

Infrastructure Investment in an Uncertain World

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We are entering a new phase of geopolitical uncertainty. The rules-based order that has enabled nations to prosper for decades is fraying, and the economic landscape is changing with it. In such a world, investment in infrastructure is more important than ever.

Aside from its inherent value in promoting economic activity and social progress, infrastructure provides the platform for countries to build resilience. But it is not just a defensive measure. As

the importance of economic security increases and technological and demographic changes mount, having the right infrastructure is also vital for capturing the opportunities these shifts create. With resources ever more constrained and contested, the key challenge lies in how countries can best prioritize to navigate this new reality.

In this report we set out a playbook for how to approach this. Spanning 92 countries and three decades, our new study examines the critical relationship between infrastructure and economic growth. We analyze the historical impact of varying levels of different types of infrastructure stock on economic growth across five country archetypes, defined by their economic development status and existing infrastructure:

This analysis definitively shows that increasing a country's infrastructure stock is almost always associated with higher long-run economic growth. Developed countries experience the greatest gains, with the main constraint on growth stemming from ineffective delivery. Developing economies also see significant benefits, but for them the constraint is more often the ability to pick the right strategic projects to help realize their long-term economic vision.

We then present a toolkit for policymakers to choose the right infrastructure projects, given their country's economic and social context. Finally, we examine how infrastructure can be delivered to maximize value creation by addressing the challenges that both the public and private sector can face at the ecosystem, portfolio, and project levels. This report explains both why and how to invest wisely.

The Infrastructure Imperative

The case for investing in infrastructure is well established. It has been shown to be critical for all countries' economic growth and social progress. Our overall analysis of 92 countries over the past 30 years shows that a sustained 5% increase in infrastructure stock can be associated with increasing long-run GDP growth by up to 0.45 percentage points. (See "Modeling the Impact of Infrastructure.")

– Modeling the Impact of Infrastructure

Our analysis examines the long-run contribution of infrastructure to economic growth across a balanced dataset of countries from 1990 to 2019. This allows us to estimate how increases in infrastructure stock, together with capital accumulation and increases in human capital, affect growth in GDP per worker over time. We use the Pooled Mean Group (PMG) estimator, a statistical method

that separates long-term trends from short-term fluctuations and is well suited to analyzing growth across different countries. It estimates two things:

- **Long-Run Equilibrium Relationship.** This is the stable, long-term pattern in which output grows in line with a country's level of infrastructure and capital and to which economies tend to return after temporary shocks. It assumes that structural relationships such as between infrastructure and output are similar across countries in the long run.
- **Short-Run Adjustment Dynamics.** These capture how quickly or slowly each country moves back toward the long-run path following shocks or policy changes. These responses can differ across countries, reflecting policies, institutions, or economic conditions.

The PMG model was first used by Pesaran, Shin, and Smith¹ to assess the relationship between infrastructure and economic growth but has been used and adapted since, most recently by Tamilsina, Stern, and Das.²

We model output in terms of increases in real GDP per worker. This is made up of three factors:

- **Physical Capital per Worker.** This includes machinery and infrastructure stock.
- **Human Capital per Worker.** This indicator includes education and skills.
- **Infrastructure Indicators.** These are grouped into three categories: digital infrastructure (such as broadband penetration, mobile subscriptions); transport infrastructure (including road and rail length and air freight capacity); and energy infrastructure (such as electricity generation and dam capacity).

Since the above indicators are highly correlated, we combine them using a statistical method called principal component analysis, which groups similar indicators into the three broader infrastructure categories. This approach avoids the noise and instability that can result when analyzing highly correlated factors individually, while retaining the ability to identify their individual impact on economic growth. This method allows us to determine long-run elasticities: the estimated percentage change in GDP growth per worker associated with a 1% sustained increase in each infrastructure input. (If you would like to understand the approach taken in more detail, please contact the Centre for Growth.)

Archetype Analysis. We grouped countries into archetypes by using the UN’s Human Development Index and Penn World Table’s data on infrastructure stock by country.

Data Inputs. In line with existing literature, we used data on infrastructure stock as our independent variables. This approach enabled us to gather the most consistent and wide-ranging data by country and over time. We include indicators across road, rail, energy, mobile, broadband, water capacity, and airports. In some cases, such as for air freight and dam capacity, we have relied on close proxies due to data availability.

We interpolated the data where there were missing values but a clear “start” and “end” value. Where this was not the case but there was little variance in the data, we kept values constant. Where start values were missing due to a lack of infrastructure—for example, broadband connections prior to 2000—we assumed a value of zero.

Data inputs used include:

- Real GDP per worker (2017 US\$1 in purchasing power parity)—Penn World Tables
- Capital stock per worker (2017 US\$ millions in purchasing power parity)—Penn World Tables
- Infrastructure stock per worker (2017 US\$ millions in purchasing power parity)—Penn World Tables
- Human Capital Index—Penn World Tables
- Mobile cellular subscriptions (per 100 people)—World Bank Development Indicators
- Fixed broadband subscriptions (per 100 people)—World Bank Development Indicators
- Total energy generation (in gigawatt hours)—IRENA Renewable Energy Statistics; BP (via Energy Institute Statistical Review of World Energy)
- Total road network (kilometers)—International Road Federation; World Bank (via EconStats); CIA Country Factsheets (via Index Mundi); African Development Bank
- Motorways (kilometers)—International Road Federation

- Rail lines (total route kilometers)—International Union of Railways; World Bank Development Indicators; Archived World Bank Indicators (via EconStats); CIA Country Factsheets (via Index Mundi); African Development Bank
- Dams per capital—Aquastat; Food and Agriculture Organization of the United Nations
- Air transport, freight (million ton-kilometers—World Bank Development Indicators

The benefits extend beyond economic outcomes. According to a report published in the *American Economic Journal*, new roads in India lead to children staying longer in school and performing better in exams. Another global study, appearing in *Human Nature Behavior*, showed a 10% increase in access inequality to economic infrastructure, including communication, energy, transport, and distribution infrastructure, was linked to a one-year reduction in life expectancy.

Beyond this, there are four macroeconomic and societal shifts that are increasing demand for new infrastructure:

- **Geopolitics.** A changing global landscape, including the rise of protectionism and increasing conflicts, is sharpening focus on national and economic security. Strong domestic infrastructure has become more vital than ever in building resilience in the face of these trends.
- **Climate and Energy Transition.** The shift toward renewable energy is accelerating the demand for energy generation, storage, and distribution infrastructure. Extreme weather events are also driving the need for greater flood defenses as well as climate-adapted infrastructure more broadly.
- **Population.** Shifting global demographics are leading to rapid urbanization in the developing world, while aging societies in developed nations are shifting the nature of infrastructure demand, particularly toward health care.
- **Technology.** Technological advancement, especially through GenAI, is bringing productivity advances while necessitating greater energy generating capacity and its supporting infrastructure, such as the provision of water for cooling.

