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Managing Megaprojects

Conceptual Framework and International Experience

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Simon Groom
Edna Armendariz

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Contents

Abstract

The discussion paper analyzes international experience in megaproject management, identifying problems and delivery performance. The most important distortions are optimism bias and strategic misrepresentation. It explores the approaches of Norway and the United Kingdom. Both countries have strengthened the robustness of planning and appraisal for megaprojects and have established specific methods and institutional arrangements for these projects to strengthen governance and transparency. Finally, some lessons are put forward that could help other countries, especially in Latin America, when embarking on megaprojects.

JEL Codes: H43, H54, O22

Keywords: cost overrun, institutional arrangement, megaproject, project appraisal, public investment management

1

Introduction

A consensus has emerged on the main features of a functional public investment management (PIM) system for addressing the challenges facing public investment projects of all sizes. There is, however, growing evidence to suggest that the largest projects—megaprojects—are disproportionately affected by the problems that beset all public investment and even experience problems that are particular to projects of significant scale and complexity. This suggests a need for a specialized approach to megaproject management that goes beyond the conventional PIM system. Such a strengthened system could involve supplementary methodological requirements (e.g., more sophisticated risk analysis), additional procedures (e.g., enhanced independent review), dedicated institutions, or all three.

This paper explores various options for a supplemented PIM system for megaprojects. It examines the distinguishing features of megaprojects, the special problems they face, and their effects. It then proposes methods and institutional arrangements that could be useful in addressing the two most important distortions: optimism bias and strategic misrepresentation. The paper looks at specialized approaches developed and adopted in Norway and the United Kingdom that could have wider applicability. Finally, it will identify lessons for other countries, especially Latin American countries.

2

Definition of a Megaproject

While many countries define criteria for large-scale projects and subject them to deeper analysis and stricter decision-making procedures, few specify a category that covers significantly more important projects. Box 1 contains some examples of the value thresholds used to define large-scale projects and the differences in treatment implied by such a designation.

Megaprojects have features that differentiate them from large-scale projects and that could be useful in arriving at a formal definition. Broadly, megaprojects are an order of magnitude greater in scale and complexity than large-scale projects and often involve an important innovatory element. Put in more visionary terms and paraphrasing an authority on megaprojects,[1] they are designed to ambitiously change the structure of society rather than fitting into pre-existing structures without modification. Among the kinds of public projects that fit this definition are international airports, new metro lines, high-speed railways, motorways, urban road tunnels, dams, new universities, IT systems for managing health and welfare, sports stadiums, and cultural venues.

Megaprojects should also be considered from the macro-fiscal perspective. Megaprojects can potentially contribute to economic growth and become a vital part of the economy. They might create many jobs, but their role in direct job creation may be subdued because of their relatively capital-intensive nature.[2] In addition, the potential fiscal space created by good megaprojects (i.e., by generating more future public revenue) could support additional public investment and other expenditures that could translate into growth and jobs. However, when megaprojects go wrong, the fiscal implications can be significant. Due to the sunk costs in megaprojects already in execution, cancellation is rarely an option. Consequently, public projects will continue to waste taxpayers' resources for some time, or fiscal contingencies will rise under a mixed private and government arrangement (PPP).[3] In both cases, weakened

[1] Professor Bent Flyvbjerg and other academics associated with him have led the field in exploring the particular problems of megaprojects and will be referred to frequently in this note.

[2] Once operational, megaprojects create additional jobs indirectly. Their positive spillovers include training and on-the job knowledge transfer, creating job opportunities that otherwise would not exist.

[3] In developing countries, the government can obtain a share of megaprojects' value-added through taxes, dividends,

BOX 1: INTERNATIONAL DEFINITIONS OF LARGE-SCALE PROJECTS

South Korea

For the purposes of its PIM system, South Korea defines large-scale projects as those costing more than KRW50.0 billion (US$40.0 million). Central government projects that cost more than this amount are subject to an independent analysis of their social profitability—the Preliminary Feasibility Study—as an input into a decision on detailed planning and eventual budget funding. The final decision is made based on a multi-criteria analysis, incorporating social cost-benefit analysis, national policy analysis, and regional distribution analysis. A lower figure, KRW30.0 billion (US$33.0 million, is used to define large-scale projects at the local government level that benefit from central government funding.

Ireland

Ireland applies a different methodology to conduct the economic analysis of large-scale projects, which are defined as those having a value greater than EUR 10.0 million. Such projects are subject to social cost-benefit analysis, whereas lower-value projects are evaluated using more qualitative techniques, such as multi-criteria analysis (which, unlike in South Korea, excludes the results of social-cost benefit analysis). The threshold originally began at EUR 50.0 million but has been lowered over time.Following the Norwegian model (see below) projects with a value greater than EUR 100.0 million are subject to more stringent review and decision making.

France

In France, *ex ante* evaluations of projects with a value of greater than EUR 20.0 million are subject to counter-expertise by the Secrétariat G*énéral pour* L'investissement under the Prime Minister. This is a review to critically examine the methodological approach (to ensure conformity with guidelines), the calculation of parameters used in the appraisal, and the appraisal findings. It produces an opinion that is submitted to the prime minister.

European Commission

Projects with a value greater than EUR 50 million that are seeking funding through the European Union's regional development funds must apply the cost-benefit analysis methodology established by the Directorate-General for Regional and Urban Policy and must submit the results to the European Commission for analysis.

public finances can exert pressure on the country's fiscal position.

With respect to budgeting for megaprojects, their implementation will almost certainly require significant realignment of intersectoral or ministerial budget allocations, requiring high-level political assent. Such projects are also likely to have non-negligible macro-fiscal consequences, actual or contingent, which requires careful programming and monitoring by the finance ministry. For example, the Athens Olympic Games 2008 and the construction of Hong Kong's new international airport both had negative impacts on the respective country's international credit rating. Decisions about individual megaprojects therefore need to

and profit-sharing agreements, although a large portion of megaprojects' earnings go directly to pay off foreign shareholders or creditors, especially early in the production phase when the debt incurred by the project needs to be paid off.

be made in the context of a country's medium-term fiscal and debt policy—and may even influence the design of such a policy. Considering any fiscal rules in place,[4] they may even impinge on the design of such policy. The sheer scale of megaprojects also means that poor decisions have a disproportionate impact on allocative efficiency, tying up vast fiscal resources that might have been better deployed on smaller-scale projects that could have been more efficient in generating welfare improvements.

Given the preceding discussion, is it possible to define a megaproject in operational terms? As with large-scale projects, total cost is likely to be the best proxy. One unofficial international definition proposed[5] is that the project cost exceeds US$1 billion. This is consistent with a definition sometimes used in the private sector (Parth, 2014). While not using the term 'megaproject,' the United Kingdom singles out projects with total life-cycle costs in excess of GBP 1.0 billion (US$1.4 billion). In the past, South Africa[6] has used the term megaproject to describe projects costing more than ZAR 1.0 billion (US$68.0 million[7]), although the latest National Treasury guidelines now refer to them as large strategic infrastructure projects.[8] Vietnam's 2014 Public Investment Law defined projects of national importance, which require the highest level of political approval, as those with total costs in excess of VND 10,000 billion (US$435.0 million).

The examples above indicate that, in practice, what constitutes a megaproject varies with country circumstances, reflecting political preferences, economic and fiscal characteristics, and public sector capacities. Insofar as megaprojects are seen to require special treatment within the overall PIM system, or even a supplementary system, it is up to individual jurisdictions to come up with their own definition, within reasonable boundaries. The examples above and elsewhere in this paper provide some guidance. Just as the definitions of public investment and large-scale project will need to be formally defined in the regulatory framework for PIM, the same will be required for megaprojects if specific treatment is envisaged.

[4] The same is true of 'major' projects, but these will be considered from an aggregate, portfolio perspective.

[5] This is a definition used by Flyvbjerg when discussing issues relating to megaprojects, but it is not clear how rigorously this definition has been applied in his empirical research. Flyvbjerg also suggests additional criteria, such as a project's duration and its 'transformational' nature.

[6] See, for example, the National Treasury's 2011 Capital Expenditure Guidelines.

[7] When this definition was initially set in the National Treasury guidelines, the threshold would have been higher in U.S. dollar terms. The rand has subsequently experienced a significant devaluation.

[8] See the National Treasury's 2017 Guidelines for the Preparation of Budget Submissions for Large Strategic Infrastructure Projects and 2019 MTEF Technical Guidelines.

3

Megaprojects Compared to Other Public Investment Projects: Similarities and Differences

Before initiating a discussion of the specific problems of megaprojects, it is worth recapping why public investment is worthy of special attention in the broader processes that make up a country's public financial management (PFM) system and reflecting on the desirable features and outcomes of an effective PIM system. This forms the basis for a discussion of the ways in which megaprojects might diverge from other projects and the possible supplementary features of a PIM system that might be required to address these divergences. It may be that distinct institutional arrangements, involving an independent regulatory and operational framework, could offer some advantages, given the characteristics of megaprojects. However, it is important not to undermine the PIM system by setting up parallel paths for megaprojects and other types of projects.

3.1 Overview of Public Investment Management

3.1.1 Characteristics of Public Investment

Public investment has certain characteristics and susceptibilities that distinguish it from other forms of public expenditure and that warrant special attention within the broader PFM system. These features, listed below, become more pronounced and more demanding of management attention the larger the scale of the investment:

- Uniqueness: Expenditure on investment projects tends to be a one-off and is rarely repeated in the same form. This gives such projects a uniqueness compared to recurrent expenditures, although their non-standard character-

istics can be exaggerated and result in biases (as will be discussed later).

- Lumpiness: Such projects also tend to be 'lumpy,' meaning that they are not generally scalable and an all-or-nothing decision often has to be made.
- Long implementation time: Large-scale investment projects are also implemented over several years, posing problems for budget systems where appropriations are annual, and requiring capacities to monitor progress and re-program expenditures accordingly.
- Politicization: Large-scale projects can be deeply politicized, presenting both political problems and political opportunities that can influence rational choices. Problems arise from the possibility of objections from discontented citizens who are adversely affected, such as those who must be resettled or whose land is seized. Opportunities arise from the vote-winning potential of high-visibility public expenditure, bringing short-term, construction-related jobs and profits in marginal constituencies. The political opportunities create the risk of so-called pork-barrel projects, which are instigated purely for electoral gain or political bargaining. Such projects may turn out to be white elephants, that is, excessively costly prestige investments for which there is little or no demand.
- Corruption: In addition to the political dimension, which leads to misallocation of public resources, public investment projects are also much more prone to corrupt practices than other forms of expenditure due to the large contracts involved. Corruption results in the misappropriation of public resources.
- Creation of long-lived assets: Finally, public investment creates long-lived capital assets requiring planning of maintenance and operations expenditure over the life cycle to deliver sustained benefits.

All of the issues listed above are likely to grow disproportionately with the scale of a project, bringing them to a pinnacle in megaprojects. Successful planning, implementation, and operation of public investment require minimum standards of public sector governance and management capacities. These are not easy to achieve, even in countries that are advanced in other respects. Countries that do not adhere to these standards often experience the following negative effects, which undermine the efficiency and effectiveness of public expenditure:

- The wrong projects are selected, more efficient alternatives and/or better projects are ignored/dismissed, and public expenditure is misallocated.
- Budgetary resources are dispersed over too many projects that are implemented too slowly.
- The lack of feedback mechanisms perpetuate failures.
- Projects are delivered over-budget, late, or to the wrong specification or quality standards
- Ultimately, public service delivery and the expected social benefits are compromised, government policy goals are missed, and national well-being is lower than it could otherwise have been.

