

Infrastructure: Doing More with Less

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Adequate urban infrastructure can be expensive, but the costs of not delivering housing, transportation, water, sewage, public facilities, and other necessities are also high. Inadequate infrastructure slows and even reverses economic growth, driving unemployment, crime, and urban decay. It can fuel urban tensions by widening divisions among ethnic or income groups or between long-time residents and recent immigrants. And it can foster a general malaise that drains a city's vitality and spirit.

What are the benefits of delivering infrastructure? One study in Africa showed that the return on investment for infrastructure was about 50 percent, based on contributions to GDP, and that if investments were optimized, the return would be closer to 150 percent. This value is delivered through increased productivity and job creation, among other channels. Social benefits from improved public services and living standards are also substantial.

All too often, funding shortfalls are cited for failures in delivering the needed infrastructure. But our experience and research around the world has shown that performance gaps in governance, institutions, processes, and capabilities are just as damaging. In addition, a systematic approach to key questions, such as whether existing infrastructure is being used effectively and whether new infrastructure can be delivered more efficiently, can compensate for much of the perceived funding shortfall.

Without a doubt, financial gaps are a concern. In an era of tighter lending practices and austerity at all levels of government, public officials find it more difficult and, in some cases, more expensive to meet the needs of their constituents. The McKinsey Global Institute (MGI), the business and economic research arm of McKinsey & Company, estimates that the annual physical capital investment needed in cities globally will double from about \$10 trillion today to more than \$20 trillion by 2025. The bulk of this need will be in cities in emerging economies. The 440 or so emerging market cities with the most dynamic economies, for example, will need an estimated 44,000 square kilometers in new commercial and residential floor space by 2025. They will also need to invest an estimated \$190 billion to meet demand for container port capacity and about \$200 billion for water supply and wastewater treatment systems.

In emerging markets, inadequate infrastructure can be a substantial barrier to growth. In Latin America, where urbanization is progressing rapidly, many of the largest cities emerged from the 1980s debt crisis to establish solid fiscal positions. But infrastructure spending failed to keep up with growing needs. As a result, inadequate housing, urban planning, and transportation networks became obstacles to growth. For the past two decades, economic growth rates for most of the region's 10 largest cities have been below the national growth rate.

Not a luxury, adequate infrastructure is a necessity for growth and many other municipal economic and social objectives. Adequate infrastructure reduces costs, supports economic activity, increases factor productivity in cities, and connects cities to domestic and international markets. It also creates jobs directly in construction and maintenance and indirectly by boosting

economic activity generally. And it underpins social development and sustainability by increasing intra- and interregional trade and improving relationships, providing health, education, and housing, encouraging environmentally sound practices, such as switching from road to rail, and offering many other benefits.

But funding is not the only obstacle to adequate infrastructure in the world's growing cities. Funding committed to building infrastructure in Africa from all sources rose from \$38.9 billion in 2009 to \$55.9 billion in 2010, but over the same years the share of these funds actually dispersed dropped from 48 percent to 38 percent. Altogether in both years, about \$55 billion was available for needed projects—but not used. Investors cited difficulty in identifying appropriate projects and shortages of technical capacity and other skills within governments among the reasons.

Quite simply, with the staggering demand for infrastructure in emerging economies, officials will need to continue gathering as much funding as possible to meet their needs. They must also become smarter about how they approach infrastructure development. Some cities around the world have found ways to ensure that finite funding delivers the greatest possible impact.

Whether creating new systems or upgrading existing capacity, urban leaders have considered four fundamental questions often overlooked in infrastructure development planning:

- Are we building the right infrastructure?
- Are we using existing infrastructure most effectively?
- How can we deliver infrastructure more efficiently?
- How can we benefit from working with private partners?

Finding the right answers to these questions will help urban leaders meet their growing infrastructure needs more effectively, more efficiently, and more quickly. Ignoring these questions can lead to costly and wasteful mistakes. For example, during Japan's "lost decade," the 1990s, the country overbuilt infrastructure with no clear strategy, squandering billions of dollars with little impact. In one instance, 17 bridges were built for three expressways to connect the main island of Japan to Shikoku, an island with about 3 percent of the country's population. The costs reached \$29 billion.

By improving governance systems, institutions, processes, and internal capabilities, urban leaders can build reliable infrastructure for their populations and squeeze more value from their expenditures. They rarely have the time or expertise to evaluate the details of individual projects. Judging, for example, the effectiveness of a sewer system, the thoroughness of a bridge-building contract, or the estimates included in a transportation plan are usually beyond their abilities. But urban leaders can create the right set of governance structures, credible institutions, and robust processes—and develop local capabilities. By doing so, they can go far to compensate for funding shortfalls and move their infrastructure systems forward.

The rest of this paper looks closer at the infrastructure needs of cities in emerging markets, based on the most recent MGI analysis. Next, it offers practical suggestions on how to answer fundamental questions facing any government trying to get the greatest impact from limited infrastructure funds. And before concluding, it examines how cities worldwide have improved governance, institutions, processes, and capabilities to help close the infrastructure funding gap.

Patterns of urban growth

By 2025, the physical capital investment in the world's cities is expected to have doubled, from about \$10 trillion today to more than \$20 trillion. This growth includes expenditures on buildings, infrastructure, machinery, and other equipment. The bulk of the new capacity is expected to be built in emerging market cities.

This surge in urban development, particularly in emerging countries, can be a mixed blessing. Densely populated urban areas tend to use resources more productively than rural areas or more sparsely settled cities. Bus systems enjoy heavier ridership, for instance, and rail becomes a reasonable option. Water and sewage systems serve more people per kilometer of pipeline and canal. But rapid urbanization also puts a heavy strain on global natural and capital resources, and unless infrastructure keeps pace with growth, many of the potential benefits of urbanization—economic, environmental, and social—could be reduced.

