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Reduction in the Cost of Execution of Current Infrastructure Business Models

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Key Messages from the White Paper

1. New organisational forms and transactional relationships, underline the importance of private and public organisations working closely on infrastructure to co-create, capture, share revenues and deliver valuable solutions and services to end users.

   Elaboration: These new organisational forms and transactional relationships including framework agreements, partnerships, co-located integrated project teams and joint-venture companies, change balance of public-private responsibilities, risks and relationships in infrastructure provision and created opportunities for private firms to develop innovative business models.

2. Strategic choices about responsibility and risk are fundamental determinants of business model configuration.

   Elaboration: These decisions influence a client's value proposition, organisational approach, capabilities in the value chain, revenue sharing mechanisms, and transacting relationships with other partners in the value network. It follows, risk placement and responsibility are important factors influencing the emergence of innovative business models

3. New organisational forms and transactional relationships, underline the importance of private and public organisations working closely on infrastructure to co-create, capture, share revenues and deliver valuable solutions and services to end users.

   Elaboration: These new organisational forms and transactional relationships including framework agreements, partnerships, co-located integrated project teams and joint-venture companies, change balance of public-private responsibilities, risks and relationships in infrastructure provision and created opportunities for private firms to develop innovative business models.

Abstract and Key Words

Business Models

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Reduction in the Cost of Execution of Current Infrastructure Business Models

1 Introduction

The growth and prosperity of advanced nations is dependent on physical infrastructure, including communications (e.g. postal, telephone and internet), transportation (e.g. road, water, air), energy (e.g. electricity and gas) and other utilities (e.g. drinking water and waste) (Chandler, 1977). Infrastructure underpins the essential services of modern economic life. As a result, it delivers significant benefits, both directly through the services it delivers, and indirectly, through the impact of those services on the rest of the economy. However, these benefits come at a cost. Infrastructure is expensive to build, operate and maintain, and often produces large negative externalities, such as CO_2 emissions, noise and pollution, etc. Moreover, infrastructure is typically long-lived, so the costs of any poor choices, let alone mistakes, can be extremely high. To complicate matters further, the costs and benefits of infrastructure provision fall unequally across society, and are often impossible to objectively compare. Infrastructure investment is inherently political.

Despite this complexity, there is a degree of consensus that the UK needs to spend more on upgrading its infrastructure. Much is badly out of date, and the UK has legal commitments to address climate change. The 2014-15 World Economic Forum Global Competitiveness Report ranked the UK ninth in terms of competitiveness, but only 28th for the quality of its infrastructure. This may well be having a negative effect on how attractive the UK is to investors and as a place to live and do business. Lack of infrastructure has a significant cost – travel congestion, for example, eats into productive time and reduces efficiency and performance.

When investing in infrastructure there is a very large variance in the actual costs. This creates an opportunity cost: what else could the money be spent on? Costs over-runs on projects can be extremely large, and hence these counterfactual costs can be huge. The cost over-runs on the F-35 project are estimated to be in the region of $1.4trn, enough to go a long way towards putting a carbon scrubber on every power station in the world. Hence, a key issue for policy and industry is how to reduce the costs of infrastructure, and ensure that investment is both effective (the right things are built) and efficient (they are built as cheaply as is reasonably possible, but no cheaper). Moreover, effectiveness needs to avoid locking society into long-lived choices, that may seem appropriate now, but will seem inappropriate in the future as conditions and technologies change.

The focus of this white paper is on improving the execution of business models in infrastructure delivery projects, and what is means for firms and governments. The white paper argues that infrastructure projects (including the transition into operations and operations themselves) are subject to significant variance in their costs, which are caused by a variety of features of projects. Some of these can be managed by firms, some can be addressed by governments, and some are down to luck. Improving the efficiency of infrastructure provision, and influencing its effectiveness, is therefore in part an issue of organisational design. Efficiency is improved when the risks are allocated to the economic actors best able to manage them.