3.1.2 Characteristics of a Well-functioning Project Investment Management System

A consensus has emerged on the basic characteristics of well-performing PIM systems. They are encapsulated in various diagnostic frameworks (e.g., IMF, 2015; World Bank, 2010). Drawing on these frameworks, the institutional design of the PIM system should ensure the following:

- Aggregate public investment is kept at a level that does not threaten fiscal stability through unsustainable borrowing.
- Fiscal risks from public investment, including the PPP portfolio, are identified early and proactively managed.
- Actionable strategic guidance drives initial identification of investment project concepts, which are screened accordingly for consis-

tency with this guidance, as well as for project rationale and affordability.

- Screened projects are subject to systematic and objective appraisal of their social profitability and sustainability as well as their technical feasibility, and an impartial third party scrutinizes the findings.
- New projects are selected for budgetary funding contingent on a positive appraisal decision and consistent with policy priorities, available fiscal space, and the funding requirements of ongoing projects.
- Project implementation involves competitive procurement and delivery-focused project management and accountability arrangements.
- Responsive implementation monitoring is in place, together with flexible arrangements for adjusting ongoing projects within predefined boundaries and reassessment of off-track projects.
- Implementation performance and project impact are reviewed upon completion or at various points after completion, and lessons are fed back at various points in the project cycle, including at identification, appraisal, and selection of new projects. Findings can also be used in portfolio balancing and PIM system design.
- Integrated budget planning and asset management policies support sustainable delivery of services from newly created assets to target beneficiaries over the planned project life cycle.

Developing the necessary institutional arrangements is not straightforward because it requires relatively advanced technical capacities as well as a sufficiently strong coalition of the willing at the political level.

3.1.3 Expected Outcomes from a Better-functioning Project Investment Management System

A direct relationship between PIM practices and outcomes in terms of infrastructure provision and quality is difficult to pin down. An IMF paper (IMF, 2015) has recently tried to quantify the relationship. One of its main findings was that countries with stronger PIM institutions make more stable, credible, efficient, and productive public investments and have lower perceived levels of rent-seeking and corruption. The paper determined that strengthening PIM practices can reduce the measured public investment "efficiency gap," that is, lost infrastructure output per dollar spent, between the best performers and the rest by around two-thirds. The research showed that the largest payoffs from strengthening PIM systems were likely to be found in emerging market economies and lower-income developing countries. However, due to the small sample size, causality was difficult to establish.

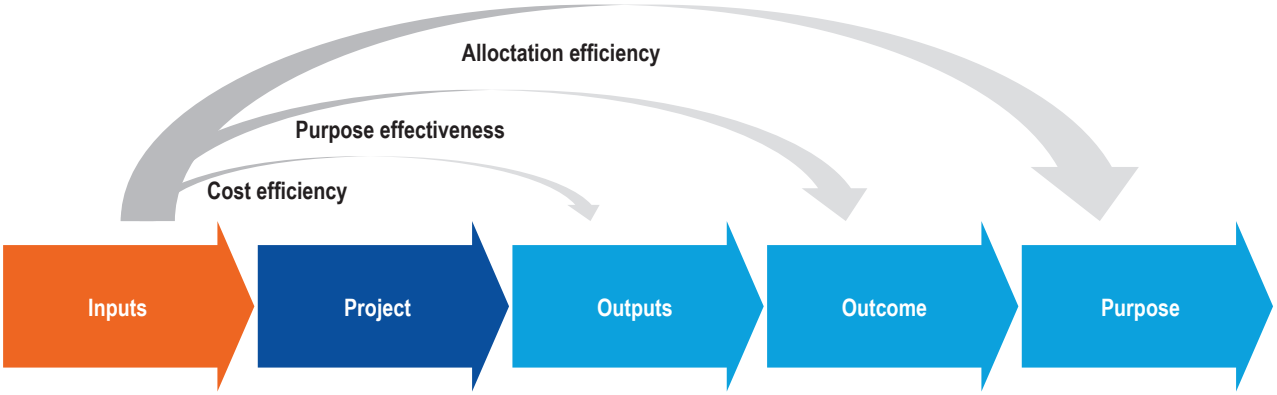
Other attempts to quantify the potential savings from strengthening PIM have been made. A recent report by McKinsey estimated the potential cost savings from eliminating wasteful projects by employing better project selection and improving allocative efficiency as being in the region of 15–20 percent.[9] In a more theoretical exercise, Little and Mirrlees, pioneers of cost-benefit analysis, estimated the expected value of improved project appraisal to be at least 10 percent of capital costs (Little and Mirlees, 1994).

The rate of rejection in better-performing countries reveals the kinds of gains that might be attainable from more rigorous selection processes. In Chile, a country with a strong system of appraisal, between 54 and 67 percent of projects (69–77 percent by value) were assessed on first submission as being feasible, or socially recommended, depending on the year (Gomez-Lobo, 2014). In South Korea, only 64 percent of major projects assessed through the country's rigorous preliminary assessment process were found to be economically and socially feasible (Korea Development Institute, 2017).

Figure 1 illustrates the three areas of performance where a strengthened PIM system can act on the value chain and assist in achieving better

[9] See McKinsey Global Practice (2013). Estimate was based on a review of academic literature and by talking to experts.

FIGURE 1 THE VALUE CHAIN—LINKING INPUTS TO OUTCOMES



Source: Samset and Holst Volden (2013).

societal outcomes. Cost efficiency measures the project's technical performance in turning inputs into the planned project outputs or deliverables. Purpose effectiveness is a measure of a project's success in delivering the intended benefits to the targeted population. Allocative efficiency captures the extent to which the realization of the intended benefits delivers the desired higher-level outcomes and the project's impact on achieving national policy goals and delivery.

3.2 What's Different about the Performance of Megaprojects?

3.2.1 The Evidence

The previous discussion applies just as much to megaprojects as it does to large-scale projects. However, there is evidence that megaprojects suffer more severely from the problems inherent in public investment. Moreover, they are more prone to failure than other large-scale projects, with serious consequences for public finances, public sector performance, and the economy as a whole.

The empirical evidence on the performance of public megaprojects relies heavily on the research of Professor Bent Flyvbjerg and his associates, who have built up a large database of projects covering different countries, sectors, and time periods. Initially, the focus of this research was on the transport sector, but it was subsequently extended to other sectors. In this pathbreaking work (Flyvbjerg, 2005), significant cost overruns were discovered in a sample of 258 major transportation projects across the world, with no tendency to diminish over time.[10] In fact, nine out of ten projects exceeded their budgets, with an average real cost overrun of 45 percent for rail, 34 percent for bridges and tunnels, and 20 percent for roads. Not only were budgets exceeded, but benefits were also found to fall short of forecasts by significant amounts. Thus, in a sample of 208 road and rail projects, nine out of ten rail projects underperformed in terms of demand, with actual passenger flows on average only 51 percent of the forecast numbers. Forecasts for road projects were, interestingly, more accurate. The database and analysis were subsequently extended to cover large dams around the world (Ansar et al., 2014), of which three out of four experienced cost overruns, which averaged 96 percent in real terms. There were no significant differences in performance by region of the world. Combining the findings from his analyses, Flyvbjerg has subsequently estimated that perhaps one in a thousand projects might be expected to succeed in terms of on-time delivery, to budget, and with the expected benefits (cost-efficient and purpose-effective according to

[10] The analysis was of a large database of projects assembled for the purpose and spanning the 70 prior years.

the terminology in Figure 1) (Flyvbjerg, 2014). From this, he concludes that it is difficult to establish the reasons for success in any statistically meaningful way, because there are too few successes and the average experience is disastrous.[11]

Evidence from the private sector also indicates that megaprojects are fundamentally different from other large-scale projects and are subject to proportionately greater and category-specific problems. Analysis of a large database of natural resource megaprojects,[12] defined as projects with total costs greater than US$1.0 billion, showed a 65 percent failure rate compared to a failure rate[13] of around one-third for lower-value projects.

The empirical evidence pointing to a significantly higher failure rate for megaprojects is supported tby a body of qualitative evidence suggesting that poor management of megaprojects is an issue even in countries with strong governance arrangements in other spheres of public sector activity. Box 2 lists some notable recent problem

[11] Flyvbjerg has coined his iron rule of megaproject management to capture these findings more cleverly: "Over budget, over time, under benefits, over and over again" (Oxford Handbook of Megaproject Management, 2017).

[12] Confidential source. The database included projects in the mining and energy sectors.

[13] Failure was defined as meeting one or more of four criteria: cost increases of more than 25 percent; schedule delays of more than 25 percent; loss of cost competitiveness relative to industry benchmarks of more than 25 percent; and presence and continuation of severe operational problems two years after completion.

BOX 2: SOME EXAMPLES OF PROBLEMATIC MEGAPROJECTS

- Boston Big Dig artery/tunnel project: Cost overrun of 220 percent (final cost US$15 billion) and eight years late (construction 1991–2007).
- Berlin's new airport: Budget has doubled (EUR 2.5 => EUR 5.3) and delivery nearly 10 years late (construction 2006–2020).
- FYRA – southern Netherlands high-speed rail service: 60 percent cost overrun (final cost EUR 6.4 billion), faulty trains returned to manufacturer, and services permanently halted shortly after opening (service started 2009 and cancelled in 2013).
- Dublin Port Tunnel: total cost €752m compared to a winning bid of €457m, opening three years later than intended. Ex post evaluation indicates marginal EIRR (construction 2001–2006).
- Great Belt Rail Tunnel, Denmark: Costs increased 120 percent and completion, in 1996, was four years behind the original schedule.
- Flamanville Nuclear Plant, France: Since construction began in 2007, cost has more than tripled to EUR 10.9 billion and the project will be delivered 7–8 years late (much the same as Finland's nuclear plant of the same design).
- New National Broadband Network, Australia: In present value terms, costs exceed benefits by between US$14 and US$20 billion (announced 2007; full rollout to be completed in 2020).
- Cuidad Real airport, Spain: Cost EUR 1.0 billion (including supporting infrastructure/services), opened 2009 and closed 2012, virtually unused.
- FiReControl Project, United Kingdom: Designed to improve the efficiency and resilience of fire and rescue services by replacing 46 local control centres with 9 regional centers, the project was started in 2004 and then stopped before completion in 2010 at a cost of £469 million with nothing to show but 8 deserted buildings with limited alternative uses.

Source: Author's compilation.

projects in some of the better-managed countries of the world.

3.2.2 The Reasons

Paradoxically, despite their recognized deficiencies, megaprojects are increasingly the delivery model of choice and are becoming more, not less, prevalent. This raises the question of why they are so attractive. Four dimensions of their attractiveness have been identified—technological, political, economic, and aesthetic.[14] Technological attractiveness is the draw that pushes the boundaries of engineering possibilities: the 'longest-tallest-fastest' syndrome. Vote-winning potential and vanity (legacy projects with nameplates) are the basis for political attractiveness. At least in the short term, megaprojects are very visible in creating jobs and generating profits for contractors, making them attractive from the narrow perspective of today's economy (rather than their capacity to generate net benefits for future generations). They generate expectations among promoters, workers, professionals, banks, and investors that politicians find increasingly difficult to resist as a project concept gathers planning momentum. Finally, the opportunity to create iconic and beautiful designs is another aspect of the inherent attractiveness of megaprojects. None of these facets of a megaproject's appeal is necessarily bad, but they do interfere with objective decision-making, cost control, and disciplined implementation. They also engender an excessive focus on the creation of an asset, rather than on best way of addressing the societal problem or opportunity that the investment is ultimately intended to address. For these reasons, megaproject management needs to recognize and counter these powerful influences.