The June 2012 MGI report on global urbanization, *Urban World: Cities and the Rise of the Consuming Class*, looked closely at three areas of infrastructure need in developed and developing cities: demand for commercial and residential floor space, municipal water systems, and container port capacity. These areas were chosen because of their diversity and because credible data were readily available at the municipal level. That allowed us to examine historical patterns and to estimate future demand—and to offer an illustrative overview of infrastructure demands triggered by rapid urbanization.

We paid particular attention to a group we call the Emerging 440, which comprises the 443 cities in emerging markets included in the world's top 600 in expected contribution to global GDP growth to 2025. The Emerging 440 will be a powerful force in the global economy. They will likely account for almost half the world's economic growth over 2010–25, and more than 600 million people in these cities will gain access to discretionary spending and join the consumer class.

Among the Emerging 440, 20 are megacities (populations of more than 10 million), while the remainder have populations of at least 200,000. And though 57 countries are represented in the Emerging 440, more than half the cities are in China, underscoring the country's predominance in this era of rapid urbanization.

As would be expected, patterns of estimated demand differed sharply. Global demand for container port capacity should show the most significant growth, driven by the sharp rise in the

global consumer class. Most of the world's consumer products, as well as intermediate manufacturing goods, are shipped in containers, and we expect demand for container capacity to grow at a compound annual rate of 7.2 percent over 2010–25, much faster than the 4.4 percent compound annual GDP growth estimated for cities during this period. Meeting this demand would almost triple today's capacity at global container terminals.

Demand for commercial and residential space and municipal water is also expected to grow significantly, if more slowly than global GDP. Many cities have already begun massive building programs to meet the growing needs, and these efforts are likely to continue as cities accommodate projected growth. Over 2010–25, cities around the world will need to build more than 80,000 square kilometers of commercial and residential floor space, including replacement space. At a compound annual growth rate of 3.8 percent, available urban floor space will expand by more than 40 percent during this period.

Of the three infrastructure components examined closely, demand for municipal water is expected to show the slowest growth over the next decade or so, but it will still outpace population growth almost twofold. We expect demand for urban water to rise at a compound annual growth rate of 1.8 percent over 2010–25, compared with 1.0 percent for population growth. The difference is partly a result of a trend toward smaller households. The number of urban households is estimated to grow at a compound annual rate of 1.7 percent, well above the population growth rate.

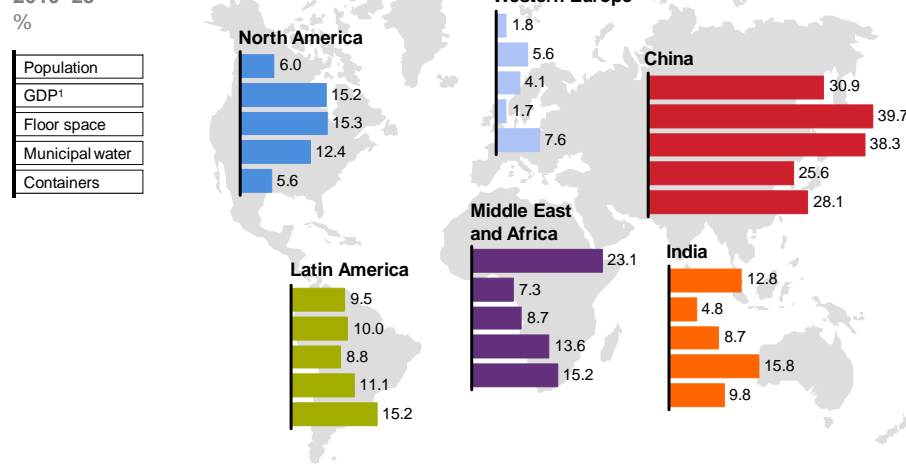
We also found significant differences between cities in developed and developing countries (figure 1). Following current trends, about 60 percent of the growth in these three categories will come from cities in emerging markets. And with the majority of the Emerging 440 in China, it comes as little surprise that a large portion of the growth across all categories will be centered there. China alone is expected to account for 38 percent of the global growth in demand for commercial and residential floor space, 28 percent for container port capacity, and 27 percent for municipal water.

Figure 1. All regions contribute to growth in urban demand, but China's share is highest in key categories

Contribution to urban growth, 2010–25 (percent)

All regions contribute to growth in urban demand, but China's share is highest in key categories

Contribution to urban growth, 2010–25



¹ GDP measured at expected real exchange rate.

NOTE: Other developed and emerging regions account for 16.0, 17.4, 16.0, 19.8, and 18.6 percent of growth in population, GDP, floor space, municipal water, and container-demand growth, respectively; Floor space growth includes replacement floors.

SOURCE: McKinsey Global Institute Cityscope 2.0

Source: McKinsey Global Institute Cityscope 2.0.

Note: Other developed and emerging regions account for 16.0 percent of growth in population, 17.4 percent of growth in GDP, 16.0 percent of growth in demand for floor space, 19.8 percent of growth in demand for municipal water, and 18.6 percent of growth in demand for containers. Growth in demand for floor space includes replacement floors.

a. GDP measured at expected real exchange rate.

Other regions—India, Latin America, and the Middle East and Africa—will also account for a significant portion of this new demand. India and the Middle East and Africa, for example, will each account for a greater share of the new global demand for municipal water than North America, with Latin America not far behind. Each of these three emerging regions will need two to three times more new container port capacity than North America over 2010–25. Only for floor space will the demand in North America be greater than that individually in India, Latin America, and the Middle East.

Population, income growth behind demand for floor space

Demand for floor space in cities will soar in the coming years, with three-quarters likely to arise in the Emerging 440. Of the 80,000 square kilometers of floor space needed, we estimate that 77 percent must be built in developing countries, primarily for residential use, and China—with about 40 percent of total demand—will be the center of activity. Our estimates comprise new

construction, representing about 60 percent of the demand, and replacement floor space. The cumulative cost to meet this need through 2025 is about \$80 trillion.