2 Business Models in Infrastructure

A business model refers to how a firm, endowed with given technology, capabilities and assets successfully configures its organisational structure (Teece, 2010) and transactional relationships with external stakeholders (Amit & Zott, 2001). It describes how all of the elements or components of a business – such as a firm's capabilities, resources, and position in the value network as well as its strategy – fit together as a whole to create value for the firm *and* its customer(s) (Magretta, 2002).

The key generic tasks in infrastructure provision form a network of value-creating activities as shown in Figure 1.

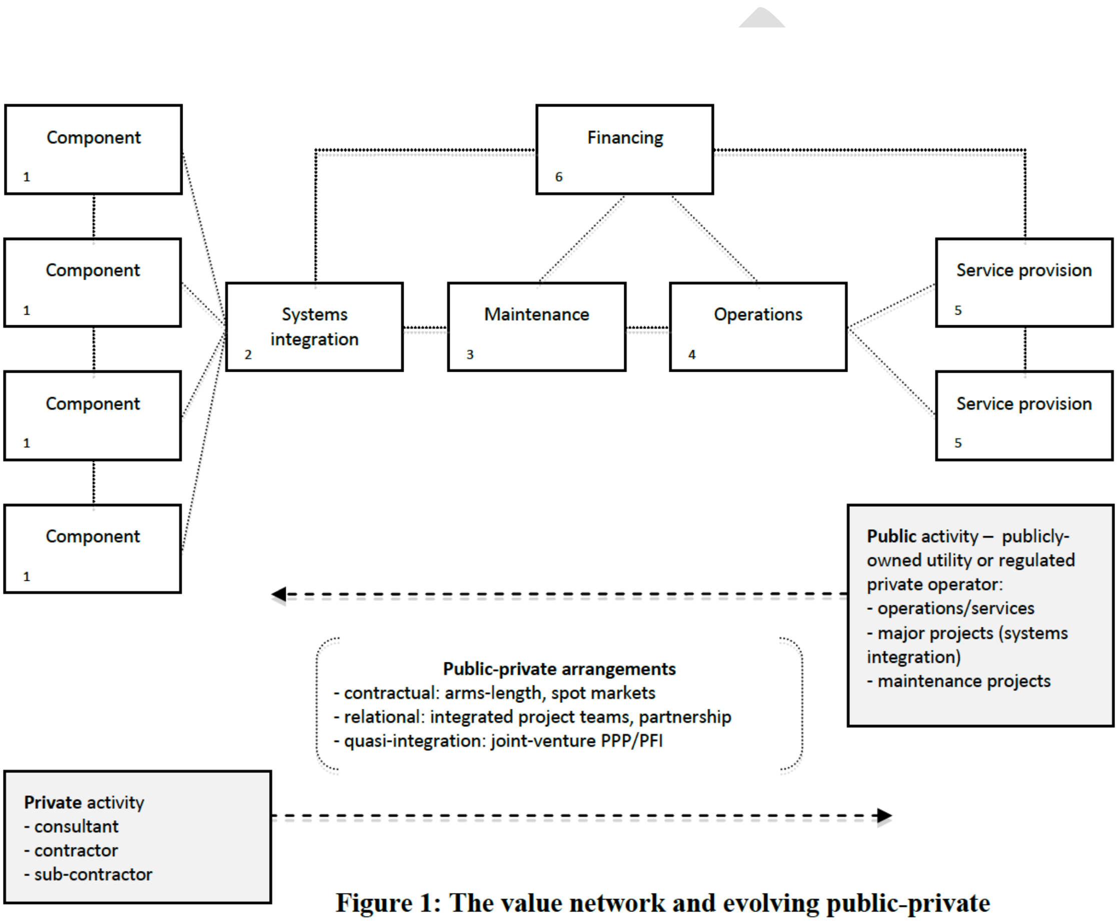

Figure 1: The value network and evolving public-private interface in infrastructure provision

Moving from left to the right side of the value network, value is progressively added by performing a number of activities (numbered in boxes) that are required to provide services to end users of the infrastructure such as individual citizens, business and government customers:

(1) The supply of components refers to the physical products (parts, materials, and sub-systems) and technical services (e.g. technical consultancy) involved in the design and construction of new build systems, such as facilities, buildings, IT and physical infrastructure.