In addition to addressing the seductive nature of megaprojects, their management needs to address the weaknesses of megaprojects identified in Box 3 and tackle their potentially disproportionally negative impact on economic efficiency. One of the most common problems is too early a commitment to a particular project solution, often at a political level. An inflexible attachment to one way of doing things means that insufficient attention is paid to potential alternatives, undermining the value of critical thinking by technical experts. Other frequent difficulties include long time horizons, leading to greater exposure to risk and increased likelihood of discontinuous project leadership. The degree of risk is often not foreseen during planning, and therefore under-budgeted and under-managed—especially the risk of extreme or catastrophic events. Underestimation of technological complexity and its impact on budgets and timelines is one important issue, as is underestimation of the interplay of complicated stakeholder interests that must be accommodated when planning and managing megaprojects. While megaprojects often have non-standard characteristics, their uniqueness is often over-played by planners and managers to the detriment of learning from other projects, especially in relation to costing and scheduling. The sheer monetary scale of megaprojects also disproportionately multiplies the incentives for rent-seeking and principal-agent conflicts of interest.[15]

Some of the issues identified in Box 3 call for more intensive application of the elements of the PIM system described in Section 3.2.2. Others must be tackled through methods and processes that are geared more specifically toward megaprojects, and potentially through supplementary institutional arrangements dedicated to their management.

[14] Flyvbjerg refers to these as the four sublimes.

[15] This is usually referred to as the principal-agent problem. The principal-agent problem occurs when a principal creates an environment in which an agent's incentives do not align with those of the principal. Generally, the onus is on the principal to create incentives for the agent to ensure they act in accordance with the principal's wishes.

BOX 3: TEN NEGATIVE CHARACTERISTICS OF MEGAPROJECTS

- "Megaprojects are inherently risky due to long planning horizons and complex interfaces.
- Often, projects are led by planners and managers without domain experience who keep changing throughout the long project cycles that apply to megaprojects, leaving leadership weak.
- Decision making, planning and management are typically multi-actor processes involving multiple stakeholders, both public and private, with conflicting interests.
- Technology and designs are often non-standard, leading to "uniqueness bias" among planners and managers, who tend to see their projects as singular, which impedes learning from other projects.
- Frequently there is overcommitment to a certain project concept at an early stage, resulting in "lock-in" or "capture", leaving analyses of alternatives weak or absent, and leading to escalated commitment in later stages…
- Due to the large sums of money involved, principal-agent problems and rent-seeking behaviour are common, as is optimism bias.
- The project scope or ambition level will typically change over time.
- Delivery is a high-risk, stochastic activity, with overexposure to so called "black swans", i.e., extreme events with massively negative outcomes. Managers tend to ignore this, treating projects as if they exist largely in a deterministic Newtonian world of cause, effect, and control.
- Statistical evidence shows that such complexity and unplanned events are often unaccounted for, leaving budget and time contingencies inadequate.
- As a consequence, misinformation about costs, schedules, benefits and risks is the norm throughout project development and the decision-making process. The result is cost overruns, delays, and benefit shortfalls that undermine project viability during project implementation and operations."

Source: Flyvbjerg (2014).

4

The Two Critical Distortions of Megaproject Management and How to Deal with Them

4.1 Introduction to the Concepts of Optimism Bias and Strategic Misrepresentation

Optimism bias and strategic misrepresentation have been identified as the two critical distortions in megaproject planning that warrant special attention. Optimism bias is the psychological tendency for planners and decision makers to assume the best and systematically to downplay risks, underestimate costs, and overestimate benefits. It is a subconscious behavioral characteristic and does not necessarily represent malign intent: it can persist in highly professional environments where advanced front-end planning methods and procedures are applied, and even where peer review is prevalent. The evidence for optimism bias comes from the systematic tendency for costs to be underestimated and benefits to be overestimated, as described in Section 3.3.1: if it were a question of poor estimation rather than systematic bias, one would expect to see underestimates to be as frequent as overestimates, which is not the case. Optimism bias applies in lower-value projects, but its extent and effects balloon when it comes to megaprojects.

Strategic misrepresentation arises from a misalignment of incentives. It is more sinister because of the conscious manipulation of evidence to promote a project. It involves the deliberate distortion of risks and forecasts (of costs and benefits) to 'sell' a varnished version of the project to decision makers. The aim is to get a foot in the door, in the knowledge that once a project is approved and in the national budget it is easier to secure further funding to cover the inevitable cost increases. Often, planners are subject to political pressure to put a positive spin on a project, to get it through the starting gate. Strategic misrepresentation was used in making the case for the Oslo Opera House (see Box 4), which was initially estimated to cost EUR 240 million but ended up

BOX 4: OSLO OPERA HOUSE – AN EXAMPLE OF 'STRATEGIC BUDGETING'

"The Oslo opera also illustrates a commonly used technique in major public projects, termed 'strategic budgeting', i.e., to initiate the project using a low budget to 'get the ball rolling' before the project concept is settled, including the project's objectives and strategy. In this case this was done by commissioning at an early stage a competition for the design of the opera building. Once the planning had gained momentum, the possibilities for reversing or terminating the project were limited."

Source: Olsson et al. (Undated).

costing EUR 450,[16] excluding surrounding redevelopment costs (which had conveniently been forgotten in the initial estimate) (Olsson et al., undated). The cost escalation associated with this project was one of the triggers for Norway's PIM reforms.

4.2 Approaches to Addressing Optimism Bias and Strategic Misrepresentation

There are various possible ways to address optimism bias, including enhanced front-end techniques (i.e., better methods for estimating costs, benefits, and risks), more robust external review, oversight by independent committees, and stronger professional associations. With respect to improving front-end techniques, a stochastic approach to costing is preferable, which involves paying closer attention to estimating and applying a realistic probability distribution for costs rather than focusing purely on the best estimate. This includes a technique known as reference class forecasting, which has been promoted as a means of arriving at more realistic estimates for budgeting and contingency planning purposes.[17]

Reference class forecasting involves forcing planners to abandon perceptions of their project's uniqueness and taking an outsider's view of costs and benefits using other similar projects as a benchmark. Often this involves using international benchmarks, since prior examples may be rare in any given country. While this approach sounds like common sense, it has rarely been applied in practice, even though it can have a significant impact on estimates. The United Kingdom and Norway are applying this approach successfully.[18] In the Netherlands, a major investment in the rail sector, the Zuiderzee Line, was not pursued after reference class forecasting exposed the high risk of significant cost overruns compared to the engineers' best estimates.

Better governance practices, backed up by capacity building, are the way to address strategic misrepresentation. Such practices will entail improvements in institutional arrangements with a focus on increasing objectivity, accountability, and transparency. The impact of improved governance is not easy to identify because it is often difficult to surmise what would have happened in the absence of any change. In the United Kingdom, a dedicated organization, the Infrastructure and Projects Authority, has been established to help in better managing delivery risk. In Norway, independent reviewers are used at critical points in project devel-

[16] Later reports on the construction of the opera house state that it came in under budget. This is a comparison between the final cost and the approved construction cost after detailed design and contracting. The decision to go ahead with the project was made on the basis of the much lower cost.

[17] Reference class forecasting is based on the work of Nobel prize-winning behavioral economist Daniel Kahneman who developed its application in other domains. Flyvbjerg has promoted its use when planning in infrastructure projects. See, for example, Flyvbjerg, Holm, and Buhl (2005).

[18] Ireland has also adopted reference class forecasting in the roads sector.

opment, and their findings are then fed into consecutive decisions taken by Cabinet and Parliament.

4.2.1 Addressing Optimism Bias using Reference Class Forecasting[19]

Reference class forecasting involves estimating a realistic central cost estimate and associated probability distribution based on a sample of similar projects. It does not replace the estimation of project-specific costs by qualified engineers and planners; rather, it is an outside perspective that sheds light on any adjustments needed to the central estimate and on required allocations for planning contingencies, which can be set to reflect the risk appetite of decision makers. It is increasingly applied in both the public and private sectors and has been recommended by the American Planning Association.[20] A three-step approach to carrying out reference class forecasting has been proposed:

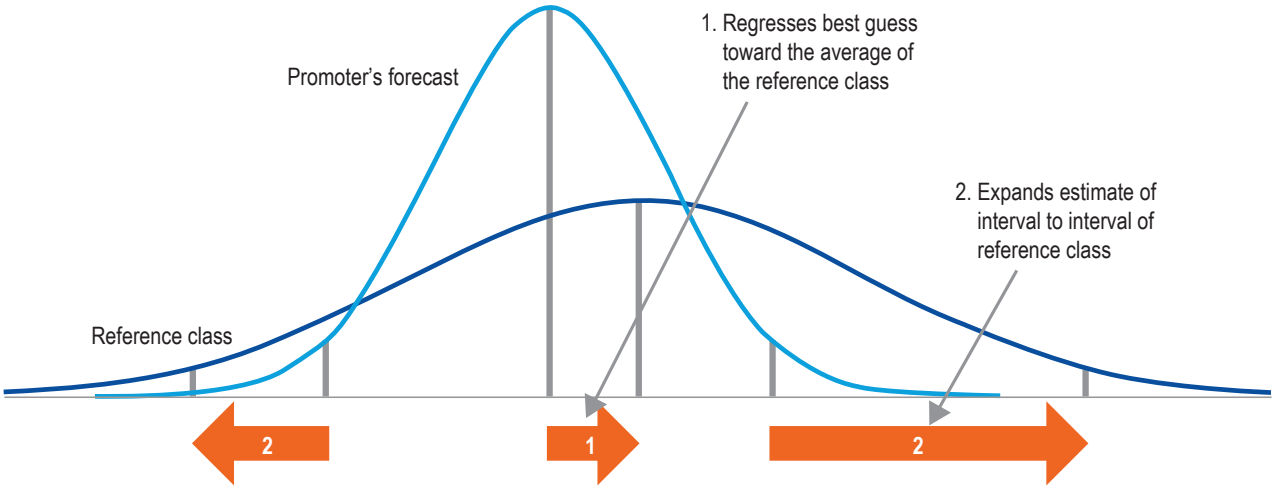
- Identification of a relevant reference class of past projects. This must be broad enough to be statistically meaningful but narrow enough to be truly comparable with the specific project.
- Establishing a probability distribution for the selected reference class. The probability distribution has primarily related to capital costs in the application of reference class forecasting, but it could equally be applied to benefits or any other key forecasting variable. This requires access to credible, empirical data for a sufficient number of projects within the reference class to make statistically meaningful conclusions
- Comparing the specific project with the reference class distribution, in order to establish the most likely outcome for the specific project.

The main drawbacks of reference class forecasting are collecting the required information and finding a statistically significant sample. It requires a dedicated effort to build up and share data, and it benefits from the exchange of information at the international level.