Residential construction will make up roughly three-quarters of this demand, and the focus will be in developing countries. Already, a little more than half the world's residential floor space is in developing countries, and that proportion should increase significantly as new demand is met. Our study suggests that the increase in demand will equal about 90 percent of current stock. This estimate comprises new construction and replacement space needed to compensate for deteriorating buildings.

A critical factor in this growing demand is the rising number of households, especially in developing countries. Because average household size is shrinking in most emerging markets, the number of households is growing faster than the population. Demographics and behavioral shifts are the main reasons behind this trend. In some areas, young adults are moving alone to the cities, while in others the population is aging, and seniors tend to live in smaller households. In addition, the demand for floor space by individual households rises with incomes, and GDP per capita is growing fastest in developing countries.

About 80 percent of the global demand for new or replacement housing over 2010–25 will occur in emerging cities. China and South Asia together will likely account for about 60 percent of the demand, or 34,000 square kilometers.

The brunt of available commercial space will remain in developed markets, which today account for about two-thirds of global commercial floor space. Demand for services, a primary user of commercial space, is greatest at the highest incomes. But even in commercial space, demand for new and replacement construction will be highest in emerging markets. About 60 percent of the demand for new space will be in cities in developing countries, led again by China. China will need about 5,700 square kilometers of new commercial space over 2010–25, or 30 percent of total new demand. Demand in China will be just higher than that in North America, whose need is an estimated 5,200 square kilometers in the coming years.

All told, about \$35 trillion of investment will be needed to satisfy demand for residential and commercial floor space in cities in emerging markets, with China alone needing \$25 trillion.

Ports, water illustrate need for a range of improvements

Beyond residential and commercial floor space, cities will need to invest in a broad range of infrastructure projects to meet growing demand. From basic services such as water supply and wastewater treatment to the basics of growing economies such as transportation and communication networks, urban centers in developing countries will account for the vast majority of this demand.

For example, the number of cars in use globally is expected to double to about 1.7 billion by 2030. By far, most of this new traffic will be in developing countries. Modern road networks will

need to be built or improved to accommodate this massive fleet, even as urban density encourages a switch from cars to metro rail. Another estimate suggests that air traffic will increase 5 percent annually over 2010–25. The demand for new terminals will focus on cities in developing countries, which will see expanding passenger and cargo traffic as their economies and incomes continue to grow. China, for example, is expected to build about 100 civil airports over the next decade. Information technology networks, including connections to broadband, and electricity supplies are among the other areas likely to see significant growth pressure.

Our study focused on water supply and wastewater treatment and on container port capacity as two aspects of infrastructure development that illustrate the overall expected demand in diverse areas. The two areas were also selected because some data were available at the municipal level, allowing more accurate analysis.

About \$480 billion in urban infrastructure investment will be needed globally by 2025 to finance growing demands for water supply and wastewater treatment. A potable water supply is the most basic responsibility of cities to their residents. Water supply is so fundamental to a developing country's needs that it is included in the United Nations' Millennium Development Goals, a blueprint for fighting poverty and improving health standards. Indeed, cities in developing countries will account for more than 80 percent of the growth in overall water services.

Global demand for urban water supply should increase from about 190 billion cubic meters annually to about 270 billion. Growing urban populations and increasing incomes trigger a parallel rise in the demand for water. Of the 80-billion-cubic-meter increase, the Emerging 440 will account for about 67 billion, or more than 80 percent. The imbalance is largely because cities in developed markets have near-universal water availability, and their needed investments will focus primarily on system improvements and organic demand increases. In Sub-Saharan Africa, water and sanitation accounts for almost 25 percent of overall annual infrastructure investment need.

While cities in emerging markets will focus largely on meeting water supply needs, they will also face significant demand for improved wastewater treatment. Water supply investment in the Emerging 440 will represent about 80 percent of water infrastructure spending through 2025, with wastewater treatment accounting for the remaining 20 percent, while the split will be more even in cities in developed countries. Altogether, demand for increased wastewater treatment facilities will grow about 18 billion cubic meters in the Emerging 440, spread fairly evenly across regions.

Container port capacity illustrates the growing demand for higher level infrastructure in cities in developing countries. A sharp rise in the number of households with discretionary income has lifted hundreds of millions of people into the consumer class, and because about 90 percent of consumer goods are shipped by ocean-going containers, demand for port capacity will increase

in turn. Growth will also be pushed by increased demand for manufacturing inputs, which also are generally shipped in containers.

Global container traffic—incoming and outgoing—will grow more than 2.5 times over 2010–25, the equivalent of 24 new ports the size of Shanghai’s facilities, the largest in the world today. More than 90 percent of this new capacity will be needed in cities in emerging markets. Investment to develop these facilities would amount to more than \$200 billion during this period, with China alone accounting for about 30 percent.

Along with the investment in physical assets, improvements will also be needed in port superstructure, intermodal systems, equipment, and information technology systems. And many existing facilities will need to be upgraded or replaced.

Significant pressure on natural, capital resources

The factors behind rapid urbanization present significant challenges to better managing natural and capital resources. Rising incomes and increased consumption are putting pressure on these resources, including those once considered abundant and unthreatened.

The market stimulus brought by infrastructure projects worldwide will inject needed energy into the global economy, especially if augmented by the resulting growth in consumer spending in emerging markets. Beyond the immediate stimulus, these projects accelerate economic growth and in many ways represent deferred consumer spending. Roads are built with the expectation that consumers, among others, will travel them. Apartments will need to be furnished and filled with appliances.

At the same time, the growing demands of an expanding consumer class will add considerable strain to global natural and capital resources, already stretched thin. The challenges facing municipal leaders in the Emerging 440 will be unlike those faced in cities that matured during the Industrial Age, when natural resources were fairly abundant. Fortunately, new technology and ideas can help cities in developing countries meet these challenges using attractive and efficient solutions to deliver modern infrastructure to their residents.