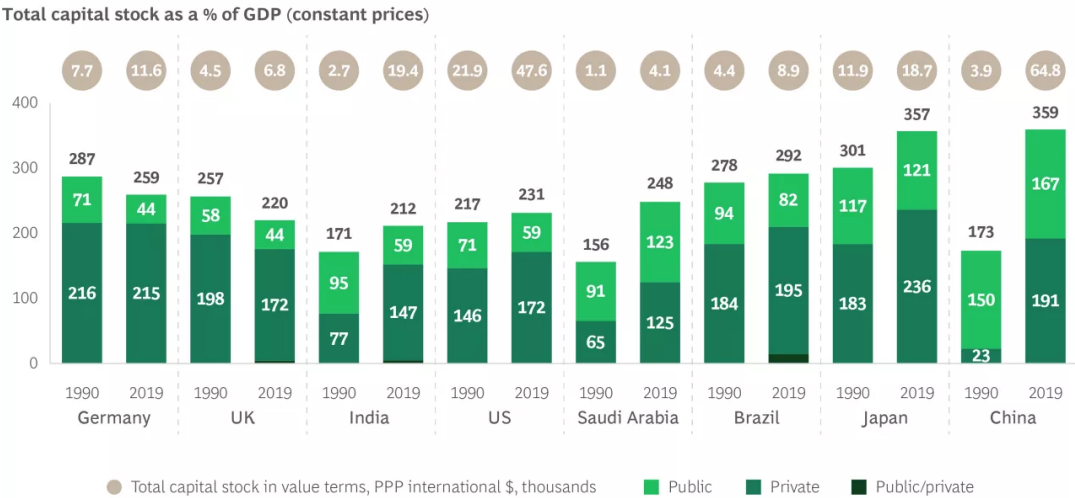
And finally, certain nations are facing additional specific pressures. Developed nations, for example, are struggling with aging infrastructure. In the US, one in three bridges needs repair or replacing, and the average dam is 14 years past its intended lifespan. In Germany, over 50% of locks and weirs are more than 70 years old. Of the €12 trillion investment needed in European infrastructure by 2040, €3.6 trillion is required just to modernize and retrofit building stock. Meanwhile, fast-growing nations need to expand infrastructure stock to meet new demand, particularly for public services; for example, as of December 2024, India has expanded digital infrastructure to 625,000 villages.

“ Countries that are not investing may be considerably less able to seize the opportunities afforded by new technology and more vulnerable to geopolitical and demographic shifts.

Despite the growing demand, we are seeing a huge divergence in infrastructure investment across countries. Some nations investing heavily; in others, investment is flat or even declining (see Exhibit 1). Those that are not investing will likely be considerably less able to respond to the opportunities afforded by shifts in technology and more vulnerable to geopolitical and demographic shifts.

EXHIBIT 1

Fast-Growing Countries Are More Likely to Have Invested Heavily in Infrastructure Than Highly Developed Ones



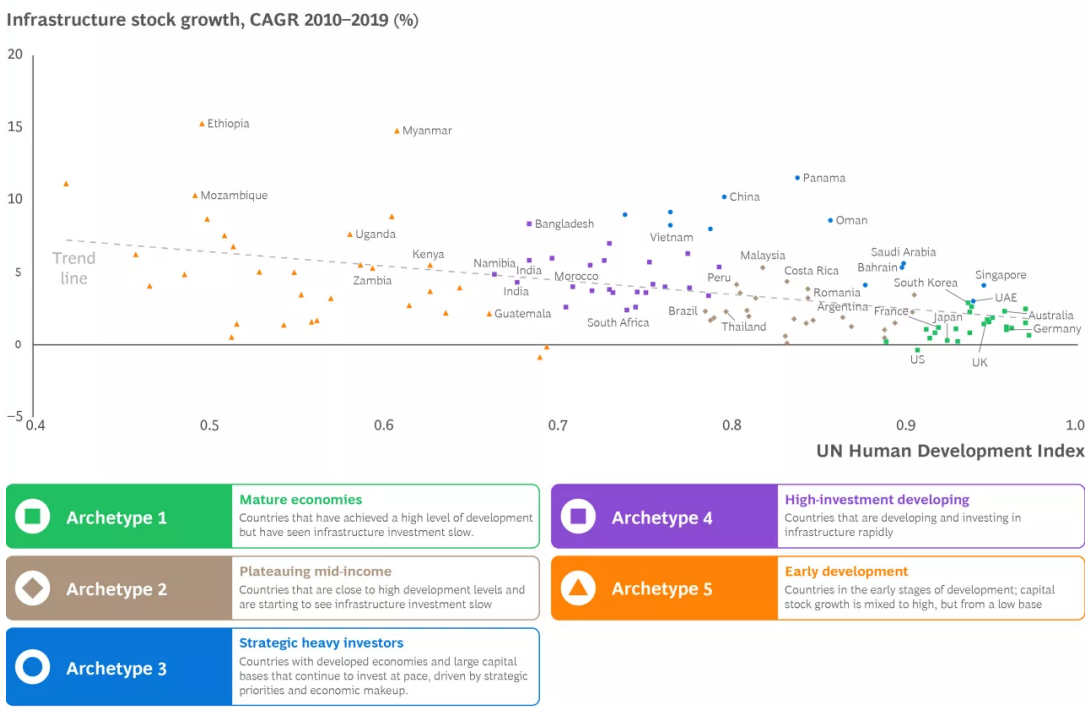
Sources: IMF Investment and Capital Stock Dataset, BCG analysis.
Note: An international dollar has the same purchasing power over GDP as \$US1 has in the United States; GDP converted to international dollars using purchasing power parity (PPP) rates allows comparisons of economic output across countries without the distortions caused by differences in price levels.

The Economic Impact of Infrastructure Investment

To understand how countries have historically approached infrastructure investment and the economic benefits associated with it, we grouped our 92 countries into five archetypes according to the growth of their infrastructure stock since 2010 and their level of development (see Exhibit 2).

EXHIBIT 2

Country Archetypes Are Determined by Stage of Development and Growth of Infrastructure Investment



Sources: IMF; PWT; UN; World Bank; BCG analysis.
Note: Archetypes plotted by comparing human development with the growth in infrastructure stock; countries with high development and above-average infrastructure growth (archetype 3) are identified by calculating the residual, which shows where countries have higher infrastructure stock growth than would be expected for their level of development (e.g., archetype 1 average residual = -0.9%; archetype 3 average residual = 4.1%).

The five country archetypes range from highly developed countries where infrastructure investment has almost stalled to countries that have achieved high levels of development and continue to invest heavily to countries still in the early stages of development. Each archetype has different priorities and faces specific challenges in maintaining economic and infrastructure growth (see Exhibit 3).