Figure 2 illustrates reference class forecasting in statistical terms—assuming that possible values for costs are normally distributed around

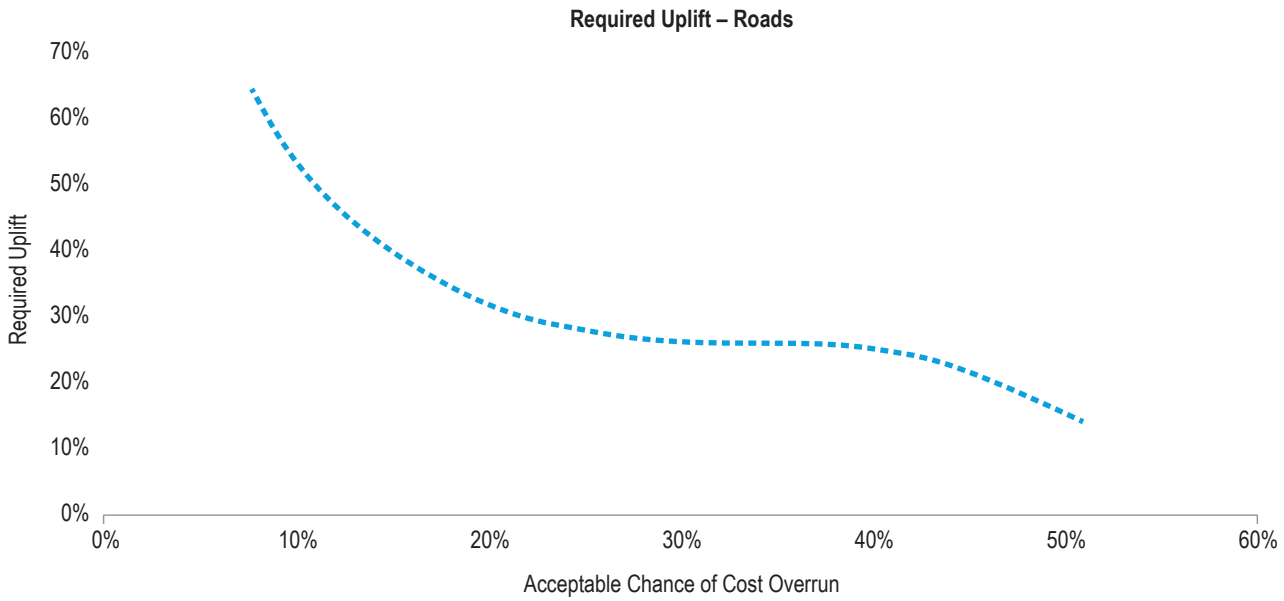
[19] This section draws on the previously mentioned work by Flyvbjerg, Holm, and Buhl (2005), which in turn draws on work by Kahneman (e.g., Lovallo and Kahneman, 2003).
[20] The American Planning Association provides leadership in the development of vital communities by advocating excellence in planning, promoting education, research, advocacy, and ethical practice.

FIGURE 2 STATISTICAL REPRESENTATION OF REFERENCE CLASS FORECASTING



Source: Flyvbjerg (2009).

FIGURE 3 RISK APPETITE AND REFERENCE CLASS FORECASTING



Source: Flyvbjerg (2006).

the mean—and indicates two key adjustments that can result. The lower cost estimate represents what inward-looking planners will come up with if they are focused entirely on the specifics of their project. Not only will their estimate tend to be lower than the actual best estimate, but optimism bias induces them to consider a relatively tight probability distribution. This means that they underestimate the probability of a cost overrun and fail to allow for adequate contingencies. Using reference class forecasting will yield not only a higher best estimate, but also a flatter probability distribution, meaning a higher probability of an overrun. As a result, there are two upward adjustments compared to the designers' first estimates: first to the central estimate of costs and then to the planning contingency to reflect the higher probability of costs exceeding the central estimate. The discussion here is about costs, but the same approach can be applied to the implementation schedule and the benefits (in which case, the reference class probability distribution will shift to the left of the project-specific distribution in Figure 2).

The probability distribution estimated through reference class forecasting can be used to make adjustments that reflect the risk appetite of decision makers, as illustrated in Figure 3 for road projects. This requires decision makers to express their risk appetite in terms of the acceptable chance of a cost overrun. Once this is determined, appropriate uplifts to the central cost estimate can be made to reduce the probability of a cost overrun. For example, Figure 3 indicates that if a 50 percent chance of a cost overrun is acceptable, then a 10 percent upward adjustment of the planners' cost estimate is required. However, if decision makers are more risk averse and the acceptable chance of a cost overrun is only 10 percent, then an uplift of 60 percent will be required. This can be further illustrated by a concrete example, the proposed Zuiderzee Line railway project in the Netherlands. The project promoter's estimated cost for the project was EUR 4.1 billion. An analysis of a reference class of 68 rail projects established that the best estimate should be 39 percent higher than the insider estimate, at EUR 5.7 billion (Flyvbjerg, 2007). This is the estimate with a 50 percent probability of a cost overrun (the expected

value in statistical terms). For a lower probability of an overrun, say 20 percent, then the adjusted estimate would need to have been raised to EUR 6.7 billion, 63 percent higher than the original estimate. Influenced by this information, this project was not built in the end. More generally, work by Flyvbjerg and his associates in relation to the United Kingdom has suggested that uplifts of 32 percent, 57 percent, and 55 percent are required for road, rail, and fixed link (tunnels and bridges) projects, respectively, to reduce the probability of a cost overrun to 20 percent (Flyvbjerg, 2006).

4.2.2 Improving Governance as a Counter to Strategic Misrepresentation

Some basic principles are evolving to guide improvements to megaproject governance, some of which remain to be tested. Making the assessment and management of project risks more central to decision making and ensuring that there is accountability for doing so are important. This requires a supportive regulatory framework that requires risks to be assessed properly and managed and that identifies the parties that are to be held accountable. Accountability may be enhanced and incentives better aligned if the role of government shifts from direct involvement in promoting projects to a more arm's length role. In such a model, government's role is restricted to formulating, monitoring, and auditing the achievement of the public interest objectives to be sought through the project. Greater transparency and the specification and monitoring of concrete performance requirements can assist in achieving more accountability for project failures that result from misrepresentation.

Flyvbjerg et al. (2003) identify the difficulty in ensuring accountability as a major drawback of the conventional approach to appraisal and development of projects. Accountability requires a means of measuring whether objectives are being met and a mechanism for penalizing failure and rewarding success. They advocate four instruments for ensuring greater accountability for project performance:

- Transparency: Public scrutiny and openness on the part of government are essential. This means engaging stakeholders and civil society, holding public hearings, and undertaking independent peer reviews. Involvement of the supreme audit institution in project reviews should also be considered.[21]
- Performance specifications: the focus of decision making should be on achieving public policy goals; this means that the intended outcomes and impacts of a project need to be established first, before consideration of technical alternatives and appraisal. Performance specification needs to be SMART (i.e., specific, measurable, achievable, realistic, and time-bound) to allow monitoring and evaluation.
- Explicit formulation of the regulatory regime: Clear rules of the game need to be established beforehand, particularly for determining risks and who bears them. Rules should cover:
  - Economic rules governing construction and operation of the project;
  - Other economic rules influencing financial and economic performance; and
  - Rules regulating the provision of complementary investment necessary for project success.
- Risk capital: A requirement for private sector financiers to participate directly in projects[22] without the surety of a sovereign guarantee, so that they are more keenly aware of and subject to the consequences of risk.

Involving more risk capital from private investors is one of the more controversial proposals for countering strategic misrepresentation. The idea is that the private sector would have 'skin in the game' and suffer financial losses if forecasts of costs and benefits fail to materialize. This involvement goes beyond public–private partnerships and extends to

[21] This has happened in the United Kingdom, with the second high-speed rail project, HS2.

[22] Flyvbjerg et al. (2003) go as far as to suggest that at least one-third of the capital should be provided in this way.

the private sector putting up risk capital to directly finance specific public sector projects (rather than through financing the public sector deficit). The intention is that the private sector will be more scrupulous in verifying the accuracy of forecasts and the assessment of risks when its financial investment is at risk. The private sector's role is purely financial in this case—focused lending for a specific project rather than lending to fund the government budget deficit—and does not imply the public sector's relinquishing control over a project.

In practice, the application of these principles points to several concrete proposals, some of which represent significantly scaled up elements of the baseline PIM system described in Section 3.2.2. Ensuring the neutrality of the appraisal process is central and must be hardwired into organizational arrangements that exclude project promoters and other vested interests. In short, appraisal of megaprojects must be performed by parties with no interest in the outcome. In addition to measures to guarantee the objectivity of appraisal, their quality and neutrality must be assured through an institutionalized high-level review process involving an impartial third party. This could even go as far as involving a country's supreme audit institution or a body of equivalent status in an ex-ante performance audit. Benchmarking against other similar projects, nationally and internationally, could be formally required. This would encompass reference class forecasting as described in the previous sub-section. In the interests of transparency, all forecasts, peer reviews, and benchmarking findings should be made available for public scrutiny, through the media, civil society organizations, and public hearings.

Misrepresentation of projects through manipulation of forecasts (i.e., "cooking the books") should have serious consequences. These could begin with severe professional sanctions and, it has been suggested, might even extend to criminal penalties for deliberately deceptive forecasts. Accountability would be enhanced by designating a single project delivery organization, with a strong governance framework and contract-writing skills. The organization and its leadership would then be fully accountable for delivery shortfalls. Where projects are evidently failing and forecast benefit-cost ratios are unlikely to be achieved because of cost overruns or benefit shortfalls, there need to be regulatory procedures for reassessing and, if necessary, stopping such projects—with consequences for the planners involved.

5

International Experience in Megaproject Management

The experiences of the United Kingdom and Norway are illustrative. Both countries have used reference class forecasting to try to strengthen the robustness of planning and appraisal for the largest projects. Both countries have also established specific institutional arrangements for these projects and have taken steps to strengthen governance and transparency. This is not to say that they have conquered the problem of megaprojects, but they have at least recognized it as a discrete issue to be addressed within the broader domain of public investment management.

5.1 The United Kingdom

The United Kingdom has employed several approaches for dealing with optimism bias and strategic misrepresentation. Although optimism bias had been recognized and addressed at a technical level much earlier, the turning point for governance reforms came in 2010 with the publication of a report by the National Audit Office (NAO) (2010), the country's supreme audit institution (see quote in Box 5).

The NAO's report provided the impetus for the creation of a specialized institution, the Major Projects Authority, and the adoption of a strengthened system of project assurance.