The surge in demand for natural resources signaled by the expected growth in the consumer class coincides with growing scarcities. Local shortages of resources once taken for granted, such as fresh water, are becoming more common in both developed and developing countries. Prices have risen dramatically since 2000, and, with markets increasingly interlinked, a surprise in one can send shockwaves through others. Throughout the 20th century, prices of basic resources—energy, materials, food, and water—trended down, falling on average about 0.7 percent a year and supporting global economic growth. Amazingly, the gains of those 100 years were wiped out by the unprecedented price increases of the past decade. Despite recent easing of some prices, volatility will likely continue.

Because of higher incomes in cities, per capita consumption of energy and other resources tends to grow faster in cities than in overall country populations. But the concentrated populations in urban centers also have efficiencies that conserve resources and enable technology-related options. For countries in the Organisation for Economic Co-operation and Development, urbanites travel 20–30 percent less than suburbanites, substantially reducing emissions and the demand for fuel. Urban environments allow technology-driven solutions that save energy, such as variable pricing for parking and congested areas, which reduce vehicle use. Urban density also enables public transportation options, which create further savings. And because urbanites live in smaller homes, they consume 20–30 percent less energy than suburbanites.

Indeed, some cities may find that by allowing higher densities they may avoid pressure for costly road improvements that ease greater use of private cars, bringing in turn increased fuel consumption and pollution. The savings can be used to expand urban rail systems, which higher densities also support. Such tradeoffs can be made only at the city level, where officials can more closely compare economic costs and benefits, as well as the likely impacts on economic development, society, and the environment.

MGI research has shown that cities can slow the growth in energy demand by half and cut 20 percent from their projected energy needs by 2020 by employing current energy-efficient technologies effectively. These systems can quickly pay for themselves through energy savings that would benefit urban households and businesses. Deployed correctly, these solutions can cut the investment for energy-supply infrastructure and reduce public and private energy costs for decades.

One study has shown that by 2030 greater energy efficiency in buildings—better insulation, modern lighting, and other measures—could reduce global energy demand by 31 quadrillion British thermal units, 20 percent greater than the energy used now by shipping and air transport combined. Improved energy efficiency in residential and commercial buildings could contribute about a fifth of the \$2.9 trillion in potential savings identified from more productive use of natural resources, with the majority captured by cities.

Similarly, demand for capital resources has been growing over the past decade, and needs have been exacerbated by the aftermath of the 2008/09 global economic and financial crisis, which left capital scarce. Before the crisis, global investment rates rose from 20.8 percent of global GDP in 2002 to 23.7 percent in 2008, boosted in part by growth in urban capital needs. Despite a sharp drop in 2009, MGI analysis suggests that investment rates should rise again, reaching about 25 percent of global GDP by 2025, with urban infrastructure needs fueling some of the growth.

When the global recovery takes root, the increased demand for capital will likely lead to higher capital costs. This should further compel cities in developing countries to use available funds as effectively as possible, channeling them to the most productive projects. Countries can also

contribute to the effort by implementing policies that create deep and stable domestic financial markets. Such measures could, for instance, work to gather national savings and direct them toward rational investments. McKinsey estimates that globally 2.6 billion adults do not have a bank account, and, especially in emerging markets, financial institutions serve only a small portion the national market.

The most recent MGI research has underscored the growing demand for infrastructure development and improvements in cities around the world, particularly in developing countries. Failure to meet these needs could dampen urban economic growth and contribute to an array of other problems. Financing infrastructure development will always be a priority for municipal officials, and whether starting from scratch or improving existing assets, more value can be squeezed from available resources by carefully considering the four crucial questions on each project.

Optimizing existing and new infrastructure

Infrastructure funding is finite, but value for money may not be. By optimizing value, officials can create greater capacity from their projects and deliver greater benefits to their constituents. Before beginning a project, government leaders should ask themselves four questions:

- Are we building the right infrastructure?
- Are we using existing infrastructure most effectively?
- How can we deliver infrastructure more efficiently?
- How can we benefit from working with private partners?

Spending time to gather fact-based answers to these questions, rather than relying on gut instinct or popular opinion, can help municipal officials deliver the greatest benefits from finite resources. With a less vigorous approach, officials may be tempted to overbuild infrastructure, wasting money and other resources on projects with more capacity than needed under reasonable predictions, erecting showcase pieces as political status symbols, or building redundant assets in the absence of interagency coordination. Underbuilding can also be a problem, perhaps associated with a lack of transparency and corruption. An open, systematic approach to infrastructure investment can mitigate these problems.

In many cases, cities can cut 40–50 percent from infrastructure costs by exploring these questions vigorously, freeing funds for further improvements. Asking them can help avoid unnecessary projects that offer benefits to few compared with their cost and that deliver only marginal gains compared with other infrastructure options.

By systematically considering these questions when drawing up infrastructure programs, governments can produce substantial returns on their investments. Well-delivered infrastructure can produce returns on investment of up to 50 percent, measured as GDP gains against cost, and when optimized the return is much higher. We have often seen that in developing countries cities

enjoy GDP per capita as much as six times higher than that of rural areas. Quality infrastructure is a primary factor behind the difference.

Building the right infrastructure

When making infrastructure decisions, government officials are often bombarded from all sides. They face piles of information on the technical minutiae of a project and competing—and occasionally petty—political factors. Projects can be windfalls for landowners and contractors, and lobbyists are quick to promote their views of a project’s importance. At the same time, city planners can deliver reports totaling hundreds of pages covering, for instance, traffic forecasts, financial and risk analyses, technical specifications, estimated environmental impacts, and potential social and economic impacts—all supported by arcane calculations beyond the understanding of most nonexperts.

Fact-based decisions are difficult when faced with a flood of unfiltered data and opinion. But municipal officials in many developing countries have found solutions that allow them to focus efforts and resources on the right infrastructure for their situation, projects whose benefits are appropriate to their costs and that contribute to clear economic or social objectives. They have done this by embedding infrastructure development into their broader social and economic development strategy, creating portfolios of infrastructure options, and evaluating the options rigorously and objectively.