EXHIBIT 3

Countries in Each Archetype Should Prioritize Different Aspects of Growth to Overcome Their Infrastructure Challenges

		Priorities	Challenges
	1 Mature economies	Reverse trend of low investment to drive productivity growth Manage energy transition and energy security Modernize and future-proof for AI age	Significant cost and time overruns (e.g., planning and regulatory burden) Lack of public support for infrastructure investment Identification of interventions that generate best returns (e.g., too many small projects) High cost base (wages, energy, etc.) Significant competition for resources and capabilities (e.g., from other countries)
	2 Plateauing mid-income	Unlock next phase of growth to avoid middle-income trap Expand infrastructure coverage to drive development Build economic security and diversify in world dominated by large economies	Making strategic infrastructure investment choices to enable continued economic growth and diversification and avoid stagnation Managing more complex delivery environments as economic complexity rises
	3 Strategic heavy investors	Maintain export-led growth Ensure economic and geopolitical security Manage demographic and environmental pressures Become world leaders in emerging areas (e.g., AI)	Overpromising and increasingly struggling to deliver Struggling to set proper incentives Too little focus on project ROI, with more emphasis on strategic aims Choosing the right projects for desired ROI, with supply often outstripping demand Lack of delivery and execution expertise in relation to project complexity
	4 High-investment developing	Expand infrastructure across the board to: • Support economic growth • Manage pressure of rapid urbanization and demographic change • Improve wealth distribution	Strategically picking the right projects and organizing them across portfolios Reliance on external funding and frequent inability to access loans and financing Weak institutions creating challenges around regulation, enforcement, and corruption
	5 Early development	Establish infrastructure base and leverage national resources Manage demographic surge Drive rapid economic and social improvement	Rapid urbanization outpacing infrastructure delivery and creating urgent need Conflict and insecurity creating additional risk and increasing costs

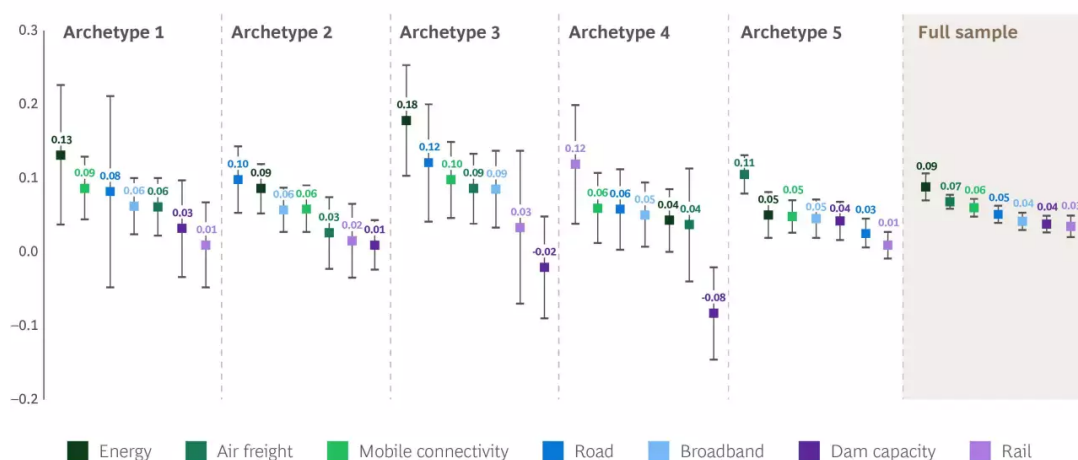
Sources: World Bank; BCG analysis.

The impact of infrastructure on economic growth varies by type of infrastructure and by each country's stage of development. To test which infrastructure has had the largest impact, we looked at changes in infrastructure stock over 30 years across the 92 countries grouped into our five country archetypes. This enabled us to identify the relationship between changing infrastructure stock and GDP growth, while controlling for other factors that might have impacted economic growth, such as an expansion in human capital (see Exhibit 4).

EXHIBIT 4

The Impact of Different Types of Infrastructure on Economic Growth Varies Depending on Country Archetype

Elasticity



Source: BCG analysis.

Note: A 0.09 elasticity means that a 1% sustained increase in infrastructure stock would raise long-run GDP growth by 0.09 pp; a 1% increase refers to an increase in the infrastructure stock (for example, if a country had 100 km of road, a 1% increase in road infrastructure stock would bring the total road stock for that country to 101 km); the confidence intervals are a function of how certain the model is in interpreting the relationship between our key variables: infrastructure stock and GDP.

The results are presented in terms of elasticities: an elasticity of 0.9 means that a 1% increase in infrastructure stock has the ability to increase long-run GDP growth by 0.9 percentage points. The confidence intervals included in Exhibit 4 are a function of how certain the model is in interpreting the relationship between our key variables: infrastructure stock and GDP. Our overall model and the majority of our results identify statistically significant relationships between infrastructure and long-run GDP growth, while the larger confidence intervals in archetypes 1 and 3 reflect lower growth in real GDP and infrastructure stock, making identifying a relationship between the two somewhat more difficult.

The model leads to five general findings regarding the complex relationship between country archetype, type of infrastructure, and resulting economic benefits.

Energy and digital infrastructure tend to generate the strongest economic returns. This holds true particularly in more highly developed countries. Across our full sample, energy generation infrastructure yields the highest elasticity—0.09—which means that a sustained 1% increase in generation capacity raises long-run GDP growth by 0.09 percentage points. A greater increase—for example, 5%—would have the potential to boost long-run GDP growth by 0.45 percentage points. Considering that OECD countries are forecast to increase GDP by an average of just 1.7% in 2026, this added growth would be both material and significant.

Unsurprisingly, the effects are strongest in archetypes 1 and 3, since more advanced and diversified economies rely on consistent access to power and connectivity given their dependence on technology and other key economic sectors. This is likely to become more critical as AI further raises the demand for energy and digital infrastructure. BCG modeling suggests

power demand for data centers globally (excluding China and crypto) is set to increase from 86 gigawatts today to 198 gigawatts in 2030, with Gen AI expected to account for over 70% of this growth.

Mobile connectivity produces a long-run elasticity of 0.06. Again, the gains are most pronounced in archetypes 1 and 3, highlighting that while digital infrastructure is universally valuable, it delivers the greatest benefits where it complements already digitized and connected production and service sectors.

Developing economies produce materially different results, with transport infrastructure proving more beneficial. Transport infrastructure shows the greatest variation in growth impact across archetypes. Its impact is particularly large for archetypes 4 and 5, with rail producing an elasticity of 0.12 for archetype 4 and air freight producing an elasticity of 0.11 for archetype 5. This compares to elasticities of 0.01 and 0.06, respectively, for archetype 1.

These findings suggest that the effect of expanding transport infrastructure is highly context dependent, varying according to whether a project improves domestic versus international connectivity—whether, for example, it unlocks regional production bottlenecks or if it links to key external trading partners.

Higher-quality infrastructure, such as upgraded transport infrastructure in developed economies, yields greater results than more “basic” infrastructure. The lower elasticities for transport in developed economies may be because the absolute amount of the infrastructure stock has not changed much. But this misses the impact of the quality of the infrastructure.

We tested this using the example of motorways versus regular roads. In archetype 1 countries, building more roads of any type has a smaller impact on long-run GDP than building more major motorways. While a 1% increase in overall road length can boost long-run GDP growth by 0.08 percentage points, a 1% increase in motorways (as a share of total road length) boosts long-run GDP growth by 0.11 percentage points. So, for developed countries, upgrading existing infrastructure, especially if it is aging, may drive higher returns than expanding basic infrastructure.

Developed countries tend to see greater GDP growth effects in the medium term from a 1% increase in infrastructure stock than do developing countries. While infrastructure almost always positively impacts long-run GDP growth, on average, elasticities are higher for more developed economies (archetypes 1, 2, and 3). While this may seem surprising for low-growth archetype 1 countries, there is a logical reason for it. A 1% increase in infrastructure stock in developed countries represents a larger absolute investment than it does in lower-income countries, since the latter start from a smaller capital base, both in aggregate and per worker. Moreover, developed economies have more skilled workforces, which is likely to boost the marginal productivity of capital by enabling more effective use of additional investment. Over the longer term, however, academic research suggests the relative impact of new infrastructure on developing countries may eventually be greater.