5.1.1 Strengthened Independent Review and Decision-making Procedures

The United Kingdom subjects higher-value projects to more stringent approval processes according to a hierarchical system, as illustrated in Figure 4. The Treasury (the economic and finance ministry) delegates spending decisions to ministries ('departments' in the UK terminology) for all spending below defined thresholds, which vary by sector, tending to be higher for economic infrastructure and lower for social infrastructure (Box 6). The Treasury reviews and approves all spending decisions above these thresholds. The set of projects falling under Treasury scrutiny/approval is called the Government Major

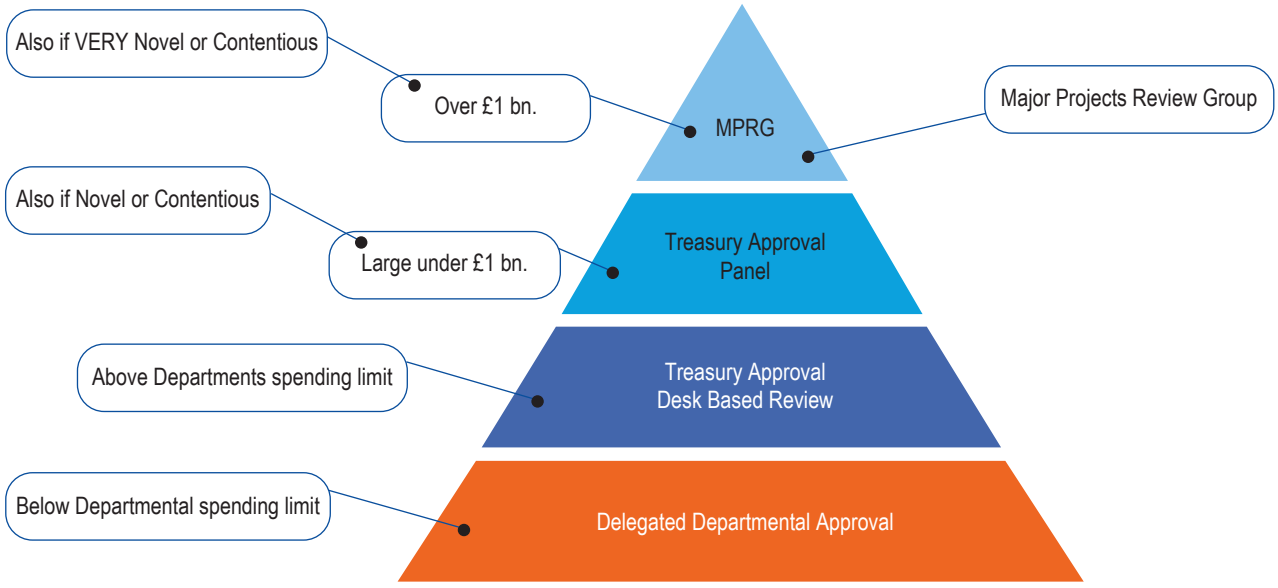
BOX 5: NAO REPORT ON QUALITY ASSURANCE OF PROJECTS IN THE GOVERNMENT MAJOR PROJECT PORTFOLIO

'The National Audit Office has today called for a central, mandatory system of assurance to be established for government. The spending watchdog recognizes that central government has made a number of improvements towards providing assurance for high-risk projects – particularly by introducing OGC Gateway™ reviews and establishing the Major Project Review Group. However, the lack of an integrated system is limiting the ability of government to make further improvements.

Central government's high-risk projects are frequently large scale, innovative and reliant on complex relationships between diverse stakeholders. Such projects frequently present a level of risk that no commercial organization would consider taking on. Projects can fail to deliver to time, cost and quality. Assurance provides information to those involved in projects, helping decision makers to be better informed and reduce the risk of project failure.'

Source: Press release for 'Assurance for High-Risk Projects,' National Audit Office (2010).

FIGURE 4 THE UNITED KINGDOM'S HIERARCHY OF REVIEW AND DECISION MAKING



Source: Presentation by HM Treasury, 2014.

Project Portfolio (GMPP), which as of September 2017 consisted of 133 projects[23] with a total whole-life cost of £423 billion (US$549.9 billion).[24] Lower-value projects within the GMPP are approved (or otherwise) based on a desk-based review undertaken by specialists in reviewing business cases. Larger projects, or those seen as novel and/or inno-

[23] When the MPA was established, there were closer to 200 projects in the portfolio, but the number has fallen subsequently, probably reflecting the impact of ongoing fiscal consolidation.
[24] See National Audit Office (2018). Project costs are reported as whole-life costs in the United Kingdom, that is, including operating and maintenance costs after completion of construction. The average whole-life cost of a project in the portfolio is £3.2 billion (US$4.2 billion).

BOX 6: DELEGATED EXPENDITURE AUTHORITY LIMITS IN THE UK

Delegated authority limits vary by implementing organization, sector, and sub-sector. Thus, in the transport sector, for example, national road projects (implemented through the Highways Agency) are subject to TAP when capital costs exceed £500 million, while local government transport projects require TAP for values in excess of £50 million. In the health sector, capital investment or property transactions with values above £50 million require Treasury approval authority (although prior consultation with the Treasury via the Department of Health is required for projects in the £35-£50 million range). For the Department of Defense, the figure is £100 million, whereas the figure for the Foreign and Commonwealth Office is £15 million. Ministries must in turn establish their own delegated limits for public agencies (arms-length bodies) falling under their responsibility: above these limits the ministry itself will scrutinize and approve investment proposals, whereas below the limit responsibility is delegated to the agency proposing the investment. Thus, for example, the Department of Health requires an investment of £10-£35 million to be approved by the Board of the National Health Service (NHS) for England; an investment of £3-£10 million to be approved by the finance and investment committee of the organization proposing the investment; and an investment of up to £3 million to be approved by a senior officer (chair, chief executive, or chief financial officer) of the proposing organization.

Source: Author's compilation.

vative, are also subject to a desk-based review but go on to deeper scrutiny, beginning with a Treasury Approval Point Panel for intermediate projects with a whole-life cost below £1.0 billion (US$1.3 billion). The criteria and constituents of the review system are explained in more detail in Annex 1.

Within the GMPP, megaprojects are subject to even more rigorous review and decision-making procedures by a specially created body, the Major Projects Review Group (MRPG). Projects that meet one of the following criteria come under the MRPG:

- Whole-life cost over £1 billion (US$1.3 billion);
- High risk and complex in their procurement and delivery of benefits;
- Sets a precedent, or are highly innovative; or
- Other projects of concern, as identified by the Treasury.

The MPRG is a standing body created in 2007 and jointly chaired by the Director General for Public Finance and Spending in the Treasury and the Chief Executive Officer for the Civil Service in the Cabinet Office (office of the prime minister). Panels are assembled under the MPRG on an ad hoc basis from a pool of experts. Panels include the two chairs and usually two individuals from a pool of public and private sector experts. The chief executive of the IPA also sits on the panels. The senior responsible owner[25] and project director for a project must attend the panel meeting and may be joined by other members of the project team.

The MPRG Secretariat in the Infrastructure and Projects Authority supports the MPRG panel (see Section 5.1.3 for further discussion of the role of this body, which is responsible for overseeing and coordinating the technical, operational, and assessment aspects of the process). The Secretariat is a technical body that brings together various disci-

[25] The senior responsible owner is the person ultimately responsible for a project within a ministry. For the largest projects, this will generally be the most senior civil servant in the ministry. Less senior officials may be responsible for other projects.

plines[26] and that looks in more depth at proposals for megaprojects than is foreseen in the desk-based review to which all major projects are subjected. A planned project assurance review (PAR) led by the IPA and undertaken by another team of independent reviewers precedes the MPRG panel (Figure 5).

The MRPG panel reviews a project according to the following criteria:

- Deliverability: the extent to which a project is deemed likely to deliver the expected benefits within the declared cost/time/ performance
- Affordability: the extent to which the level of expenditure and financial risk involved in the project can be taken on, given the parent department's overall financial position, both singly and in light of its other funding priorities
- Value for money: achievement of the optimum combination of net whole-life public value, risk, and public sector costs, including quality (and fitness for purpose) to meet the business needs of the proposing body

Based on its review of these criteria, the MRPG can issue one of three decisions which is communicated by letter from the chair to the permanent secretary of the responsible ministry:

- Approve the project to proceed as planned
- Approve the project to proceed but with conditions
- Halt further development of the project

In the conceptual discussion in Section 4, one proposal for ensuring independent external review of megaprojects was to involve the country's supreme audit institution in an ex ante review of appraisal and planning. This is not formalized in the United Kingdom, but the NAO does occasionally carry out such reviews for particularly large or controversial projects. Box 7 summarizes its 2013 review of the HS2, a project to construct a second high-speed rail line from London to the north of the country. The NAO has no authority to stop projects and, despite the reservations noted in Box 7, which many commentators believe have not been satisfactorily addressed, the project is now going ahead.

5.1.2 Reference Class Forecasting

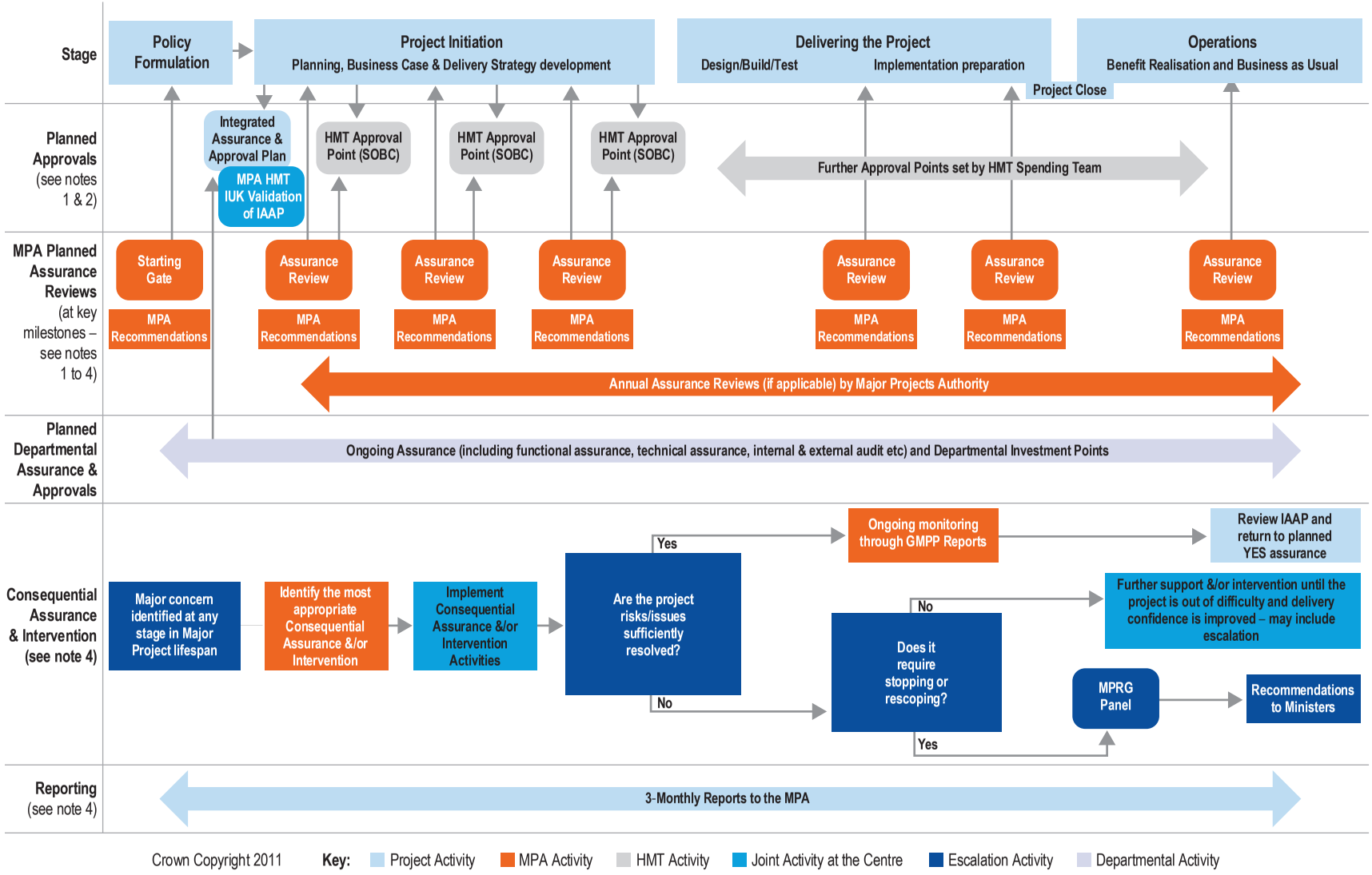
The United Kingdom has made reference class forecasting central to its appraisal methodology in an attempt to combat optimism bias. This approach was introduced in the 2003 methodological guidelines, known as the Green Book (HM Treasury, 2018), and has been restated in the 2018 revision of the guidelines. The guidelines make it obligatory for those appraising projects to uplift the planners' cost estimates by defined percentages to reflect experience of optimism bias across projects of a similar type. The adjustments are based on a significant joint research effort between the government and external experts. This research looked at a large sample of completed projects and compared planning estimates for implementation period and cost with actuals to develop probability distributions.