(2) Systems integration refers to high-level task of performing the overall design, build and integration of components into a functioning system, including the coordination of a network of external and internal component suppliers.

(3) Maintenance refers to the services involved in maintaining, preserving and extending the potential life of fixed assets.

(4) Operation refers to the range of services required to operate a system throughout its life cycle, such as monitoring, controlling and optimising the performance of buildings and infrastructure.

(5) Service provision refers to the delivery of a range of services to meet end user requirements, such as improvements in reliability, safety and performance and added value services (e.g. online „pay as you go‟ underground train services) and other enhancements that improve the user experience.

(6) The financing element of infrastructure provision relates to different activities in the value network, such as asset management in maintenance (activity 3) and Design-Build-Finance-Own-Operate projects (activities 2-5).

Historically, during the 19th century, radically new infrastructure technologies such as railways, telegraphs, telephony and electricity systems were introduced in the US (and to a lesser extent Europe) by competing private firms that created a variety of business models to profit from technological innovation. After this initial period of competition, these new infrastructures in transport, water, energy and communications became considered 'natural monopolies' and placed under various forms of public ownership in Europe and Federal regulation in the US. Private business models could no longer attract sufficient investment and were unable to offer viable efficient alternatives to monopoly. Government funding or regulation was required to overcome market failure by ensuring that the value created was distributed evenly to meet efficiency and universal service obligations.

Over the past two decades, the boundaries and responsibilities of public infrastructure monopolies have been reshaped (Graham & Marvin, 2001). As demands on Government budgets have grown it has become harder for them to finance large scale infrastructure projects and for twenty years or more this has driven a trend towards seeking to utilize private sector expertise in delivering public sector projects and programmes. Many core activities previously performed by public-sector infrastructure operators have been transferred to the private sector. A favourite mechanism to facilitate this has been Public Private Partnerships or PPPs. PPPs span a variety of possible relationships between the public and private sectors for the co-operative provision of infrastructure services ranging from fully public to fully private. PPPs were used in the USA by the Federal Government during the 1950s and 1960s to stimulate private investment in inner-city infrastructure and regional development. The Carter administration in the 1970s, the Reagan administration in the 1980s and the Clinton administration in the 1990s continued and expanded their use, based on the premise that the private sector could more efficiently and effectively provides goods and services than the public sector. They have been used extensively in the USA for prisons, water supply and wastewater treatment (Kwak et al, 2009).

PPPs became much more popular in the 1980s when some governments were pursuing policies of privatization and reviewing the role of the state in providing a range of services.

The Thatcher government in the UK in the late 1980s was strongly influenced by the US experiences and implemented similar PPP schemes to stimulate economic regeneration at local level and there followed a rapid growth of public private partnerships for the development of public sector infrastructure. The rise of 'new public management' (NPM) ideas in the 1990s coupled with market-based philosophies further influenced the development of PPPs. PPPs became very popular in Australia during the 1990s where the focus in the early 1990s was on roads, hospitals, water and power spreading during the mid 1990s to ports, prisons and sport stadia, in the late 1990s to airports and in the early 2000s to defence, schools and courts. European countries were attracted to PPPs – including Spain, the Netherlands, Denmark, Germany, Hungary, Italy, – but it was the UK where their use really became widespread.

In 1991 when John Major's Conservative Government imported the idea of the Private Finance Initiative from Australia it was considered the best way to draw private finance and professional expertise into public services and to safeguard investment in infrastructure in times of fiscal constraint. It was believed PFI had many advantages as it enabled public sector organisations to spread the cost of infrastructure investment over the lifetime of the asset. More importantly for government departments facing pressure on their budgets PFI could be off-balance sheet because of the transfer of risk typically involved. Labour's Tony Blair and Gordon Brown fully embraced the concept and expanded the PFI programme to such an extent that it became seen as the only game in town. PFI projects were used across a range of sectors including schools, hospitals, roads, prisons, housing, defence and waste facilities – much like in Australia. Reports by the National Audit Office (NAO, 2003, 2005) comparing the construction performance of PPP and traditional procurement found that only 30% of conventionally procured projects were delivered on time and 27% within budget compared to figures of 70% and 78% for PPPs. Despite this relative success, some high profile PFI failures led to a torrent of criticisms of the scheme and the global financial crises of the late 'noughties' made it increasingly difficult to secure private funding for PFI projects which resulted in the Government having to fund them with public finance. PFI came to be associated with the word "toxic" – referring to the debts that the public sector had been saddled with and no politician dared to mention the term in relation to public procurement.