Developed countries also show wider confidence intervals—likely due to lower year-to-year growth and less cross-country variation in GDP and infrastructure expansion.

Growth in developing countries depends on both human and physical capital. Our control variables show how much of an archetype's GDP growth is explained by overall growth in both physical capital (including machinery and private infrastructure) and human capital, rather than by infrastructure itself. For archetype 3 and 4 countries, physical capital plays a greater role, with coefficients of 0.24 and 0.12, respectively. For archetype 5, human capital is much more important, with a coefficient of 0.09.

This suggests that developing economies must employ complementary investment alongside infrastructure investment if they are to realize the full benefits of infrastructure projects. Such investment is less vital for developed economies, which are more services driven and have lower labor productivity growth.

How to Pick the Right Projects for Maximum Impact

Given that the impact on economic growth of infrastructure investment varies by the type of infrastructure, the first issue for policymakers will be how to pick the right project for maximum economic and social gain. The answer is not straightforward. Leaders must weigh where a country is in terms of its existing infrastructure base and economic development, where it wants to go, and what it wants to be.



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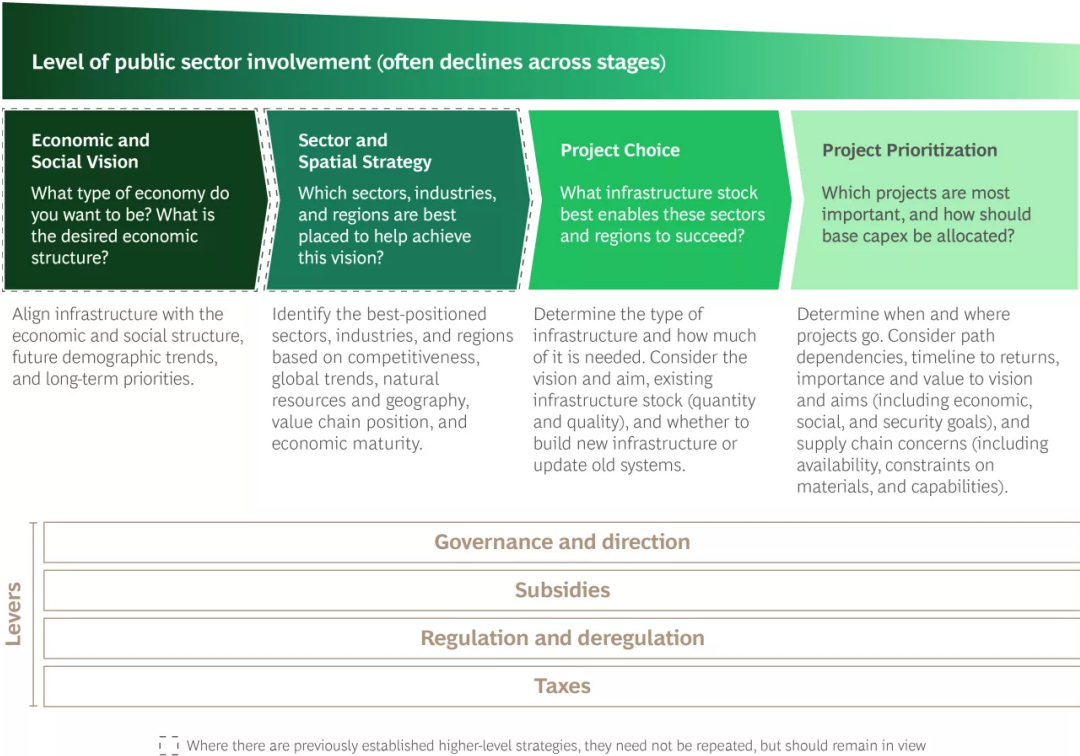
Unfortunately, leaders rarely consider such questions fully when developing infrastructure plans. And when they do, despite their best intentions, they often struggle to understand how to allocate scarce resources most effectively. This can be the result either of a lack of information or a

disjointed decision-making process. In either case, countries can sometimes miss the opportunity to strategically align and sequence a pipeline of projects that are complementary to wider national priorities. At worst, a poorly chosen infrastructure project can lead to wasted spending and limited economic gains.

Instead, the public sector should follow and incentivize a more structured approach, one that also applies when any eventual capital allocations are made by the private sector. This requires a holistic perspective whereby leaders either consider existing economic and social strategies or develop them before prioritizing the chosen projects (see Exhibit 5).

EXHIBIT 5

Public Officials Should Follow a Structured Approach to Infrastructure Decision Making



Source: BCG analysis.

What is the economic and social vision? Policymakers should begin by assessing their country’s sources of economic competitiveness, current economic and social structures, and long-term strategic priorities, such as strengthening security or resilience. In doing so, they should also consider wider demographic trends and cultural underpinnings that impact lifestyle choices (such as a preference for cars over public transport, or certain types of housing) to ensure the vision is durable and forward-looking. Infrastructure planning should be aligned with wider economic, population, and fiscal planning.

The importance of this process is reinforced by our modeling results. For developing economies, transport infrastructure is vital because it enables the movement of raw materials and resources. For developed economies, expanding energy infrastructure yields the greatest benefits. This is likely to become even more important as AI and data centers create new demand for energy and reinforces the need for these assessments to be forward-looking. Such analysis is particularly relevant where countries aim to move up the development curve. Archetype 2 countries seeking to move to archetype 1, for example, will likely need to look at a combination of their own situation, how other countries made the transition, and future trends that are likely to facilitate the shift.

What is the sector and spatial strategy? After setting the economic vision, countries must decide which sectors, industries, and regions are most likely to help to achieve it. They first need to consider their level of competitiveness. This assessment must go deeper than basic sector comparative advantage. It should extend to understanding their level of competitiveness within value chains and in specific technologies. Again, this should be a forward-looking exercise, seeking to understand global trends and, in particular, where supply and demand gaps are likely to present new opportunities. Finally, consideration should also be given to the country's natural resources and economic geography. Is it well placed to take advantage of development of the particular sector or area?

Where decision makers are operating at the regional or local level, further attention should be given to the interaction with neighboring areas and how the decision might impact the region's competitive advantage, both positively and negatively. Furthermore, decision makers at the regional and local levels will often be making their own strategic, fiscal and related plans. It is vital that these are considered and aligned with national-level planning.

What infrastructure stock will best enable the chosen sectors and regions to succeed? To answer this question, countries must first pinpoint the key problems that need to be addressed to enable the sectors or regions identified for development to succeed. Broadly speaking, four areas regularly need interventions to remove barriers and support success: infrastructure and core inputs; production costs; market access; and demand. Additional capital expenditure is likely to be most effective where infrastructure, inputs, or production costs are the main barriers.

Once these areas are identified, two further decisions must be made: Would these challenges most likely be overcome through entirely new infrastructure, or would repairing existing stock have the same effect? And is government intervention really necessary or appropriate? There will likely be some sectors where the right course of action may be to allow the private sector to act independently.