Cities can segregate and categorize the information from their portfolio of options to get a clearer view of the true costs and benefits of major projects and make better decisions. In a Middle East city, we helped officials rank their infrastructure needs by looking at nine core aspects of each project, which covered about 90 percent of the task. The examination covered the financial health, economic impact, social welfare, and strategic fit of proposed infrastructure investments. For example, it asked what contributions to GDP were expected from the investment and what fundamental needs were addressed. The tool was so easy to use that it could be installed on tablet computers, giving officials online access to the analysis, even during cabinet meetings.

Such tools cannot offer a “correct” answer to whether a project should be approved. Beyond the data analyzed, subjective considerations are always relevant. While stretching water or electric services to the areas of a city that are hardest to reach may cost more per household, health and other benefits could easily outweigh the costs. Such tools offer analyses consistent across projects and allow officials to set priorities more effectively. Projects that rank high are given a boost, and if projects that rank lower are approved, the tradeoffs needed are more transparent.

In the Middle East effort, officials were struggling to rank numerous infrastructure proposals in areas ranging from roads and bridges to power generation and from schools to hospitals. Weighing the benefits of a new road against those of a new hospital, for example, can seem like comparing apples and oranges. As is often the case, officials were presented with volumes of

data on projects and assumptions that were commonly unclear or inflated. For example, potential GDP impact would be double- or triple-counted across projects to create stronger business cases.

To clear the fog and help choose the right infrastructure investments for their city, officials reclassified the projects from more than 20 different asset classes to just 3: those with expected financial returns, such as hotels; those with economic returns, such as roads; and those with social returns, such as schools and hospitals. They looked at each project's financial health, economic health, social health, and contribution to the city's strategic objectives and standardized the assumptions and definitions across all project proposals. For example, impact on GDP was clearly delineated by such direct effects as employment gains and productivity improvements. The process was meant not to deliver the correct technical answer but to support a debate based on crucial facts that clarified the implications of competing investment decisions.

The results of the analysis gave officials comparisons that made it easier for them to make better decisions and move forward with the right infrastructure choices. A web-based tool provided officials with ready access to, for example, matrices that compared projects by their scores across various benefits, as well as key data on individual projects. The government also established an investment review unit to manage and maintain the transformation and build the necessary internal skills.

The Republic of Korea pursued an approach that systematically linked its infrastructure program to official social and economic development objectives. As part of the effort, the government established institutions that in 2005 became the Public and Private Infrastructure Management Center, which developed a standardized methodology and reviewed all major projects. The center has helped translate national economic and social objectives into a multiyear infrastructure program, saving an estimated \$60 billion in infrastructure costs.

Using existing infrastructure effectively

A robust infrastructure development program must also consider whether existing infrastructure is being used most effectively. Officials and planners often harbor biases toward new projects, which offer the chance to be creative, the challenge of building something from scratch, and the potential to deliver substantial improvements. By contrast, maintaining and improving operations for existing infrastructure is less captivating.

But getting more use and benefits from existing infrastructure is essential as city leaders seek to invest infrastructure funds more effectively. In transportation, for example, measures should be considered to steer residents from road to rail, to optimize urban planning to balance traffic flows, and to adjust fees and other restrictions to balance usage with social costs. London and Singapore, for instance, control private traffic in the city center to reduce congestion and encourage residents to use bus and rail systems.

Windhoek, Namibia's capital, has an exceedingly dry climate, and demand for water increased about 7 percent a year over 1992–99. To meet this challenge, city officials focused on a rehabilitation program that featured a variety of measures. They emphasized repairs to the current system, established regular leakage-detection procedures and water audits to identify inefficiencies, and increased use of underground storage capacity, an alternative to dam storage (where evaporation losses were high). In addition, they promoted the use of greywater and semitreated water for industrial and agricultural purposes and brought usage fees closer to the true costs of collection and distribution. And they launched a community education program that included training local plumbers and gardeners how to use water efficiently. The result: a 40 percent reduction in the city's water consumption per capita, accommodating significant urban growth and extending the city's projected "run dry" date by six years.

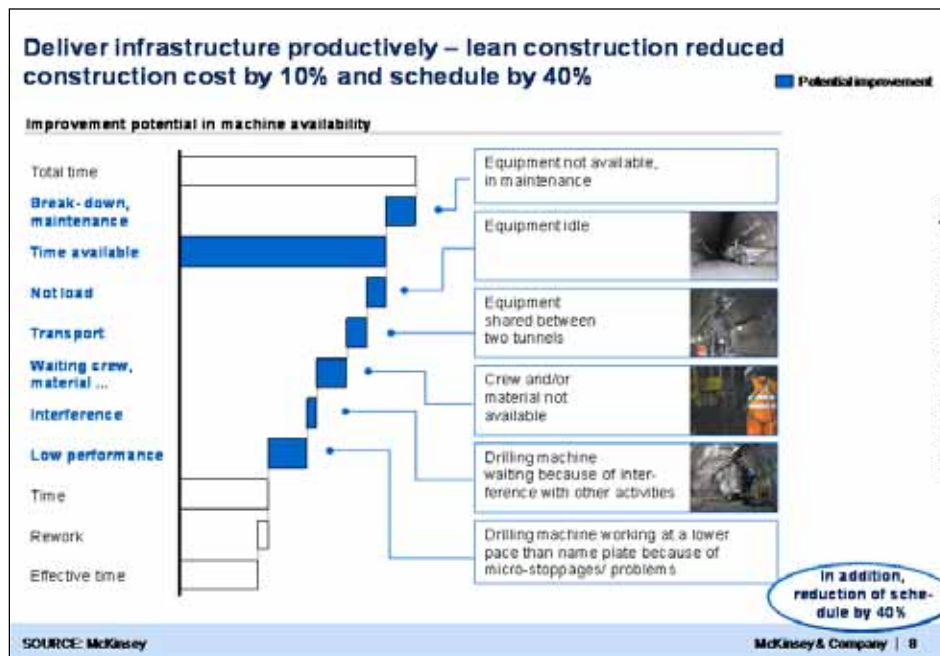
In an example from a developed country, California launched an electricity demand management program in response to the 1973–74 oil shock, which more than quadrupled global oil prices. Measures included adjusting electricity prices based on consumption, regulating efficiency standards for appliances, and introducing a slate of programs to promote energy efficiency. The efforts were a success, and the state's 2010 consumption per capita was about 40 percent below the national average, having been steady for more than three decades.