Despite this demonization the Tory/Liberal coalition government that replaced Labour in 2010 continued to commission new PFI projects across a wide range of sectors including transport, education and health. But in November 2011 the Chancellor of the Exchequer, George Osbourne announced a substantial review of PFI and in December the Government issued a call for evidence inviting any party with an interest in the delivery and financing of public assets and services to share their views about what reforms should be made to the PFI process to improve its performance. When the call for evidence closed on February 10th, 2012 a total of 139 organisations plus 16 individuals had responded. December 2012 saw the publication of a report "A New approach to Public Private Partnerships", (HM Treasury, 2012) which presented a detailed account of the new scheme and the thinking behind the remodelling of the scheme.

The report pointed out a number of unsatisfactory aspects of the original PFI model, including the slow and expensive procurement process which led to increasing costs and reduced value for the taxpayer; the inflexibility of PFI contracts which made it very hard to adapt to changes in requirements over the life cycle of a PFI project; insufficient transparency in the future liabilities to the taxpayer or on the returns made by investors in PFI projects; the inappropriate transfer of risks to the private sector leading to higher risk premiums being charged to the public sector; and the concerns about value for money of PFI projects because of windfall gains perceived to have been made by equity investors in PFI projects. It also suggested that the PFI mechanism had been used on a number of projects where it was unsuitable – e.g. those with insufficient long-term certainty on the future requirements of services or those where rapidly changing technological requirements made it hard to predict requirements over the long term - and therefore failed to provide value for money.

PF2 maintained the view that the private sector should be involved in the delivery and investment in public infrastructure and services. It was designed to address a number of issues including taking on board the implications of the recent and on-going economic situation; speeding up the time from inception to contract; making the whole process more transparent; moving towards centralised procurement; providing for more flexibility in contracts; Government to become a shareholder in future programmes; and moving towards gainshare arrangements so that Government and private sector shareholders would benefit equally from any financial reward.

PFI works best for large projects in conditions of relative certainty. Where certainty is lower – perhaps because of a lack of knowledge of the condition of the assets, or of future service requirements – the PFI's disadvantages begin to outweigh its advantages.

3 Projects:

Projects are time bounded, co-ordinated activities that move from an initial plan or idea, to its implementation in a completed artefact or system or set of activities. In effect, projects move from ideas to artefacts, and once complete, the project ends. Projects are therefore inherently forward looking and uncertain. At the start of a project the end result may be known, but it may well be unclear how to get there. As a result, projects involve proposing solutions to achieve intermediate end points, which are then implemented and either modified if they fail, or built on if they succeed. Typically the outcomes of high level design choices, will have implications for the design of lower-level components and systems. The extent of the over-runs in the time taken to deliver a project, its costs, and variances on quality, therefore depend on the number of redesign cycles that need to be explored to find the final project solutions. In general the more complex a project is, the more likely it is to go wrong, which in turn means proposed solutions will need to be modified, (creating the potential for redesign chain reactions) and hence the more variance there will be in its costs. This variance increases uncertainty, which itself generates additional costs.