This decision-making process might look like the following: If a country decided that it wanted to expand its knowledge economy and become a technology hub, a key consideration might be the type of infrastructure needed to support AI innovation and deployment. Supporting AI would likely require significant computing power and data center capacity, which in turn needs sufficient baseload energy infrastructure and reliable transmission and distribution, as well as suitable

water infrastructure for cooling. Depending on the sector and area and the country's context, the right infrastructure stock will vary and often extend beyond the obvious.

How should projects be prioritized and capital expenditures allocated most effectively? Once decision makers establish the type of infrastructure stock needed, they must determine when and where investments should be made. Sequencing a pipeline of projects, such as building water infrastructure in advance of the completion of a new data center, ensures that the new assets can be put into operation quickly and the returns maximized (see Exhibit 6). This is a function of four factors:

- **Path Dependencies.** Identify what needs to be in place, and when, for maximum benefit— for example, whether a new airport requires rail lines to connect passengers to it or a new wind farm first requires a new grid connection.
- **Timeline to Returns.** Carry out detailed cost-benefit analysis and reference class forecasting that uses comparable data from past projects to inform decision making to understand the size and timeline of expected returns, as the benefits of some assets will be realized quicker than others.
- **Importance to Economic and Social Vision.** Link prioritization of projects back to core aims. For example, if resilience is a more important goal than economic growth, expanding transport infrastructure to support supply chains and improve economic connectivity might be the best decision.
- **Supply Chain Capacity.** Prioritize projects and spend based on a supply chain mapping analysis of potential bottlenecks, capacity shortages, and skills availability. Sequence projects according to supply chain capacity and set in motion interventions to strengthen critical supply chains.

EXHIBIT 6

Choosing the Right Project Can Unlock New Industries and Increase Competitiveness

	Morocco: Tanger Med Port	Brazil: Green energy infrastructure	Kenya: Digital infrastructure
Economic and Social Vision What type of economy do you want to be? What is the desired economic structure?	Vision was to transition toward an export-driven economy, with the country becoming a key actor in European and Mediterranean trade and geopolitics.		Goal was to grow the economy and build financial inclusion, particularly for more rural parts of the country.
Sector and Spatial Strategy Which sectors, industries, and regions are best placed to help achieve this vision?	Aim was to grow local automotive and agricultural industries through transport, production, and logistics corridors.	Ambition was to enable digital industrialization and position Brazil as a hotspot for data and AI.	Targeted the ICT sector and sought to leapfrog global competitors by embracing mobile payments, which are more popular than cash or credit cards.
Project Choice What infrastructure stock best enables these sectors and regions to succeed?	Built new industrial port on the Mediterranean Sea, integrated the port within the growing car manufacturing industry, and created dedicated logistics corridors integrated with highway and railway lines.	Built renewable infrastructure, including hydropower, wind, and solar, to meet energy demand. Built new data centers to host energy-intensive AI and cloud computing operations.	Expanded digital infrastructure, including 100,000 km of fiber-optic networks, enabling Kenya to lead the way in digital financial inclusion in Africa.
Project Prioritization Which projects are most important, and how should base capex be allocated?		Brazilian government is aligning new data center projects with clean energy development. The national development bank is co-funding grid capacity upgrades to power the new digital infrastructure.	

Source: BCG analysis.
Note: ICT = information and communication technologies.

Finally, a key consideration throughout this process will be how to incentivize the involvement of the private sector and the markets. The public sector can support private-sector participation through, for example, strong governance to provide direction, subsidies to support targeted private infrastructure investment, regulations that drive or remove barriers to infrastructure construction, and taxation (either through incentives like credits or by taxing negative externalities).

Selecting the right projects is only half the battle, however; delivery determines whether value is realized or lost.

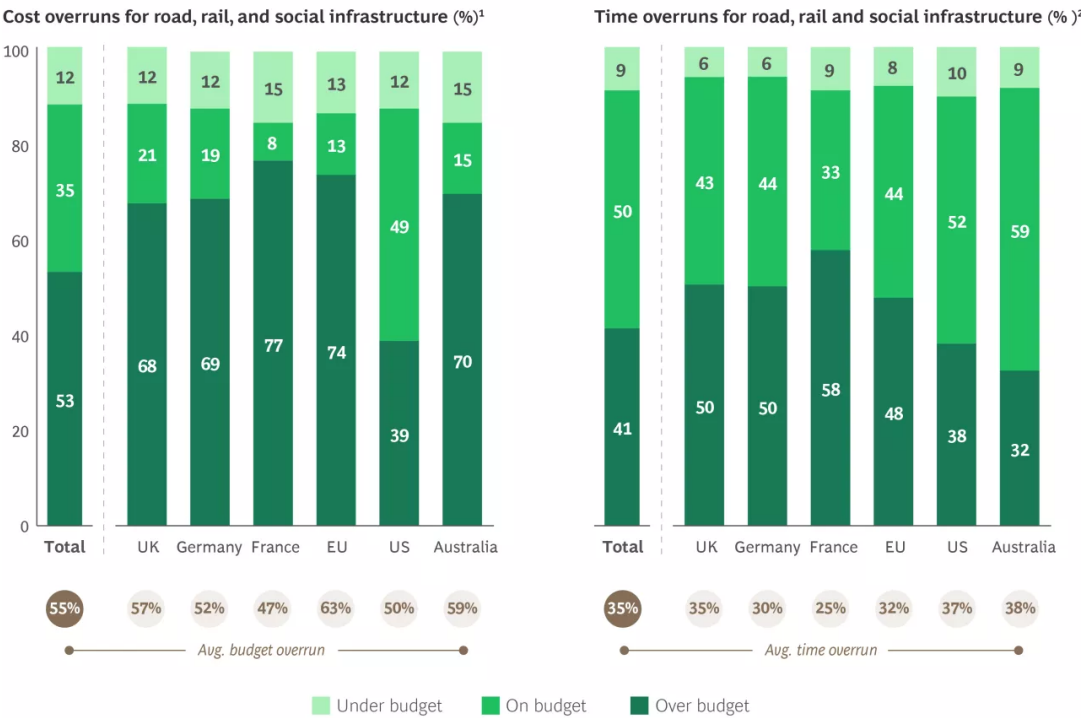
How to Protect Value in Project Delivery

Once the first question—which infrastructure projects to choose—is answered, the next consideration is how to deliver the projects effectively and efficiently to maximize their value. Time and cost overruns are endemic across large infrastructure projects. A 2024 BCG study found

that across Australia, France, Germany, other European countries, the UK, and the US, projects have, on average, faced budget overruns of 55% and time overruns of 35% (see Exhibit 7). While construction productivity has steadily climbed in fast-growing economies like China and India, it has declined in much of the West, even while overall labor productivity has grown.