Delivering infrastructure efficiently

Delivering infrastructure more efficiently must focus on improving productivity in construction. For most major infrastructure projects, construction costs represent a substantial portion of investment. Yet globally, unlike almost every other commercial sector, the construction industry has shown no substantial productivity improvements in recent decades, and in some markets, such as the United States, productivity has declined. Occasional improvements in the industry have been the result of new materials rather than significant changes in operations.

A look at the drilling operations in a tunnel project illustrates the problem (figure 2). Among the problems were work delays because of a series of minor stoppages, crew or materials that were not available when needed, equipment that was not available because of maintenance, and equipment that was simply idle. Many industries have adopted lean manufacturing approaches to their needs, and the construction sector would be wise to do the same. Lean emphasizes eliminating as much waste as possible in a process, say by shuffling the sequence of work, scheduling maintenance in a way that does not slow the process, and ensuring that equipment is used to full capacity. We estimate that introducing lean practices at the drilling operation could cut completion times 40 percent and costs 10 percent.

Figure 2. Deliver infrastructure productively—lean construction reduced construction costs 10 percent and completion times 40 percent



Source: McKinsey.

As large consumers of construction services, governments—and ultimately taxpayers—are paying a heavy price for these continuing inefficiencies. Cities have substantial market power and can encourage their contractors to address the waste in their operations. Among the measures they can use are contractual terms that oblige companies to work with officials to streamline project delivery, initiatives to explore new sources of materials and other resources (from low-cost countries, for instance), and programs to introduce lean construction in all projects. McKinsey estimates that an average productivity increase of about 30 percent is possible in the medium term if these or similar measures are followed.

Lean principles helped the Swedish Transport Administration cut production costs in its construction program 10–15 percent and increase productivity 2–3 percent a year. Lean measures, such as parallel activities during construction and ample support to allow pavers to operate efficiently, were estimated to save as much as 40 percent of work time, depending on the operation. Careful planning allowed the administration to reduce the need for earth to be excavated and hauled, as well as the need for hot mix for road surfacing. Increasing the slope slightly in some sections of roadway reduced the need for excavation and asphalt surfacing almost 18 percent, with no expected impact on traffic or safety. Using prefabricated elements and sourcing from low-cost countries were other elements of their program.

Getting value from public-private partnerships

Public-private partnerships (PPPs) have become a growing trend in infrastructure development across the world. The potential of using private investment to supplement public funding is very

attractive. It is also risky, as governments and operators witnessed with the Eurotunnel between France and the United Kingdom, Melbourne's CityLink toll road, and many other projects in both developed and developing countries. Business plans are easily undermined by hostile political pressure, overly optimistic traffic estimates, and even competing infrastructure projects. And when a PPP goes wrong, it leaves a trail of litigation and, more often than not, the public picking up the tab.

Despite the risks, however, PPPs can be a valuable part of a city's infrastructure development program. Private companies can bring many advantages to the partnership, including a clearer sense of the sturdiness of the business plan and experience squeezing costs out of capital projects and operations. Governments with little experience working with private partners should begin with smaller projects, such as design-and-build contracts, before attempting more elaborate, revenue-generating programs. Countries like Canada, with very successful PPP programs, have built their achievements on decades of experience.

Our work and research has shown that four factors can contribute to the success of PPPs:

- *Consolidated organization.* Many cities have combined all their PPP projects into a single unit, rather than leaving them under the control of various agencies. Centralization allows consistent processes that can lower transaction costs and builds experience and expertise within the PPP unit. Once a department approves a PPP project, it hands over responsibility to the PPP unit.
- *Critical mass.* Cities have also driven PPP programs effectively by creating pipelines of similar projects. By focusing efforts on, say, road maintenance or power generation, the city builds a critical mass that can lower overall costs. One-off projects are generally more expensive than a collection of projects that can spread start-up costs among different efforts and gain economies of scale.
- *Defined process.* A clearly defined process also contributes to the chances of success. Cities and their private partners write detailed process descriptions that include explicit milestones, documentation requirements, and transparent contractual terms. This effort builds capabilities and experience within city agencies and creates trust with the private partners.
- *Start slow.* Cities should also expect to move slowly up the learning curve. Initial PPP projects should follow reasonably simple business models that are easy to evaluate, monitor, and administer. As city administrators gain experience, they can pursue partnerships with more complicated structures and more sophisticated risk allocation mechanisms.

Successful PPP projects can deliver extensive value to all sides of the partnership. Over 1993–2001, Chile awarded 21 toll-road concessions to private partners totaling about \$5 billion. Starting with the simplest projects first, the country eventually improved more than 2,000 kilometers of highway, including urban routes ringing the capital of Santiago, which were

tendered later in the program. Fees for driving on the Santiago ring are based on time of day, to manage congestion and electronic payment systems and ease entry and exit from the network.

One estimate suggests that the government has captured about \$150 million in revenues from the PPP system, while only one concession partner has filed a claim under the system's minimum-use guarantees. In addition, one study of road users and local and national leaders gave the system a score of 6 on a 7-point scale. Following the success of the toll-road projects, the country expanded its PPP program to include prisons, hospitals, public buildings, and public transport infrastructure.

Opportunities to close the infrastructure gap

Addressing the four crucial questions will help officials craft an infrastructure program that better meets the needs of their community with the money available. To create even more value, officials must review the structure and character behind the delivery system. In many cases, opportunities to stretch limited resources can be realized by improving governance, processes, institutions, and capabilities.