Table 1 gives the optimism bias adjustments as specified in the 2003 and 2018 guidelines. Adjustment factors are given for works duration and capital expenditure by type of project. Upward adjustments must also be applied to future operating and maintenance costs. It is not stated in the Green Book, but the adjustments are such as to reduce the probability of a cost/implementation overrun to 20 percent. Notionally, optimism bias factors are meant to be applied to all projects regardless of their size. However, the Green Book guidance is that methods should be applied proportionately to project size and riskiness, meaning that less effort will tend to be expended on lower value projects.

Lower and upper bounds for the adjustments are indicated. The adjustment may be reduced toward the lower bound if mitigation measures have been designed to address project risks and the costs of these measures have been incorporated into the total estimated cost of the project. The optimism

[26] Treasury desk reviews tend to be carried out by economists. The Secretariat has access to other planning and engineering skills.

FIGURE 5 ASSURANCE REVIEWS BY MPA/IPA



Source: 'Cabinet Office and HM Treasury (2011).

Note:

1. For more information on how to plan for integrated assurance and approvals, see MPA guidance on Integrated Assurance and Strategy and IAAPs.
2. The Integrated Assurance & Approvals Plan (IAAP) is periodically updated (after assurance reviews, scope or risk changes) and re-validated by MPA, HMT & IUK (where appropriate).
3. Assurance Reviews provided will be relevant to the specific approval point or other requirement – either OGC Gateway Review or a Project Assessment Review (PAR).
4. For more information on the components of this process see MPA guidance documents on Planned Assurance & Approvals or Consequential Assurance & Intervention.

For the latest versions of MPA guidance please contact your organisation's PPM Centre of Excellence/Portfolio Office (or equivalent), or email MPA-Info@cabinet-office.gsi.gov.uk.

BOX 7: SUMMARY OF THE NAO'S REVIEW OF EARLY PROGRAM PREPARATION FOR HS2

"In an early examination of progress by the Department for Transport in planning for the High Speed 2 rail network, the National Audit Office has expressed reservations about the Department's business case. In particular, in presenting its case for investment in the project, the Department is said to have poorly articulated the strategic need for a transformation in rail capacity and how High Speed 2 will help generate regional economic growth.

According to today's report, the Department's methodology for appraising the project puts a high emphasis on journey-time savings, from faster and more reliable journeys. However, the relationship between these savings and the strategic reasons for doing the project, such as rebalancing regional economies, is unclear.

It is also unclear to the NAO whether the business case covers just the route between London and the West Midlands (phase one, due to open in 2026) or the full Y-shaped network with lines from Birmingham to Manchester and Leeds respectively (phase two, due to open in 2032). The Y-network has a stronger economic case but this is much less certain as route designs are less well-developed.

The benefit-cost ratio calculated for phase one has twice contained errors, and the Department has been slow to carry out its own assurance of the underlying analysis. The NAO's opinion is that the Department and its advisers HS2 Limited should update the data underpinning some key assumptions in the ratio.

The most recent benefit-cost ratio (published in August 2012) is 1.4 to 1 but is likely to change. This to be expected as the ratio is sensitive to changes in data underpinning assumptions, such as GDP growth forecasts. It does not, however, reflect the Department's current assumption on the relationship between passenger numbers and GDP growth. The Department now expects passenger numbers to grow more slowly when GDP increases. It should also carry out research into how business travellers use their time on trains. HS2 Limited has also not yet analyzed the effect on passenger demand, revenues and the benefit-cost ratio of charging passengers premium prices.

The report notes that the estimated cost of phase one will change as costs become firmer. In some documents, the estimated cost is between £15.4 billion and £17.3 billion but a new estimate is being developed based on a clearer route and more information. The NAO estimates that there is a £3.3 billion funding gap over four years (2017–18 to 2020–21) which the government has yet to decide how to fill."

Source: Press release by National Audit Office (May 16, 2013).
Available at: https://www.nao.org.uk/report/high-speed-2-a-review-of-early-programme-preparation/.

TABLE 1 OPTIMISM BIAS ADJUSTMENTS IN THE UNITED KINGDOM[A]

	Optimism Bias Adjustment (%)			
	Works Duration		Capital Expenditure	
Spending Type	Lower	Upper	Lower	Upper
Standard buildings	1	4	2	24
Non-standard buildings	2	39	4	51
Standard civil engineering	1	20	3	44
Non standard civil engineering	3	25	6	66
Equipment/development	10	54	10	200
Outourcing	n/a	n/a	0	41

Source: HM Treasury (2018).
[a] If a specific risk has been identified and a mitigation measure designed and costed in the total estimated costs, then the optimism bias adjustment may be reduced proportionately toward the lower bound.

bias adjustment may be reviewed at different stages of project preparation and appraisal and reduced downward as risk mitigation measures and their costs become more concrete. In line with the preceding discussion, the following four-step procedure for applying the optimism bias adjustment is proposed:

- Step 1: Decide which category of adjustment it is appropriate to use depending on the type of project: standard buildings, non-standard buildings, standard civil engineering, etc. (see Table 1).
- Step 2: Consider whether the optimism bias adjustment can be reduced to the extent to which risk has been identified, mitigated, and included in costs estimates.
- Step 3: Apply the optimism bias adjustment determined in previous steps and estimate the net present social value using the adjusted cost estimate.
- Step 4: Revise the optimism bias adjustment during appraisal to reflect designed-in risk avoidance and risk mitigation.

Table 2 gives the example of the cost estimates for the project to construct a high-speed railway from London to Birmingham (HS2, as discussed in

TABLE 2 COST ESTIMATES FOR PHASE 1 OF THE HIGH-SPEED RAIL 2

Item	Cost £ million	Includes
Rail systems	510	Track, ballast, fencing, drainage, junctions
Control systems	145	Signalling control and telecommunications
Traction power systems	185	Overhead line equipment and power supply
Stations	1,675	Euston, Old Oak Common, Birmingham Interchange and Curzon Street
Civil works	585	Earthworks, retaining walls and roads
Structures	790	Bridges and viaducts
Tunnels	1,410	Twin and single bore tunnels
Utilities	120	Relocation of utilities e.g. water, power
Additional items	470	People mover and rail reconstruction work
Contractor administration costs	775	Preparatory work, site supervision, testing, training, spare equipment
Total Construction Cost	**6,665**	**Excluding risk**
Environmental mitigation	250	Additional environmental mitigation
Land costs / compensation	965	Land acquisition / compensation plus scheme administration (as assessed at Sept 2011)
Depot facilities	500	Main rolling stock depot, London stabling, depot relocations HEX and IEP)and infrastructure maintenance depot
Provisional sum	225	Allowance for emerging requirements from concept of operations work
Project overheads	435	Client and project management costs
Design	600	All design costs and topographical / ground investigation surveys
Existing rail interface costs	190	Possession management, compensation for operational disruption
Statutory charges	70	Consultation and planning consent related costs
Construction risk	2,215	Route section and route-wide construction risks from the Quantified Risk Analysis
Additional scheme risk provision	4,165	Provision for external risks in line with HM Treasury Supplementary Green Book Guidance
Total	**16,280**	**At Q2 2011 prices**

Source: HS2 Ltd (2012).

Box 7). The table indicates that there are two components of risk: the first is for quantified location-specific risks (construction risk) as estimated by the design team, and the second is for optimism bias, in line with the approach set out in Table 1. The allowance for specified construction risk represents 13.6 percent of the total estimated cost, and the optimism bias adjustment represent 25.6 percent of the total estimated cost. In line with Table 1, the allowance for optimism bias has been reduced from the upper bound to reflect the extent to which allowance has been made for specific risks.

Unfortunately, the United Kingdom has not carried out an ex post assessment of the impact of applying the optimism bias adjustment, so there is no empirical evidence on its effects. While the method may have had an effect on dealing with subconscious optimism bias, if there is strategic misrepresentation, it may cause project promoters to game the system by using low-ball initial estimates to compensate for the required upward adjustment or by over-selling the effects of their mitigation measures on risk. It then falls back on the external reviewers to challenge the estimates and assumptions.

5.1.3 A Dedicated Organization and Capacity Building

In 2011, the Major Projects Authority (MPA) was created as an independent body to strengthen the management of the GMPP. It reports jointly to the Cabinet Office and the Treasury and had a staff of around 70. In 2016, the MPA became the Infrastructure and Projects Authority (IPA), when it was merged with Infrastructure UK, a body created in 2010 to advise the government on long-term infrastructure needs and provide commercial expertise especially in relation to public–private partnerships. The reporting lines remain the same, as do the functions of relevance to the current report, but the new body has a staff of around 150.

The role of the IPA is to support the successful planning and monitoring delivery of large and complex projects, although there is no direct involvement in project implementation. The IPA coordinates a system of assurance over the progress of projects against plan, from identification to completion.[27] It coordinates assurance reviews, which are both planned and contingent, that is, triggered by specific events or concerns. The planned assurance reviews take place at critical points in the project cycle and are designed to provide decision makers, notably in the Treasury and in the agencies promoting the project, with the assurance they need concerning the viability and deliverability of a project when making decisions. The intention is to identify problems early, including during preparation and appraisal, and to address them promptly at the appropriate level in the decision-making hierarchy. Figure 5 shows the incidence of planned assurance reviews by the IPA in relation to the decision-making process, with reviews taking place prior to the three sequential decisions by the Treasury based on three assessments of increasing depth and reliability: the Strategic Outline Business Case,[28] the Outline Business Case,[29] and the Full Business Case.[30] The figure also shows the process for triggering and resolving contingent assurance reviews. The IPA is also tasked with improving transparency and openness in the management of major projects and with promoting the development of high-level project leadership capacities within the government. Box 8 describes the functions of the IPA.

In terms of the outcomes achieved by the MPA/IPA, the latest annual report claims it has been instrumental in making savings of £3.0 billion (US$3.9 billion) since its inception. The MPA/IPA was also instrumental in establishing the Major Projects Leadership Academy (MPLA) situated within the Said Business School of Oxford

[27] Established through the Major Projects Approval and Assurance Guidance, Cabinet Office, and HM Treasury, 2011.
[28] A preliminary assessment that focuses on the strategic case for the project: pre-appraisal.
[29] An assessment based on a full feasibility study that focuses on the economic case for the project: appraisal.
[30] A final assessment that focuses on implementation arrangements, but also re-examines the economic case on the basis of the preferred bid.