EXHIBIT 7

Infrastructure Projects in the West Have Consistently Faced Cost and Time Overruns

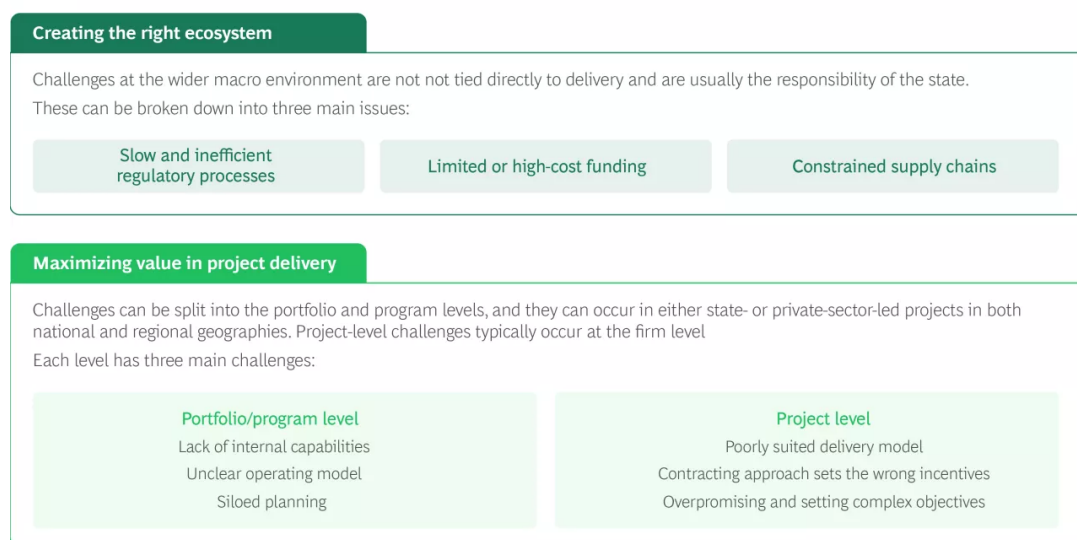


Sources: Global Data Construction Intelligence Centre database; BCG analysis.
¹N = 949, including UK (120), Germany (59), France (61), Eurozone (196), US (540), and Australia (93).
²N = 936, including UK (127), Germany (64), France (66), Eurozone (210), US (494), and Australia (105).

To make sure they are building their infrastructure projects efficiently and gaining the most value from them, governments should distinguish between the different levels at which infrastructure construction decisions are made. At the broadest level are ecosystem considerations, which relate to creating the best macro environment to facilitate the construction process. These decisions are not tied directly to delivery and are usually the responsibility of the state. Then come delivery considerations, which can be separated into two levels. The portfolio (or program) level is typically, though not exclusively, managed by the public sector at the national or regional scale. The project level is specific to the particular project and the firm or firms carrying it out. (See Exhibit 8.)

EXHIBIT 8

Challenges Can Arise at Three Critical Stages—Ecosystem, Portfolio/Program, and Project Levels



Source: BCG analysis.

While the challenges and solutions outlined generally apply to all infrastructure projects, certain scenarios may have more relevance to certain types of economies. For example, at the ecosystem level, slow and inefficient regulatory processes are most common in highly developed economies such as those in archetypes 1 and 2, while a lack of access to capital funding is most acute in developing economies, such as those in archetypes 4 and 5.

The Ecosystem Level

Establishing the right ecosystem involves creating an environment in which investment can flow and project delivery can happen at speed and scale. Success depends on addressing constraints across three key areas: regulation, financing, and the supply chain.

Regulatory and Permitting Barriers. The path to getting projects approved is often slow and uncertain, for several reasons. First, planning approvals are often lengthy and costly, with multiple opportunities for objections from various stakeholders. Second, permitting issues, such as securing environmental approvals, require huge amounts of information, adding time and cost. Third, regulatory frameworks such as health and safety rules are routinely updated or changed; as a result, designs often need to be amended, even for proven technology. This can be particularly costly. Finally, procurement processes for service providers can be complex and onerous. The average pre-construction phase in major infrastructure projects across advanced economies, for example, lasts 50 months, a year longer than the average construction phase.

How these challenges are overcome will likely depend on countries' different regulatory systems; however, there are several cross-cutting principles and best practices that all officials should keep in mind when constructing a regulatory and permitting environment that encourages speed and clarity:

- Engage local stakeholders early and focus on the concept and principle as well as the broad outcomes of the infrastructure projects, rather than getting into specific discussions around design choices.
- Focus on the potential scope of objections from stakeholders and limit the time available to make them. Too often, stakeholders launch legal challenges multiple times during the planning process. While there should be clear opportunities to do so, they should not be open-ended.
- Create a single agency responsible for overseeing and driving the permitting process, either at the sectoral or regional level or for the highest-priority projects. Acting as a single front door for those seeking approvals, this entity should have the power to enforce strict timelines and coordinate the various permitting assessments.
- Reuse and amalgamate existing assessments to reduce duplication. Create a centralized digital system with a repository of information so that environmental impact assessments and other challenges don't have to be repeated. Alternatively, create a regulatory framework that takes a zonal or programmatic approach so that risks are scoped out on a wider basis rather than project by project, since there are often significant overlaps across projects.
- Set a high bar for design changes, particularly if the approach has been used successfully in similar economies. The use of "no change" committees or similar entities has been effective in many projects. Automatically recognizing technologies and standards already proven successful in other countries can also significantly streamline approvals.
- Set consistent and transparent procurement processes for large infrastructure projects. Ideally, a single framework should be enforced across different agencies and sectors to ensure that best practices are followed.

Case Study. In the early 2000s, facing rising time and cost overruns, the Dutch government reformed its planning and permitting processes. The 2008 Spatial Planning Act devolved responsibilities to provincial and municipal governments, while the central government retained authority over 13 national priorities and boundary-crossing projects such as key transport networks. Streamlined processes enabled innovation, as seen in Amsterdam's Buiksloterham. Once an industrial site, it was rezoned for mixed use and issued permits for bottom-up development. This fostered a thriving district and a "living lab" circular economy of sustainable offices, cafés, and workspaces.

Undersupply and High Cost of Capital. Direct public-sector grants can often be excessively complex and time-consuming due to lengthy approvals and fragmentation among those issuing grants. However, where private finance is required or sought out, it is often too costly. In some cases, governments have attempted to shift all the risks onto the private sector, including those it is poorly equipped to manage, resulting in an inflated cost of capital. In others, projects require significant upfront investment but have unpredictable revenue streams, making the infrastructure assets less commercially viable. In a BCG survey, over 50% of capital providers identified weak public funding models and long payback periods as a barrier to financing projects.

Addressing this problem requires putting the right incentives in place for both the public and the private sector. In the case of the public sector, officials should use the public balance sheet. Fat-tailed risks—those with a low probability but a high impact—sit most naturally with the public sector. In these instances, governments should use targeted interventions such as guarantees, insurance backstops, or contingent liability mechanisms to explicitly manage them. Doing so helps reduce the overall cost of capital, improves delivery certainty, and encourages greater private participation.

Case Study. To address chronic wastewater overflows, the UK government adopted a novel risk-sharing model to fund the Thames Tideway, a £5 billion infrastructure project. Through a regulated asset-based model, the government issued six contingent financial support contracts and agreed to step in as lender of last resort in extreme scenarios. This reduced financing risk, signaled the importance of the project, and enabled the developer to raise capital at low cost. The model helped contain annual consumer charges to between £20 and £25, compared to earlier forecasts of between £70 and £80, while ensuring resilience during shocks such as the COVID-19 pandemic.¹

Governments looking for investment from the private sector should leverage public-private partnership (PPP) models. PPPs enable consistent revenue streams (via direct user charges or government-backed availability payments, for example) from early in a project by bundling design, build, finance, and operation into long-term contracts with clear returns. And making the private partner accountable for delivery enables efficient execution, helping to maximize asset value.