A number of features of projects influence this variance in costs:

a) The number, size of the tasks involved, which tends to increase complexity as they get larger. More tasks increases the potential for things to go wrong. This can be addressed by standardisation and modularity in the design of the project and its organisation, as well as by organisational learning and improved project management.

b) The extent to which the project is novel and requires the discovery and use of new 'operational principles' or technologies. Projects that can draw on well-established ways of working and techonlogies are less likely to suffer failures. This risk can be mitigated by avoiding innovation or taking innovation off-line and using demonstrator projects before new approaches are introduced.

c) Complexity is not just about the number of components and subtasks within a project, or their novelty. It also relates to how inter-dependent the sub-tasks (and sub-components and subsystems) are. The more that components interact with each other, the more likely it is that problems will emerge and diffuse through the project. This complexity can be reduced by improved design, more modular systems and standardisation.

d) Organisational structures, also influence project performance. The size, novelty and complexity of the design, are often mirrored in larger, more complex organisational structures for design and delivery. This increased organisational complexity complicates communications, and increases the potential for misunderstanding and late or limited diffusion of essential information. Many large projects, are too large for a single organisation, and as a result a web of specialist suppliers will be involved in its deliver, typically co-ordinated by a systems-integrator. The resulting inter-organisational communications problems only compound the existing intra-organisational issues, and are themselves compounded because projects, organisations, risks, capabilities and incentives are unlikely to be perfectly aligned.

e) The variance in project costs is also influenced by how "fragile" the underlying technologies are. This reflects how isolated changes are within the design. Some technologies, such as bricks are robust to changes. While others, such as software are fragile. As a result, even a small change in design can lead to a redesign chain–reaction. This makes it very difficult to scale, maintain and upgrade software, which is problematic given its importance to the operation of so many infrastructure systems. The management of these kinds of risks is non-trivial, but they can be reduced by using well-established methods and technologies, keeping fragile technology (like novel software) off critical paths, and by reducing design and organisational complexity.

f) The clarity and consistency of customers' demands also influences project performance. When customer requirements are clear and unchanging, and there is good shared understanding of them within the project team, variance is reduced.

However, if customers constantly change their requirements, designs and deliver have to be modified, which can have serious knock-on effects to overall costs.

g) Similarly, the original specifications may have been appropriate, but if the external environment changes, they may well need to be modified, creating additional project risks. The long-time scales involved in large projects increase this risk. Similarly, long time scales can mean that designs become inappropriate if the available technologies are rapidly changing.

h) Lastly, there will be psychological and cultural factors that can cause an inability to foresee and adapt to problems that may seem obvious to others. These will be positioned within a wider social and political environment, that will influence the extent of commitment to failing projects, and the ability and inability of political actors and firms to respond.

These features help explain why a project like building a brick wall, (where there is little interdependence, the technology isn't fragile, the tasks are limited, the design, customer's requirements and environment are relatively stable), is likely to have limited cost variance and can be relatively easily predicted *ex ante*. By contrast, a large, complex, software intensive project like building a new missile defence system or fighter jet, is highly inter-dependent, highly fragile, organisationally extremely complex, politically fragile over the long time periods involved, and hence subject to changing customer requirements. As a result, it is more likely to have significant cost variance.

When producing infrastructure, some of these risks can be managed by reducing their underlying causes, and by improving the capabilities of actors to manage them. Reducing costs is therefore partly an organisational design problem, which requires ensuring that the right organisations, with the right capabilities, are managing the right kinds of risks.

4 Organisational Design Problem

Infrastructure provision is complicated because projects do not necessarily overlap with a single organisation, and webs of organisations do not necessarily match the distribution of risks. Hence the key issue is to ensure an organizational match to reduce execution risks as far as possible. This requires identifying where risks are, and where the capabilities and willingness to manage them are, and then arranging the system (as far as possible) to ensure a better overlap. Sometimes the risks cannot be managed, and under such circumstances, the State ends up acting as "risk manager of last resort", even if the State lacks any real capability to manage those risks. So while governments can attempt to outsource delivery and delivery-risks, if things go catastrophically wrong, the final default position is that the State acts to 'keep the lights on'.

5 Managing Infrastructure Costs

When economists talk about cost they are generally referring to the money that is spent in creating goods or services. Price, on the other hand denotes the amount the buyer has to pay for the good or service and is usually higher than the sellers' cost of production. Selling products at the production price, breaks even, (i.e. producers would not lose money on the sale), but would also mean they would not make a profit either. Hence a mark-up is usually included. For businesses cost is usually a *monetary valuation* of the factors of production – materials, resources, labour, time and utilities (electricity, water, gas etc.) and (more intangible) factors such as the risks incurred and the opportunity forgone in producing some other good or service with the factors of production. This latter is referred to as the opportunity cost of production.