BOX 8: THE MAIN FUNCTIONS OF THE MPA/IPA

- The main functions of the MPA/IPA in relation to the Government Major Project Portfolio (GMPP) are the following:
  - Develop and maintain the first system for monitoring delivery of the GMPP, including:
  - Annual Report on progress of around 200 projects and
- 'Traffic-light' warning system for delivery confidence
- Instigate a mandatory Starting Gate Review process—an initial decision step before any public announcement of a new project idea can be made
- Introduce a system of Integrated Assurance and Approval Plans, a schedule of assurance assessments to support decision making and inform approvals by the relevant ministry and the Treasury (see Figure 2)
- Carry out and support consequential assurance and escalate issues that cannot be resolved to higher authorities (accounting officers and ministers)
- Work with ministries to build capability in project management, including setting up the Major Projects Leadership Academy
- Promote transparency concerning major projects through public information flows

University. The academy was set up in 2012 to fill an identified gap in high-level leadership skills among civil servants, which had been seriously affecting the government's capability to interface effectively with the arms-length agencies and private sector contractors responsible for managing the day-to-day delivery of major projects. By the end of 2018, 250 senior civil servants—senior responsible owners and project directors—had graduated from the academy. The MPLA is financially self-sustaining through the fees it charges individual government departments, which they pay from their training budgets.

The training offered by the MPLA is not full time; it is intended to be undertaken while trainees continue to work on their projects, where they can apply the knowledge and skills that they obtain. This also allows issues and insights from their experience of an actual project to be introduced into the training, which is designed to be highly interactive and shared with other trainees. Courses last 18 months, with three residential modules of five days and ongoing assignments in between. The total time commitment is around 30 days.

5.1.4 Transparency

The MPA/IPA has increased transparency through its annual report on the progress in delivering the GMPP. The report classifies each project in the portfolio using a delivery confidence rating expressed in terms of traffic light colors, where red indicates a need to re-scope and/or reassess a project, amber indicates concerns, and green shows that a project is on track. The system tracks projects both during implementation and preparation. It can be used to identify high-risk projects at an early stage and ensure that risk mitigation measures are put in place. Box 9 describes the delivery confidence assessment and traffic-light warning system.

The NAO analyzes the annual report and underlying data within the public sector and submits its findings to the parliamentary Public Accounts Committee, and outside the public sector to the media and civil society organizations. As an example of civil society interest, Figure 6 reproduces analysis by the Institute for Government, an independent think tank funded by private donors that provides commentary and public events to

BOX 9: THE UNITED KINGDOM'S DELIVERY CONFIDENCE ASSESSMENT

Each project in the GMMP is subject to a delivery confidence assessment (DCA). It examines overall progress in delivering the portfolio in terms of aggregate movements in the ratings from the DCAs.

Delivery confidence is defined as confidence in a project's ability to deliver its aims and objectives:

- By the deadline;
- Within the budget; and
- To the quality requirements, including delivery of financial and nonfinancial benefits.

The DCA reflects the following objective and subjective factors:

- Issues that threaten delivery in terms of time, cost, and quality and that jeopardize the delivery of benefits;
- The review team's professional judgement of the likelihood that the project will succeed, even in the absence of clear evidence either way; and
- The project's ability to overcome identified shortcomings or threats.

Delivery confidence is reported using a traffic light system, the RAG (red-amber-green) rating. Projects rated green are those most likely to succeed, while those rated red are facing serious delivery problems. The definitions of the RAG ratings are given below:

DELIVERY CONFIDENCE ASSESSMENT - RAG RATINGS AND CRITERIA

Delivery confidence RAG rating	Criteria for RAG rating
Green	Successful delivery of the project on time, budget and quality appears highly likely, and there are no major outstanding issues that at this stage appear to threaten delivery significantly.
Amber-Green	Successful delivery appears probably; however, constant attention will be needed to ensure risks do not materialize into major issues threatening delivery.
Amber	Successful delivery appears feasible, but significant issues already exist, requiring management attention. These appear resolvable at this stage and, if addressed promptly, should not present a cost/schedule overrun.
Amber-Red	Successful delivery of the project is in doubt, with major risks or issues apparent in a number of key areas. Urgent action is needed to ensure these are addressed, and whether resolution is feasible.
Red	Successful delivery of the project appears unachievable. There are major issues with project definition, schedule, budget, quality, and/or benefits delivery, which at this stage do not appear to be manageable or resolvable. The project may need re-scoping and/or its viability reassessed.

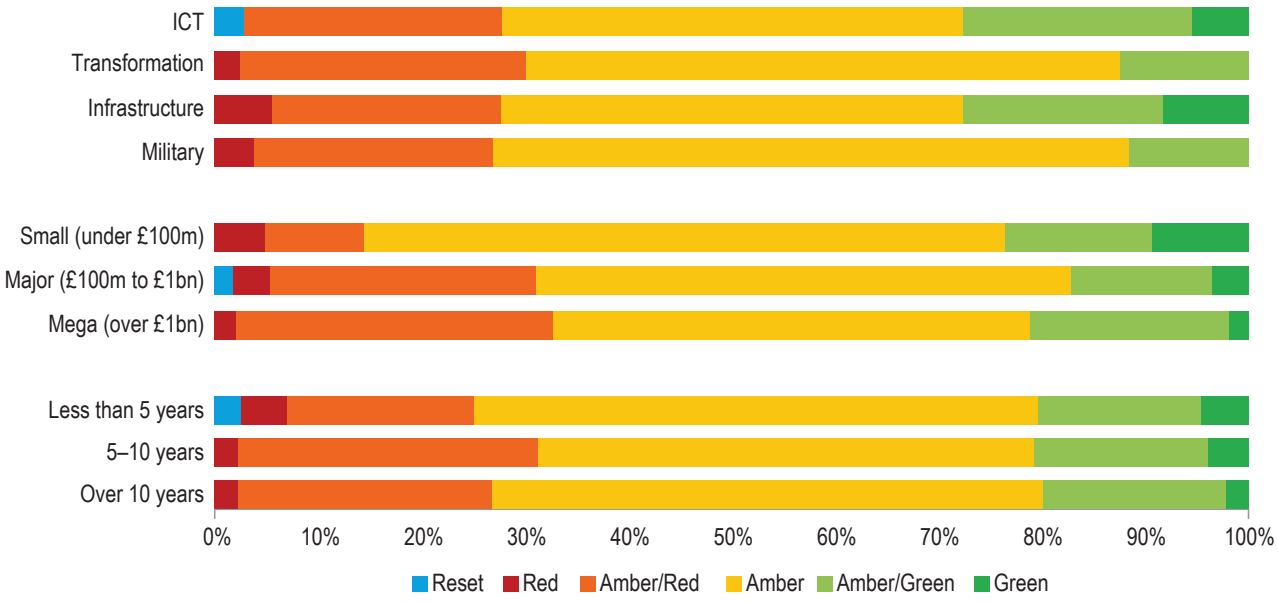
Source: Major Projects Authority (2015).

explore the key challenges facing government. The figure breaks down the confidence ratings by type of project (ICT, transformation, infrastructure, and military), project size, and implementation period.

5.1.5 Strengthened Governance Arrangements

In keeping with one of Flyvbjerg's recommendations, the UK government has introduced arms-

FIGURE 6 ANALYSIS OF THE IPA'S 2017 ANNUAL REPORT



length governance arrangements for the most costly and complex megaprojects. These arrangements have generally been established after a government decision to proceed with a megaproject and are concerned with creating the right incentives and accountabilities to bring the project in on time, to budget and to specification. They try to replicate elements of corporate governance, particularly the relationships between the shareholders and the board of a company and between the board and the chief executive, who is responsible for day-to-day management. Variants of the model include:

- *2012 London Olympics (GBP 11 billion):* The Olympic Delivery Authority (ODA) was created by an Act of Parliament in 2006[31] as an executive non-departmental public body[32] of the ministry with responsibility for culture, media, and sport. Like a private sector company, the ODA was overseen by a seven-member board, including a chair and a deputy chair, with day-to-day management under a chief operating officer reporting to the board. Board members were appointed by the responsible minister using a designated process. The board was mandated to pursue the objectives of the ODA as set by the responsible ministry (effectively the shareholder), turning to it for guidance on the most important strategic decisions only.
- *High Speed Rail 2 (estimated at GBP 56 billion — see Box 7):* The ministry with responsibility for transport established High Speed Rail 2 (HS2) Limited[33] and appointed the chair and board of the company. The ministry funds the company entirely through its budget. As delivery agent, the company is responsible for managing the detailed design and implementation of the project on behalf of the minister as the sole mem-

[31] It was also dissolved by an Act of Parliament in 2014 after having launched legacy projects on the site of the Olympics to ensure lasting and positive after-effects.

[32] This is a body that has a role in the processes of national government but is not a government department or part of one, and which operates at arm's length from ministers. Such bodies can have advisory or executive roles.

[33] HS2 Ltd was incorporated under the Companies Act as a company limited by guarantee. Limited by guarantee is a special form used for non-profit organizations requiring legal personality. For public sector policy and administrative purposes, the company is designated as a non-departmental public body, like the ODA.

ber[34] of the company. A Framework Document setting out the corporate governance arrangements establishes the relationship between the ministry and the company, and a Development Arrangement sets out the operational arrangements and review points when progress against defined targets will be assessed. The board appoints a chief executive through competitive recruitment procedures, who is responsible for day-to-day management.

- *Dreadnought nuclear submarines*, a replacement for the UK's existing nuclear deterrent (estimated at GBP 31 billion): The Submarine Delivery Agency, a new delivery body, has been created as an executive agency of the ministry with responsibility for defense. It will be responsible for the delivery of the new nuclear-powered submarines and all future such projects. Within the ministry, a specialized unit was created to act as the project sponsor and direct counterpart of the new agency. An experienced, commercial specialist heads the unit, recognizing that good procurement will be central to the project's success.

5.2 Norway

The cost overruns associated with the Oslo Opera House and equally significant cost overruns in oil and gas exploration projects led Norway to overhaul its PIM system for major projects at the beginning of the millennium. The reforms began with an emphasis on controlling the costs of projects but then introduced a focus on assuring that the right projects had been selected in the first place.

The quality-at-entry system that emerged applies for all projects costing more than NOK 750 million (EUR 75.0 million). It may be argued that such projects are too small to fit into a valid definition of a megaproject. However, Norway although rich, is a small country (just over 5 million inhabitants), and for such a country it can equally be argued that projects of this scale are megaprojects relative to the size of other projects, the economy, and the public finances. Putting this potential argument to one side, the Norwegian model emphasizes the interfaces between quality assurance, a technical process, and high-level political decisions. It also involves the use of outside experts to undertake quality assurance, introducing an independent perspective to combat optimism bias. On both these counts, Norway is a useful model for megaprojects everywhere.

5.2.1 Quality at Entry

Figure 7 summarizes the Norwegian quality assurance process that emerged from the reforms. The model consists of two sequential quality assurance steps, known as QA1 and QA2, that relate directly to the two critical pre-implementation decisions, first by the cabinet and then by the parliament. The cabinet decision relates to the choice of the conceptual solution, a strategic decision incorporating social profitability and sustainability. The second relates to legislative approval of the project's cost frame. QA2 was introduced first, in 2000, in response to a perception of runaway project costs. Essentially it concerns technical efficiency, that is, cost efficiency (see Figure 1) and management capacities. QA1 followed later in 2005 when the government realized that more weight needed to be given to assuring the purpose effectiveness and allocative efficiency of projects (see Figure 1).

Consultants contracted by the Ministry of Finance carry out quality assurance. Six consortia of consultants are contracted through framework contracts, allowing call-down on the basis of technical capacities and availability when required, without recourse to a new competitive bidding process. Approximately 20 projects are quality assured each year.

