infrastructure that is technologically advanced, sustainable and pursues lifecycle centered operations. The major roadblocks to this vision center on funding, contract structure and advanced asset management planning. As an international body, RICS is in a unique position to drive collaboration among experts to help deliver standards and ideas to advance these practices.

P3 and financial approaches must change

The US must catch up in the area of innovative finance for infrastructure. The [International Monetary Fund \(IMF\)](#) ranks US infrastructure 16th overall and falling fast. Whether DB, DBF, DBOM or DBFOM, there are opportunities for restructuring these projects so that they can be accomplished for less money while delivering value to stakeholders and the public. Canada has made significant strides over just the past decade and the US should find opportunities to develop outreach to these experts to reimagine US models for the future.

Innovative thinking for P3

As discussed in section 3.3, there is an opportunity for the federal government to take on a role that does not require massive increases in infrastructure investment at the federal level, but instead uses their authority to develop a more strategic model that will attract private investors. The solution to the infrastructure gap cannot only lie in funding. It must include new ways to conduct business and fewer roadblocks for P3 relationships.

Implement a lifecycle strategy

Federal agencies need industry support and attention from Congress to expand asset management strategies beyond the three to five year procurement cycle. There are few efforts to implement standards for strategic asset management planning that examine portfolios from the 20-50 year lifecycle that most of these structures must deliver. Recent efforts to consolidate government property are a first step to improving budgetary performance, but there must be a broader vision that examines owned assets across agencies to identify economies of scale and operational strategies that are more proactive over the lifecycle of core infrastructure.

6.2 Infrastructure management

Finance, asset management and operations comprise the complex integrated systems and processes that create and maintain value for public infrastructure. As infrastructure has grown, so have the siloes around the professional disciplines and departments responsible for delivering these activities effectively. This must not be allowed to detract from 100 years of unprecedented human achievement in innovation and expansion; instead, it should motivate the industry to preserve and build on this legacy. The US and Canada present two separate paths for infrastructure management and it is becoming clearer which path is more beneficial for long-term sustainability.

Regional P3 structures

Following the Canadian P3 model as a guide, leaders in the US should continue to develop regional jurisdictions like the West Coast Infrastructure Exchange to provide much broader policy boundaries for P3 investments. These models encourage states to coordinate projects, and reduce the complications around infrastructure that crosses state boundaries. Regional jurisdictions work with states to develop standard P3 contracts for members to establish contractual clauses and provisions consistent within each state. Introducing standards to this process helps identify inconsistency around non-compete clauses, revenue sharing agreements, teaming agreements and acceptability of unsolicited proposals, along with a host of other legal and risks.

Have all project phases at the table early

Around the design table there are fantastic minds discussing all the efficiency and technology that they will deliver, but the operations experts are not always in that room. Creating cross-disciplinary teams at the outset of a project and communication practices to identify and resolve issues alongside the CM, will enable O&M experts to deliver efficiencies throughout the life of an asset. Leaders must utilize organizations like RICS and other professional bodies to get the different groups of professionals to engage in a meaningful way through educational opportunities so they can see and understand the others' professional perspective.

Campaign for operational excellence

For decades, design excellence was a popular slogan and campaign for creating innovative structures. Today there must be efforts to refocus this toward operational excellence. Over the lifecycle of these assets more than 90% of their costs will come from O&M. Refocusing efforts to gain traction in this area requires coordinated efforts by FM leadership, government and best practice communities to reimagine every aspect of the O&M cycle from procurement and performance-based contracts to strategic asset planning. Leaders can drive commitments to fund education for personnel to bring them up to speed on preventive, predictive and reliability centered maintenance practices that will move the industry towards sustainability over the coming decades.

Implement standards

RICS has been instrumental in producing standards that are gaining acceptance around the world. The International Property Measurement Standards (IPMS) that was developed by a coalition of leading organizations in the property sector in November 2015 promotes market efficiency by creating confidence between investors and occupiers. The IPMS eliminates the possibility of variance in internal structure measurements that has plagued the facility community.

RICS is part of a coalition of leading property sector organizations that is in the final stages of developing the International Construction Measurement Standards (ICMS). The ICMS coalition will deliver a structure and format for consistent construction costs that provides transparency for private firms and governments around the world. Adoption of these standards will open the doors to compare, validate and benchmark costs to help project firms assess and identify issues in their pricing models. It will cover four levels of project or sub-project, cost category, cost group and cost sub-group. These standards were published in July 2017.

Evidence-based research

There are missed opportunities to capture failures and successes that benefit education and training objectives. This type of knowledge transfer is not happening despite the access to technology and databases that store a wealth of project information. The same mistakes are repeatedly being made while success is often difficult to replicate. Working across sectors to produce a knowledge base of case studies focused on O&M best practice, new technologies, conflicts resolution and P3 structures, among others, would provide professionals with guidance based on past projects.