Reducing the costs of the inputs – factors of production – has been the focus of a number of initiatives both in the UK and abroad. For example, in Queensland in Australia the State government came up with a suite of initiatives to try to reduce the cost of transport infrastructure including: removing 'nice to have' features from investment project scope; encouraging innovation, research and technology to drive money saving ideas into practice; to improve technical and project delivery skills to reduce effort and to deliver SMART solutions; using packaging and delivery options to reduce the cost of projects; to review specifications used for procurement and the guidelines for design and decision-making including benchmarking against other states; improvement of asset management practices and investment decision-making. In the UK a 2010 review into the cost of infrastructure confirmed that the UK was more expensive than its European peer group [Infrastructure Cost Review: MainReport, 2010]. The higher costs were mainly generated in the early project formulation and pre-construction phases and a number of contributing factors were identified including:

- stop-start investment programmes and the lack of a visible and continuous pipeline of forward work;
- blurred governance structures and a lack of clarity and direction over key decisions at inception and during design;
- the management of large infrastructure projects and programmes within a quoted budget, rather than aiming at lowest cost for the required performance;
- over-specification and the tendency to apply unnecessary standards, and use bespoke solutions when off-the-shelf designs would suffice;
- inefficient and bureaucratic use of competition processes, with some clients risk averse to the cost and time implications of potential legal challenges; and
- lack of targeted investment by industry in key skills and capability limiting the drive to improve productivity performance.

The review concluded that infrastructure costs could be reduced by at least 15%. A programme of improvement was identified with the following objectives:

- to create better visibility and continuity of the infrastructure investment pipeline

- to implement effective governance of projects and programmes
- to instil greater discipline in the commissioning of projects and programmes
- to develop smarter ways to use competition
- to create an environment that encourages industry to invest in efficiency and reduce direct construction costs

Four years later another Treasury report suggested the 15% reduction in costs had been achieved across infrastructure sectors [Infrastructure Cost Review: Measuring and Improving Delivery, 2014] although the precise amounts and the drivers behind the savings varied from sector to sector. For example, in railways, highways water and flood defence savings were achieved through improving collaborative engagement with supply chains, better governance, grouping projects into programmes and the use of smart procurement processes. Other savings were achieved through savings in technology cost - for example in electricity generation from renewable resources as nascent technologies such as photo-voltaic panels mature and reduce the input factor cost for solar energy.

When producing infrastructure there are a number of inter-related risks that contribute to costs that can be managed.

Project risk and associated additional cost – this is an endogenous risk related to the effective and efficient management of the project (i.e. ensuring effective communication of design changes to relevant organisations, effective organisational structures etc.). This is a risk that can be managed by firms, and therefore should be placed with them, with suitable incentive structures (rewards and punishments) to ensure it is effectively managed.

Political risks – for example, Government customers changing their minds, or changing designs. This would also include political risks from social groups interfering with the delivery of the project (for example, environmentalists concerned about environmental impact, or local residents concerned about noise, disrupting the project). This is largely an exogenous risk to the project, that should be managed by the government, and the costs passed on. There is obviously an issue that there isn't a single entity 'the government' and political actors may not have the right incentives to align their behaviour with the public-good. Political risks can also be managed by having extensive and well designed public engagement activities that the public feel have an effective influence on policy. The limitations of not doing this, and adopting a technocratic approach, can be seen with the lack of legitimacy of the London airport expansion inquiry.

Investors' risks related to not getting a return. Once projects are completed, investors run the risk that they will not make a return if the project is appropriated, or the funding stream is insufficient. This risk will be priced into the cost of capital, and is potentially extremely large. This can be managed by upfront contracting and the use of arms-length regulatory bodies to reduce the risks of political interfering. PFI type schemes attempt to reduce this risk by linking project provision to future funding streams. One of the most successful ways to manage these risks is for the Government to buy up a project after completion, and then securitise an asset-backed income stream based on delivery targets designed by an arms-length agency.