The gap between available funds and needed investment in infrastructure will not disappear, but beyond gathering the funds to finance infrastructure programs, municipalities must also improve how they govern their programs, create appropriate institutions to manage and maintain their infrastructure, implement the right processes to increase productivity, and build capabilities in public services. Together, these efforts can help compensate for perceived funding gaps and ensure that projects are planned appropriately, completed efficiently, and maintained and operated effectively.

Governance

City leaders have neither the time nor the expertise to micromanage projects or even judge the details of individual proposals made by agencies and ministries that own infrastructure assets. For most, it is beyond their capabilities to evaluate the quality of technical engineering specifications, review the rigor of environmental impact statements, challenge assumptions behind demand and usage estimates, or scrutinize the details of an engineering, procurement, or construction contract.

Infrastructure discussions often focus on outcomes once projects are completed. These postmortems either celebrate progress in economic and social development or lament cost overruns and delays that added years to the project's schedule. While interesting, such discussions alone do little to help cities build infrastructure better. Instead, leaders should explore the factors behind the achievements and failures and create the right conditions to make successes more likely.

One promising approach is to create independent institutions that oversee infrastructure investment and provide clarity and benchmarks on overall spending. The unit can help top

municipal officials match a city's infrastructure development program with its strategic objectives. By creating a governance structure staffed by experts with the appropriate skills, city leaders create conditions that increase the probability of successful infrastructure development. Credibility, trust, and competence are critical components of a working governance structure.

Some cities, for example, have an investment review unit. From our experience, such units can offer independent assessments of planned and ongoing infrastructure projects because they operate outside the structure of agencies or ministries that own and manage individual assets. They also report directly to political leaders and decision makers, allowing them to offer unfiltered analyses and conclusions.

Investment review units are commonly led by individuals with a keen understanding of infrastructure assets, an ability to discuss programs with a wide range of stakeholders, and the credibility to participate in high-level decision making. They are often supported by a small team comprising infrastructure specialists with expertise in specific asset classes, planners who can reconcile priorities with overall capital allocation concerns, and data analysts responsible for tools, databases, and other aspects of information technology support.

Along with improvements in institutional efficiency, better governance can increase the effectiveness of infrastructure programs. In South Africa, officials created a competition regulatory authority, particularly to govern practices in the construction sector. The agency focused on eliminating anticompetitive behavior and helped achieve substantial cost savings in new, large capital projects.

Institutions

Strong national and municipal institutions are the foundation of a successful infrastructure program. They build capabilities to support programs even as individual experts come and go from the administration. As projects begin contributing noticeable and cost-effective improvements to city living, they gain valuable credibility among constituents, contractors, private partners, political leaders, and other public bodies.

The Rwandan government established several administrative bodies, including the Ministry of Infrastructure, to rebuild infrastructure lost during its tragic civil war and to initiate new projects. The ministry, given the mandate to lead the national effort, had responsibility for implementing and coordinating the activities of other ministries and public agencies. It monitored quality and cost standards, launched programs to improve capabilities, and looked after the sustainability of the program, among other tasks.

The ministry's efforts contributed greatly to the country's stellar achievements, which included a 40 percent increase in electricity generation over 2008–11 and a more than twofold increase in the number of people with access to electricity over 2006–10. More than a third of the nation's road network was also brought up to acceptable conditions, including a large majority of district

roads. At the same time, GDP growth averaged 8.3 percent a year over 2005–10, compared with 4.3 percent just five years earlier.

Sweden witnessed similar successes after creating the Swedish Transport Administration in 2010. The measure merged the former road and rail administrations to save administrative costs, lower construction costs, and improve planning coordination among transportation networks—road, rail, sea, and air. Altogether, the 6,500 employees at the administration were charged with managing 100,000 kilometers of road and 12,000 kilometers of rail.

Despite constrained public finances, the administration had to cope with rail and road traffic growing 1–2 percent annually, significant congestion, and maintenance backlogs. To meet these challenges, the administration focused on better planning and coordination across all modes of transport, improved productivity in investments and maintenance, and increased operational and administrative efficiencies. As the new administration gained traction, it identified potential savings, for example, by reducing the excavation needed for roadbeds, increasing recycling and the reuse of switches, and optimizing and standardizing road surface material selection. More use of design-build contracts and greater internal capabilities are expected to allow 800 full-time consultants to be replaced by 400 in-house professionals, with financial savings to match.

Creating an effective institution to oversee Sweden’s transportation network also helped officials implement productivity programs throughout the administration. The administration has begun applying measures expected to reduce internal costs for administration, facilities, and information technology more than 20 percent. Potential savings in investments have been identified to reduce construction costs 10–15 percent. And more rigorous fact-based analysis is deciding whether to maintain or replace deteriorating assets and is presenting capacity-constraint forecasts and other vital information to government budget makers. With ambitious improvement targets, the administration is seeking to become much more effective—a catalyst for improving productivity in the Swedish construction sector.

Processes

Standardized processes are vital components of making infrastructure work harder. Uniform processes save time and allow economies of scale. They also make performance management easier by establishing clear metrics that can be compared across individuals, locations, and units. And the act of codifying these processes helps identify ways to save costs, time, and other resources. In addition, processes enable due consideration of a project, countering political pressure to move a project forward too quickly and potentially waste resources.

Faced with serious problems, Tanzania’s Dar es Salaam Port applied process improvements focusing on operational equipment effectiveness practices to turn around a deteriorating situation. At the outset of the project, the port, which handled incoming and outgoing goods for seven countries, was operating at just 85–90 percent capacity. Unnecessarily long container

clearances and ship turnaround times were causing the port to lose market share to others in the region.

Among the process improvements were computerized customs services, dedicated inland container depots, and extended operating hours. Combined with global standards for operational equipment effectiveness, these new processes helped the port increase its number of ships berthed by 40 percent and its container traffic by 16 percent. In addition, container clearance time was cut from 24 days to 8, and ship turnaround time from 19 days to 4. The project was estimated to have saved \$500 million in capital investments.