Case Study. Hyderabad Metro Rail was developed to ease congestion and modernize transit in one of India's fastest-growing cities. The PPP delivered a design, build, finance, operations, and transfer (DBFOT) concession to L&T Metro Rail (Hyderabad) Ltd. under a 35-year agreement, with the option of extending it. The private partner bore the demand risk and funded most of the \$3 billion cost, with limited government viability-gap funding. Revenues came from fares and transit-oriented development rights, giving the private partner control over both delivery and monetization.²

Constrained Supply Chains. Building a functioning ecosystem conducive to infrastructure development requires strong supply chains. At present, this is often not the case. Unclear and disjointed future project pipelines lead to shortages of skilled workers such as engineers,

technicians, and project managers. And due to the “stop-start” nature of the funding, they create a fragmented market of construction, engineering, and manufacturing firms. Finally, as demand for infrastructure increases, so does demand for highly specialized components and raw materials, risking bottlenecks and delivery delays when they can’t be secured.

“Through deliberate, consistent partnering across the supply chain, governments can identify synergies and give the private sector more confidence to scale up and invest in innovation.

To rectify these challenges, governments may have to take a more active role by providing greater certainty and leadership in the supply chain. This means more deliberate partnering across the supply chain carried out in a consistent way to reduce fragmentation. This would enable them to identify synergies within the supply chain and give the private sector more confidence to scale up and invest in innovation. These efforts should include:

- Developing a detailed and sequenced long-term pipeline of projects, in line with strategic priorities. This could be complemented with the development of skills programs tailored to the pipeline, especially when there are acute talent shortages.
- Using economies of scale to drive efficiencies and boost supply chain resilience, such as by securing critical components and raw materials.

Case Study. South Korea builds fleets of eight to 12 modular nuclear reactors in sequence, giving it the world’s lowest average construction cost for nuclear power plants. This creates a strong supply chain and develops valuable expertise, enabling private firms to invest in capital and skills with confidence while spreading costs across projects. It also incentivizes the training of domestic specialists rather than having to import knowledge. The outcome is cheaper, more efficient construction and a robust base of local capabilities.

The Portfolio/Program Level

The challenges at the portfolio and program levels are much more closely tied to project delivery. As a result, they are just as likely to affect the private sector as they are the public sector and often occur at the company level. While these challenges are common across all archetypes, some of the solutions are more relevant to certain archetypes than others. For example, archetypes 4 and 5 tend to struggle to source the relevant skills and experience due to the lack of

a domestic talent pipeline. Meanwhile, the many layers of bureaucracy in archetypes 1 and 2 often mean roles and accountability are poorly defined, with no single entity having the necessary focus or tools to protect value creation.

Lack of Internal Capabilities. Lack of internal capabilities undermines the delivery approach from the outset. The public sector often does not have the skills to accurately scope projects, procure the necessary skills, or oversee effective design and delivery. It veers between developing large, unwieldy organizations (common in developed economies) and underinvesting and commissioning too small a team for the size of the task at hand (common in developing economies). This is usually due to pressures around salary or cost control.

Best Practice. To counter this problem, those responsible for overall delivery should identify and invest in specific expertise to provide internal support. Having the right capabilities in place is crucial—as is designing the organization’s operating and delivery models so that these experts have the control and levers needed to make an impact. Solving this doesn’t always mean building large client organizations. It can also mean hiring a few specialists in specific areas and/or giving senior decision makers access to the required expertise through boards or external inputs.

Case Study. France established the Société du Grand Paris in 2010 as a specialized public entity responsible for delivering more than 200 kilometers of new metro lines and 68 new stations in the Paris region. Designed as a delivery authority distinct from the standard government bureaucracy, it recruited 800 high-caliber experts across engineering, interface management, and project and contract management, with clear accountability tied to outcomes. These focused capabilities, along with more agile procurement and project coordination, has enabled the organization to maintain tight control over complex delivery, even amid significant political and technical challenges.

Unclear Operating Models. Roles, responsibilities, and processes across portfolios and within projects are often poorly defined. Managers frequently fail to institute and adhere to robust stage-gating. This creates perverse incentives when organizations are faced with managing conflicting objectives or are given objectives without the responsibility to meet them.

Best Practice. To overcome such challenges, countries need to adopt an operating model that dedicates resources to maintaining value and developing the right talent and data capabilities to succeed in doing so. The model must establish clear accountability for value protection throughout the project, with separation between teams tasked with maintaining value and those making design and delivery choices.

Focusing on value requires each organization at every stage of the delivery process, from original design to construction, to have the right capabilities and action levers. For example, in a large infrastructure project, if the finance ministry focuses on value, team members need the expertise and capabilities required to enforce this focus. The delivery model should align with stage gates and real-time data to emphasize value at each stage. The goal is to embed value across delivery execution through empowered roles, robust data systems, and system-wide feedback loops.

Case Study. To boost water resilience, Abu Dhabi launched the world's largest underground desalinated water reserve. Rather than outsourcing leadership, the Abu Dhabi Water and Electricity Authority retained full ownership, partnering with Environment Agency-Abu Dhabi for scientific input, mobilizing a multidisciplinary expert team, and overseeing delivery through its subsidiary TRANSCO. Tight public-sector control ensured coordination across science, design, and construction. As a result, the project was delivered on budget and now provides up to 90 days of emergency supplies of water, securing access for some of the world's highest per capita consumers.

Siloed Planning. Siloed planning leads to duplication, missed synergies, and an inability to optimize portfolios. Projects planned in isolation by disconnected agencies miss out on integration and synergies. This hinders optimization and leads to inefficient capital allocation, redundant investments, and lower returns. This is true both of projects being run concurrently, where real-time data is often not shared, and those run sequentially, where learnings and data from past projects aren't leveraged. This is commonly caused by ineffective data-sharing platforms. For example, in Nagpur, India, infrastructure projects are managed by separate agencies working without any data or information sharing, leading to uncoordinated efforts and repeated disruptions. Roads are dug up multiple times for different utilities, wasting resources and frustrating residents. This increases costs and undermines public support.

Best Practice. The best approach to this challenge is to embed an end-to-end data and evidence-driven approach to underpin portfolio and project optimization. Planners should use data from past projects and experience as the basis for decision making. This could include leveraging reference-class forecasting at the outset to track performance in real time. Doing so can help to inform how and when to deploy certain resources, particularly for well-established assets such as roads and schools, and be used to determine the overall prioritization of projects, as covered above. For live projects, data sharing can also support supplier benchmarking, supply chain mapping, and dynamic scheduling. This process is increasingly easy to carry out, since new digital platforms and AI tools can combine unstructured databases across projects, allowing harmonized and holistic tracking and network planning.

Case Study. To support dynamic simulations across flooding, mobility, and emergency response, Singapore developed "Virtual Singapore," a nationwide digital twin that integrates real-time data from over 10,000 sensors with unifying geospatial, environmental, and mobility data from more than 100 public agencies.³ After flash floods in 2022, for instance, engineers used Virtual Singapore to model the effectiveness of drainage upgrades overnight, avoiding \$15 million in damages. It also helped identify "care deserts" and deploy mobile health pods along AI-optimized routes for elderly residents, reducing emergency response times by 40%. By mandating open data, addressing privacy concerns, and enabling cross-agency collaboration, Singapore used its digital twin to streamline planning and improve the delivery of public services.