6.3 Technology, data and automation

Section 4.0 addressed the opportunities and threats posed by technology, data and automation and how they impact the industry. Executive managers are taking actions to ensure they are prepared for the future by implementing some key principles for new technology adoption.

Key principles for new technology adoption

Evaluate: take the time to compare products and avoid proprietary systems when possible; establish a realistic value for ROI.

Communicate: prepare the workforce and make them as familiar as possible with the changes to come.

Train: prepare staff as a team and have a strategy in place for turnover and ongoing education.

Apply: establish a problem statement and set the expectation for what the new technology will solve.

Monitor: establish measures for successful adoption, ROI, and outputs.

Enhance: use performance measures and adjust training to ensure the technology performs and meets value expectations.

Have a strategy to address resistance

Changes in technology will impact organizations, whether they are prepared for it or not. It is up to leaders to advance proven technologies into their business practices so they can help clients adapt to these changes as they affect the industry. Leaders should identify early adopters and work with them to develop case studies that can be used to educate clients to encourage implementation where appropriate.

Skills gaps and vulnerabilities

With automation and robotics comes vulnerability within the workforce. Leaders are working to mitigate these threats by promoting education to fill the technical skills gaps that the industry faces. On the other side of these gaps are the efficiencies gained in productivity. These issues create anxiety for many in the labor force; however, focus should be on where to direct and train labor for the new industries these technologies create. Fear and resistance is not a solution.

6.4 Workforce

Successful infrastructure begins with the people that sustain it. Public and private sector professionals are faced with skill shortages, talent acquisition, gender disparity, integrating project teams and developing strategies to develop the next generation of infrastructure professionals. The dialogue during the roundtable discussions centered on efforts within the industry to be more attractive to talent, how to target younger professionals and opportunities for backfilling specialized skillsets that either leave the workforce or result from advances in technology.

Quick strategies for workforce wins

- Conduct P3 fundamentals courses to promote awareness and a consistent messaging strategy.
- Adopt a mentor program and invite young staff to industry network events.
- Build cross-discipline collaboration networks to integrate learning and knowledge management.
- Expose staff to new opportunities through internal departmental networks.
- Develop consistent recognition programs to highlight the innovators and problem solvers.
- Formalize an outreach strategy to promote education and career opportunities.

Outreach and selling the industry

There are growing efforts to improve job descriptions, professional titles and increase outreach to help promote the industry's image. Representations of the industry need to be updated to convey the variety of duties and skills that are required across various roles from surveyors and construction managers to the engineers and data scientists that continue to see job growth in the sector. There is also a huge talent pool of women not being exposed to the opportunities and diverse career paths within the industry. The value and attractiveness of the career opportunities can be enhanced by highlighting the policy, procurement or the complexities of packaging projects. Managing these issues will help fill skills gaps by broadening the pool of sources of talent, but they will not fill the gaps entirely.

Education

Actions are underway to engage institutions of learning to help them integrate disciplines from the industry while opening opportunities to engage students early to create awareness about infrastructure and asset management careers. The responsibility falls to industry organizations to conduct outreach to colleges and trade schools to help develop the curriculum across the sectors and disciplines in need of new talent.

7.0 Confidence through professional standards

RICS works for the benefit of the public good. As a result, it is important that we continue to work on market confidence, consistency worldwide and building trust across the infrastructure management community. In order to achieve this, we follow a four-step approach, focused on effective mitigating and monitoring of risks for our members (and their employers), members' clients and RICS.

RICS four-step approach

1. Codevelopment of international standards

In close cooperation with other national and international (non-profit) organizations RICS sets standards for the land, property and construction sectors worldwide. The rationale behind setting international standards is that it will create more transparency and consistency and therefore contributes to increased market confidence and trust.

2. Guidance, education and training

International standards are very high-level and strategic. Therefore, to be successful, it is crucial to have clear guidance in place, as well as the opportunity for people to be educated and trained in the usage of international standards and the impact they have on business.

3. Accreditation

Quality assurance can only exist if there is a thorough process in place that mandates people to meet standards of entry and guarantees that people meet professional and ethical development needs over the lifetime of their professional career.

4. Regulation

RICS has the ability to independently quality assure and regulate RICS-qualified professionals working to international standards and RICS professional statements. This independent function allows stakeholders and the public to place greater confidence in services provided in infrastructure management across the lifecycle of the asset.

Three Lines of Defense

Stakeholders expect a solid risk management framework when it comes to safeguarding standards, competencies and ethical behavior. The Three Lines of Defense model provides a simple and effective way to enhance communications on risk management and control by clarifying roles and duties.

First line – meeting standards and commitments of entry

In order to become a member of RICS, people have to undergo an assessment. This assessment centers around their work experience, three case studies and knowledge about RICS ethics and standards. Preparation takes three to six months under guidance of a mandatory counsellor. As soon as candidates become a member they have to comply with the ethics and professional standards referred to above.