The decision-making process is another area where changes can speed projects and lower costs. Instead of initially focusing on specific expenses, such as construction costs, decision makers should discuss in more detail the business plan of the project proposal under consideration, looking at such aspects as who will benefit and how. If approved, the project could be revisited following a detailed feasibility study and, after completion, initial assumptions should be compared against outcomes to increase confidence going into future projects. Decision makers at this level should approve or disapprove project plans or business plans, as well as the overall budget, but they should not necessarily become involved in preapproving specific expenditures within the project, even large outlays.

Adjusting the process can accelerate decision making by allowing leaders to focus on the bigger picture without becoming stuck in details that they might not be able to handle properly. At the same time, offering incentives, increased responsibilities, and accountability to experts within the projects encourages them to use resources more productively and find ways to minimize costs without affecting quality.

Processes can be implemented fairly quickly, and once approved they can be in place within about two months. A “soft launch,” in which the new and old processes are run in parallel, can help isolate bugs that must be corrected and increase confidence in the new system.

Capabilities

Globally, most city administrations responsible for planning and managing infrastructure development are understaffed and lack the necessary expertise, especially in relation to the capital at risk and benchmarks in the private sector. As a result, budget overruns and missed deadlines are common, leading to increased frustration among city officials and residents. As pressure mounts to finish quickly, additional costs can be massive, especially in a project’s later stages.

Part of the solution is to build the capabilities of city staff handling infrastructure programs and to populate the administration with the right number of experts in various disciplines as quickly as budgets allow. Technical skills in such areas as project management, planning, design, maintenance, and operations are clearly necessary. Capability improvements are usually needed

at all phases of infrastructure programs, from project proposal through construction and into ongoing maintenance.

Our experience helping cities build their capabilities suggests that several areas can support more efficient and effective infrastructure programs:

- *Project and performance management.* Many cities, including London, New York, and Rio de Janeiro, have specific departments or offices with project management capabilities that are responsible for understanding the city's goals, working with various agencies to reach those goals, and presenting their findings to top city leaders. These cities and others are putting greater emphasis on performance management—for example, by attaching key performance indicators to their strategic objectives. In some cases, as in Rio de Janeiro, responsibilities for project and performance management are allocated to separate departments. Together, these capabilities allow city leaders to monitor progress clearly. The capabilities needed go beyond gathering data to include understanding the dynamics behind the metrics and interpreting whether goals are on track. The result: better informed decisions.
- *Information technology.* Some cities are elevating information technology to an integral part of their development strategy, not just as an enabler that supports initiatives managed by various departments. New York and Boston each have municipal chief information officers, who champion efforts to modernize their city's information technology systems and use social media, GIS, open source platforms, and other new technologies to help accomplish their city's objectives. This new approach requires investment in building internal capabilities but can unleash substantial returns in greater efficiencies. Traffic management systems, such as electronic road pricing and smart traffic lights that optimize vehicle flow, can dampen the pressure on road expansion and reduce travel time, emissions, and energy use.
- *Communication.* Cities are also building communications capabilities, often focusing on disseminating information to the public and within the administration more effectively. Hong Kong SAR, China; Paris; and Seoul have worked on improving how they visually present their ideas and plans. By making higher quality maps, three-dimensional virtual models, and physical scale models of their plans, they have encouraged better informed and more focused public debate and internal policy discussions. As a result, decisions can take less time, and misunderstandings can be avoided.
- *Predictive modeling.* As cities are under increasing pressure to justify investments and policy decisions, credible capabilities in predictive modeling have become more important. Infrastructure proposals are supported by a wide variety of estimates surrounding future events, such as population growth, transportation demand, and economic growth. Reliable modeling is an essential foundation for these estimates. While many cities rely on outside expertise for these services, some, including Chicago, New York, and Paris, have built significant internal capabilities in this area.

Capability building is often part of a program that introduces new tools and processes as well. In one example, a Middle East government was struggling to rank its infrastructure projects. Part of the problem was linked to internal capabilities. Project proposals and funding requests often included insufficient or poor quality data, especially on business plans and expected impacts. Public planners and analysts did not have the training or tools to provide the level and quality of information to make good decisions. As seen, part of the solution included developing a tool that automated some of the analysis and provided a fact base that helped officials rank potential investments. Tailored formats for inputting the necessary data on each project improved the quality of information, and a scoring engine within the tool created a fact-based comparison of investment options. In addition, staff members went to workshops and other activities to improve their personal capabilities.

South Africa also turned to capability building as part of a strategic performance improvement initiative centered on capital expenditures. A lack of skills among public servants planning and executing large capital projects was exacerbating capacity and capital shortages in the country's power system. The country's skill-building program emphasized lean construction techniques to reduce building costs, helping reduce capital costs for new construction 12 percent and creating more than 11,500 jobs.

Conclusion

Around the world, roughly 2–6 percent of GDP is spent on infrastructure improvements, and developing countries in Africa, Asia, and Latin America are spending at the high end of the range. As urban populations continue to grow, so too will the demand for infrastructure. Mayors and other city leaders in developing countries face the daunting challenge of meeting these expanding needs with finite funding.

But our work and research has shown that funding, while important, is not the only obstacle to developing strong urban infrastructure. Improvements in governance, institutions, processes, and internal capabilities are often neglected as officials bemoan their funding challenges. Focusing on these areas can close the funding gap considerably, allowing cities to deliver greater benefits from their investments.

In addition, cities must be smarter about how they approach their infrastructure development programs. Officials must carefully consider whether they are building the right infrastructure, getting the most benefit for existing infrastructure, and delivering projects efficiently—and whether PPPs can deliver additional benefits.

Cities that progress in their infrastructure programs despite the current challenges will be those with leaders who look beyond funding to find ways to serve their citizens effectively with the resources available.