Organisational and capability risks for the industry. Organisational design approaches assume that there will be organisations around to undertake tasks. This may not be the case if there is insufficient demand to maintain capabilities. This is often an issue with infrastructure that tend to be 'lumpy' in their production, with contracts coming as a frequency rather than a flow. As a result, managing workforce capacity can be difficult. This in turn complicates the provision of skills (firms can rarely capture the full benefits of training and hence tend to invest below the social optimum). This risk can increase costs through increased wages for high demand skills in short supply, disruption and delays to projects as projects compete for resources and talent, reductions in innovation (and the resultant IP) etc. It can be managed by cooperation on training, and by customers (governments) signaling and managing a steadier stream of projects to even out demand patterns. (see Treasury (2014) *Infrastructure Cost Review: Measuring and Improving Delivery Improved* for an emphasis on pipeline visibility and certainty).

Cost arbitrage risks: definitions of costs differ by context. The costs of a project as delivered, for example, is likely to be different from its whole life-cycle costs. There is therefore potential for arbitrage unless there is clarity about the focus of cost analysis. This risk can be managed by customers (and final users) through whole life planning and effective cost controls.

Project management risks: Improving project initiation and procurement

Systems risks: There are also systemic risks from infrastructure interdependencies, at both the systems and organisational levels. Costs in projects and in the operation of infrastructure can be influenced by the actions of others. Often it is not clear how is responsible, which creates legal risks, as well as knock on effects for others. This can be managed by clarity on responsibilities and governance. A key part of governance is clarity on who is responsible for removing and mitigating inter-dependencies, reducing vulnerabilities and adding resilience. This is something that could be managed by industry, if the incentives and capabilities where in place, but given that is unlikely, a risk that is probably going to fall onto governments as risk managers of last resort. Markets are unlikely to properly price information that doesn't exist in markets that don't exist, so there is a classic market failure rationale for investment in information provision on the costs and opportunities involved.

Political risks at the design stage: This relates to risks that infrastructure projects are unneeded, or that projects are chosen that are unlikely to deliver benefits, increasing their opportunity costs significantly. Mckinsey (2013) identified three broad types of cost saving approaches:

1. Optimization of project portfolios - avoid investing in projects that neither address clearly defined needs nor deliver sufficient benefits. Project owners should use precise selection criteria to ensure that proposed projects meet specific goals, develop sophisticated methods for determining costs and benefits, and evaluate and prioritize projects—in a transparent and fact-based way—by their potential effects on the entire network, instead of looking at individual projects in isolation.

2. Streamlining delivery by speeding up approval processes, investing heavily in the early stages of project planning and design, and structuring contracts to encourage time and cost savings by, for example, encouraging the application of lean manufacturing to construction and the adoption of advanced construction techniques such as prefabrication and modularization.

3. Making the most of existing infrastructure by getting more out of existing capacity, boosting asset utilization, optimizing maintenance planning, and expanding the use of demand-management measures to generate significant savings.

The Mckinsey report further suggested that to spur change programs and capture potential savings:

Governments need to move beyond a project-by-project view and upgrade systems for planning, operating, and delivering infrastructure. A well-functioning system entails close coordination between the authorities responsible for different asset classes, clear separation of political and technical responsibilities, and clarity about the roles of (and effective engagement between) the public and private sectors. Other requirements include improved stakeholder management, better operational and financial information to guide decisions, and upgraded capabilities across the infrastructure value chain.

6 Conclusions

The changing balance of public-private responsibilities, risks and relationships in infrastructure provision has created opportunities for private firms to develop innovative business models. New organisational forms and transactional relationships – such as framework agreements, partnerships, co-located integrated project teams and joint-venture companies – underline the importance of private and public organisations working closely to co-create, capture, share revenues and deliver valuable solutions and services to end users. The strategic choices about the responsibility and risk are the fundamental determinants of how elements are configured into specific business models. These decisions influence a client's value proposition, organisational approach, capabilities in the value chain, revenue sharing mechanisms, and transacting relationships with other partners in the value network.

References

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