Second line – CPD compliance

Each member must agree to commit to continuing professional development (CPD) in order to maintain their professional skills and competencies. As a result, they need to follow at least 20 hours of CPD per annum and record them in the CPD online portal. If members do not comply, sanctions follow, varying from a caution to a fine and to publication of their name on RICS' website and relevant professional magazines.

Third line – active regulation

A proactive, robust monitoring system, aimed at educating members and raising standards in the market, reducing successful claims, ensuring confidence in and improving the image of the profession.

RICS as an organization will continue to increase its engagement with the infrastructure management community by engaging leaders through collaboration towards solving some of the biggest challenges on the road ahead.

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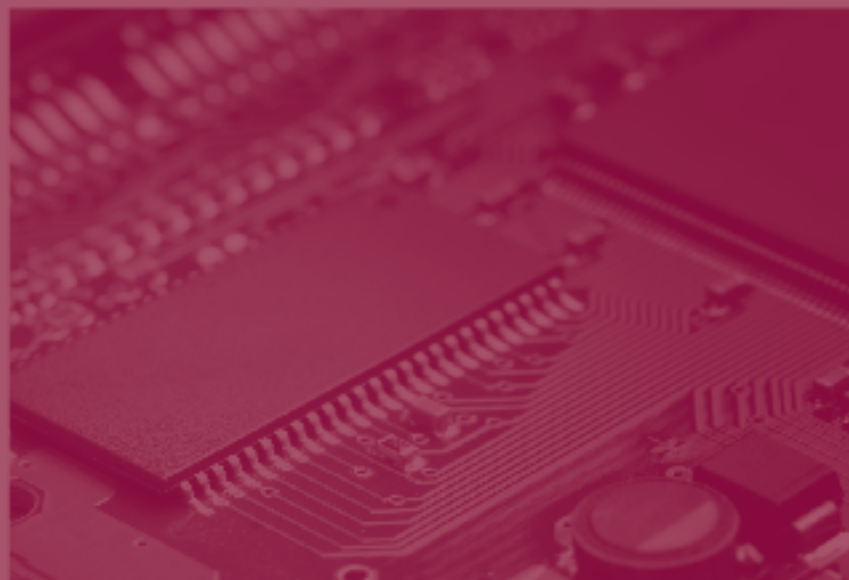
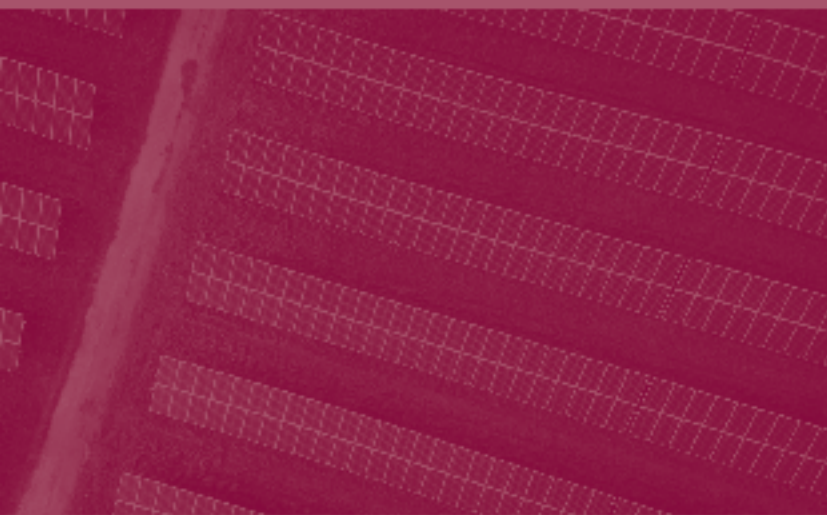
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Confidence through professional standards

RICS promotes and enforces the highest professional qualifications and standards in the development and management of land, real estate, construction and infrastructure. Our name promises the consistent delivery of standards – bringing confidence to the markets we serve.

We accredit 125,000 professionals and any individual or firm registered with RICS is subject to our quality assurance. Their expertise covers property, asset valuation and real estate management; the costing and leadership of construction projects; the development of infrastructure; and the management of natural resources, such as mining, farms and woodland. From environmental assessments and building controls to negotiating land rights in an emerging economy; if our professionals are involved the same standards and ethics apply.

We believe that standards underpin effective markets. With up to seventy per cent of the world's wealth bound up in land and real estate, our sector is vital to economic development, helping to support stable, sustainable investment and growth around the globe.

With offices covering the major political and financial centres of the world, our market presence means we are ideally placed to influence policy and embed professional standards. We work at a cross-governmental level, delivering international standards that will support a safe and vibrant marketplace in land, real estate, construction and infrastructure, for the benefit of all.

We are proud of our reputation and we guard it fiercely, so clients who work with an RICS professional can have confidence in the quality and ethics of the services they receive.

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