The Project Level

Challenges at the project level arise when carrying out individual infrastructure projects. They are largely the result of a disconnect between the goals of the project owner or client and the incentives of the individual companies that perform the actual construction of the project. In archetypes 1 and 2, we tend to see particular problems with getting the right contracting approach, while in archetypes 4 and 5, there are commonly problems with procurement as part of the overall delivery model.

Poorly Suited Project Delivery Models. Delivery model choices are often based on minimizing expenditures rather than optimizing for efficient delivery. This results in procurement processes focused on lowest cost rather than quality.

Best Practice. To optimize delivery models, projects must align procurement and commercial strategy to maximize outcomes, not just minimize cost. A project's procurement and commercial strategy needs to be tailored to factors such as the level of its complexity and the availability of key resources (including labor, equipment, and financing), while being cognizant of the wider economic context. For example, an EPCm (engineering, procurement, and construction management) model can be better suited to novel or evolving projects, offering flexibility and integration as the contractor coordinates multiple work programs on the owner's behalf. For smaller, simpler projects, particularly those that repeat a similar project already undertaken, a turnkey EPC (engineering, procurement, and construction) model provides clearer accountability through a single contractor delivering to a fixed price and schedule.

Case Study. As host of Expo 2015, Milan launched a 12.9 kilometer fully automated metro system aimed at expanding transit coverage and easing congestion. The project had strong political backing and clearly defined objectives. It was delivered via project financing, with a long-term concession awarded to Metro 5 S.p.A., a special-purpose company. Over 40% of the costs were privately financed, with delivery managed through a turnkey EPC contract and operations outsourced to ATM, one of its shareholders.⁴ Construction was accelerated using four tunnel-boring machines and a phased rollout. Delivered on time, this project shows how clear goals and an integrated delivery model can minimize risk and ensure schedule certainty.

Contracting approach sets the wrong incentives. Suboptimal risk-sharing leads to a lack of incentives to keep costs down or pursue innovations. This is often seen in the use of cost-plus contracts rather than adoption of an appropriate pain-gain sharing approach. Cost-plus contracts create delivery silos, since there is little reason for different parties to work toward shared outcomes. When risks are pushed onto suppliers, including those they can't control, there is little incentive to address them, since they know it is ultimately the core client who will be affected. This misalignment drives inefficiency and undermines collaboration.

Best Practice. To make sure that the right incentives are in place, determine which sources of uncertainty only the core client can own, with contracts structured to allocate risk on this basis. There are some risks which contractors are not well suited to managing and should remain with the client, such as political and macroeconomic risks. If a project is significantly delayed, for example, it is still the core client that is left without the functioning infrastructure asset.

Contracts should therefore seek an allocation of uncertainty and risk that suits the capabilities of both client and contractor. Contractors should own uncertainties around productivity, but the core client should be willing to own risks only it can manage. Getting this right is likely to require fully scoping uncertainties early on.

Case Study. The tiny Faroe Islands succeeded in delivering a major undersea vehicle tunnel program that connects remote island communities. Despite the islands' population of just 50,000, the Faroese government, through its agency Landsverk, executed tunnels like Eysturoy and Sandoyar efficiently and under budget. Extensive probe drilling enabled a clear understanding of subsea tunnel risks before any contracts were entered into. The contract and remuneration terms were then agreed on the basis that ground condition risks sat with the Faroese government owner, while the adjustable fixed price contract ensured the contractor was incentivized to deliver quickly. A clear understanding of key uncertainties allowed for the most effective allocation of risk, which in turn unlocked efficient delivery of the project both in terms of time and cost.

Overpromising and Setting Complex or Conflicting Objectives. At the outset, the speed and impact of projects is often overstated, while the core public-sector client often sets too many different and sometimes conflicting objectives that are largely disconnected from those responsible for the project's design and delivery. This in turn leads to instances of gold-plating, scope creep, and designs going beyond minimum viable product requirements in an attempt to meet all these objectives. On top of this, there is often pressure to move rapidly to get construction underway, which can lead to immature designs and a poor understanding of key risks.

Best Practice. Successful project leaders invest and iterate in the early stages to avoid going forward with an immature understanding of key uncertainties. Sufficient resources, including the time, money and skills, need to be available to get the scope and design correct. Getting the right engineering capabilities involved in the project from the outset is particularly crucial. The best way to do this is by running an iterative process where key stakeholders, such as the engineers, are involved throughout, rather than adopting a linear process. The project should proceed only when designs are sufficiently mature, so that all the information needed is available when determining both the delivery model and commercial strategy. Using AI to support early-stage designs and support in feasibility assessments, business cases, and approvals can lead to a more thorough early-stage process that needn't add significantly to the timeline.

Case Study. Helsinki's metro extension (Länsimetro) was designed to link the city to its western suburbs, but Phase 1 suffered from underestimated costs, fragmented contracting, and poor integration, leading to cost overruns and a three-year delay. In response, Phase 2 adopted a revised delivery model, applying reference class forecasting, shifting to a one-contract-per-station structure, enforcing a common delivery date, and using master scheduling to align all contractors. The result was improved cost control and reduced scope drift, with a final cost €100 million lower than the original 2018 cost estimate.⁵

Conclusion

Looking across the challenges facing all infrastructure projects, and the practices that can lead to the successful creation of value, a common theme arises: It is vital for core public-sector clients to be active and engaged partners, setting the right incentives across the entire supply and delivery chain. There must be a focus on engaged management to achieve clear outcomes, not just on managing processes or activities. To that end, it is critical to understand the inherent risks and uncertainties in the portfolio and project, and then to set out the right processes to plan for them.

For developed economies, getting this right presents a huge opportunity to generate value and improve the pace and value of crucial infrastructure projects. And it gives developing economies a real chance to leapfrog the painful infrastructure processes that have evolved in developed economies and to drive rapid economic and social improvements so critical to their future development.

At a time of global uncertainty and constrained resources, whichever group a country falls into, picking the right infrastructure and delivering it the right way is more crucial than ever.

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¹ M. H. Pesaran, Y. Shin, and R. P. Smith, “Pooled Mean Group Estimation of Dynamic Heterogeneous Panels,”

Journal of the American Statistical Association (1999).

² G. Timilsina, D. I. Stern, and D. K. Das, “Physical Infrastructure and Economic Growth,” *Applied Economics* (2024).

¹ Catherine Moore, “Tideway Confirms Smaller Cost Hike Than Previously Feared,” *New Civil Engineer*, November 2021.

- 2 Ajay Tomar, “Harvard University Showcases Hyderabad Metro as Global Public-Private Partnership Success Model,” *Times of India*, May 11, 2025.
- 3 “Virtual Singapore—Singapore's Virtual Twin,” 2015, <https://oecd-opsi.org/innovations/virtual-twin-singapore>.
- 4 “Milan Metro Line 5 Extension Project: A Case Study,” 2015, <https://www.railwaynews.net/milan-metro-modernisation-project-italy-urban-rail-enhancement.html>.
- 5 “Länsimetro’s Matinkylä–Kivenlahti Project Comes in EUR100 Million Under Budget,” Länsimetro, March 29, 2023).