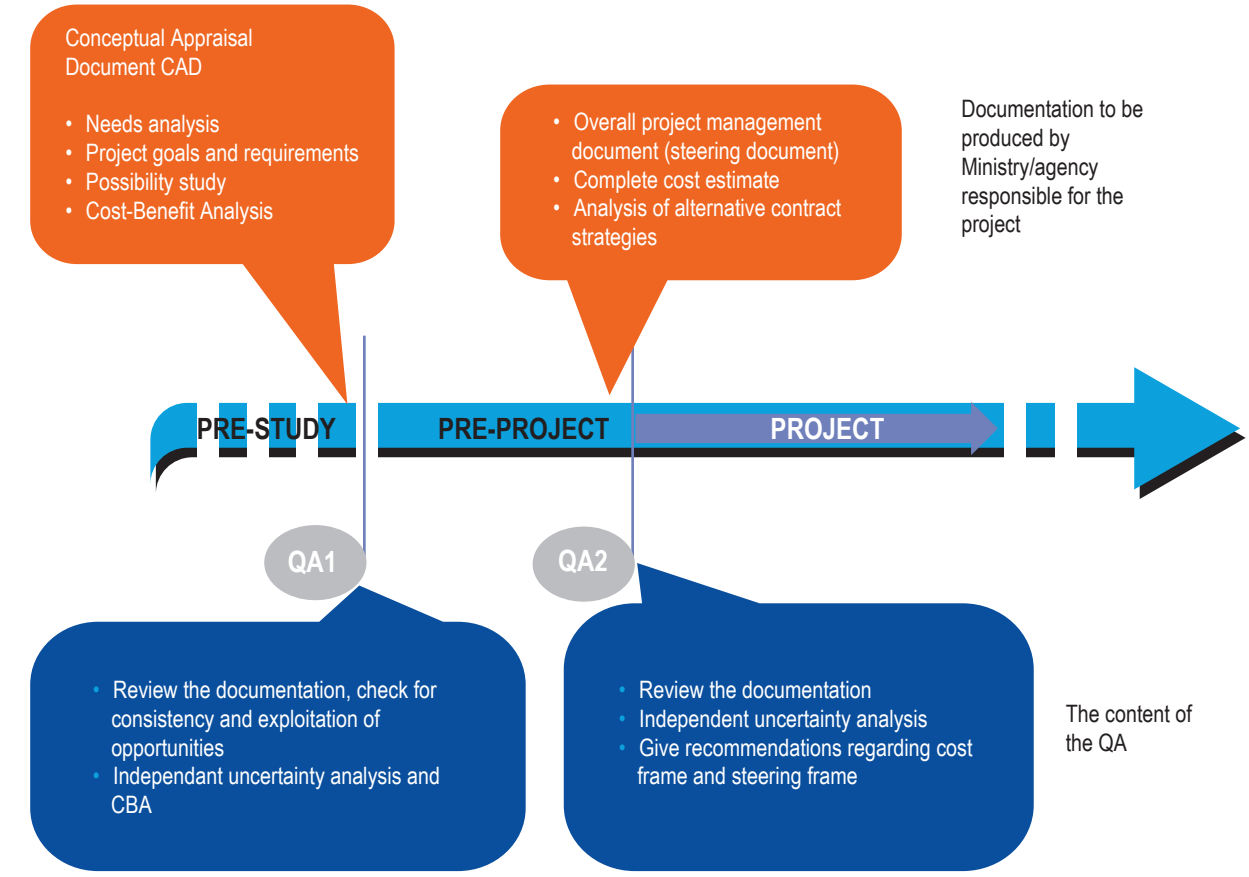
QA1

The purpose of QA 1 is stated as:

> *To ensure that the choice of concept has been subjected to a political process of*

[34] Companies limited by guarantee have members rather than shareholders.

FIGURE 7 NORWAY'S SYSTEM OF EXTERNAL QUALITY ASSURANCE FOR MAJOR PROJECTS



Source: Holst Volden (2016).

fair and rational choice. The ultimate aim is that the chosen concept is the one with the highest economic returns and the best use of public funds. The choice of concept is a political decision to be made by the Cabinet, while the consultant's role is restricted to assert the quality of the documents supporting the decision.

QA1 involves the responsible line ministry or agency preparing a concept evaluation, which is then quality assured and subjected to more intensive risk analysis by the external reviewers. The concept evaluation consists of:

- *Needs analysis:* Analyzes the demand for the project and its urgency.
- *Overall strategy:* Defines the project's intervention logic, including immediate and longer-term objectives, such as the project's purpose and goal, respectively.
- *Overall requirements:* Specify important requirements that will need to be met for the purpose and goal to be achieved.
- *Possibility study:* Explores in the broadest terms the various options—the opportunity space—for meeting the identified needs and achieving the intended objectives.
- *Alternative analysis:* A cost-benefit analysis of feasible alternatives to identify the preferred solution. At least two main alternatives should be analyzed against a do-nothing base case. Analysis of the budgetary impact and an assessment of the risks of each alternative is required.

- *Guidance for the pre-project phase:* Guidance for in-depth project preparation and an implementation strategy.

When reviewing the concept evaluation, the reviewers are required to begin by looking at the consistency of the documentation and the scope of the alternatives considered. They should then present their assessment of whether the alternatives are adequate to satisfy the identified needs and achieve the specified objectives. The review process includes an independent analysis of risk and uncertainty, which includes determining probability distributions for costs and benefits and undertaking a stochastic cost-benefit analysis to yield an expected[35] net present value. The analysis concludes with a proposed ranking of proposed alternatives, taking into account both monetized and non-monetized effects. Recommendations on the implementation strategy, focusing on measures to ensure benefits realization and on project governance, should be proposed.

The review should be carried out as early as possible, when it is still possible to make choices concerning alternative concepts. When completed, it feeds into a Cabinet decision on the preferred concept to progress to QA2, if any. Success at QA1 does not guarantee success at QA2: there is no automaticity to decisions, and a project can drop out at QA2 after approval at QA1, especially if cost increases undermine the economic case.

QA2

The purpose of QA2 is stated as:

> *To ensure the quality of the decision basis including costs estimates and uncertainties associated with the chosen project alternative before it is submitted to Parliament for funding. The control aspect is the main feature in this exercise. Also, the evaluation shall focus on challenges related to project management in the implementation phase.*

As a basis for QA2, the responsible line ministry or agency must prepare the following prescribed project documentation:

- Overall project management document (the steering document)
- A complete base estimate for costs and revenues (if revenue-earning)
- A commercial strategy containing an assessment of at least two alternative approaches to contracting

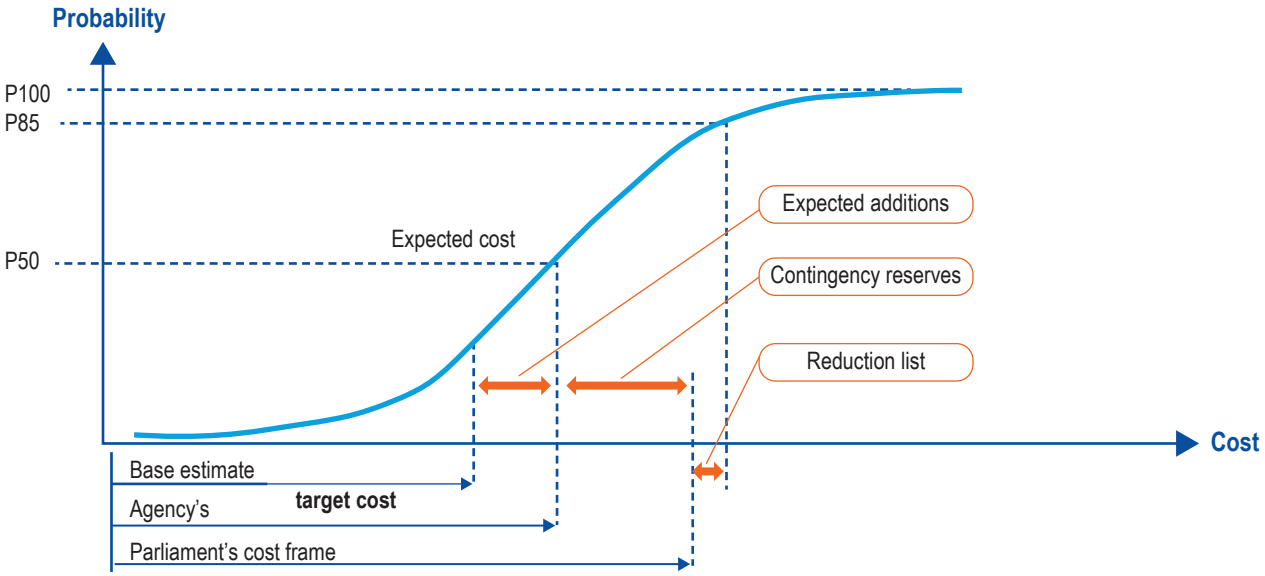
The review consultants begin by validating the definition of the project concept, including ensuring that it remains in line with QA1. They then assess the quality and adequacy of the project management document and verify that the baseline cost estimates are complete, realistic, and transparent. The main part of the reviewers' analytical work involves an independent risk analysis with an emphasis on costs. This requires an in-depth stochastic estimation of costs and an assessment of the probability of specific risks facing the project. Risk-mitigation measures, their cost, and their impacts on the project's social profitability must be examined. The outcome of the reviewers' work is a recommendation on the cost frames for the project, together with recommendations for the organization, management, and contracting of the project. QA2 takes place after in-depth project preparation and prior to a parliamentary decision to approve budgetary funding for a project.

5.2.2 Stochastic Estimation of the Project Cost Frames

Similar to the United Kingdom, Norway adopts a stochastic approach to project costing and budgeting, although the use of reference class forecasting is not explicitly foreseen (Figure 8). The project promoters are required to make their best estimate of project costs, which they include in the document setting out the base estimate of costs.

[35] 'Expected' in a statistical sense.

FIGURE 8 PROJECT COST FRAMES



Source: Holst Volden (2016).

This is reviewed at QA2 and revised upward, if necessary, to arrive at the reviewers' best estimate of costs: this is the estimate with a 50 percent probability of an overrun (or underrun), referred to as P50 (see Figure 8). The reviewers are then required to produce an estimate of the costs for which the probability of an overrun is only 15 percent. This is referred to as P85 (Figure 8).

Two cost frames are foreseen:

The agency steering frame. The agency with responsibility for implementation is required to manage and deliver the project within the agency steering frame. As indicated in Figure 1 illustrating reference class forecasting, the project promoter's estimate is likely to be lower than the independent reviewer's best estimate because of optimism bias. The agency steering frame is usually set at P50 or slightly below it, reflecting the expected additions to costs.

The Parliament's cost frame. Parliament, on the other hand, is more interested in a cost estimate with a lower probability of an overrun, so that it can appropriate the necessary contingency reserves in advance. The independent reviewers are therefore also required to estimate P85, which forms the basis for Parliament's cost frame for the project. In reality, Parliament will generally opt for a cost frame slightly below P85.

It should be noted that the contingency reserve that emerges from this process—the difference between the agency's steering frame and Parliament's cost frame—is not allocated to the implementing agency, which must include its own allowance for price and physical contingencies in its base estimate. Instead, Parliament appropriates a separate contingency reserve that can be accessed in the case of justified overruns beyond the agency's steering frame. If costs rise as high as P85, then some cuts will be expected to be made. Part of the reviewers' job at QA2 is to identify in advance areas where cuts can be made without seriously affecting project outputs and benefit realization. This system seems to be working.

5.2.3 Monitoring and Evaluation of System Performance

A prominent feature of the Norwegian system is the Concept Research Programme, the monitor-

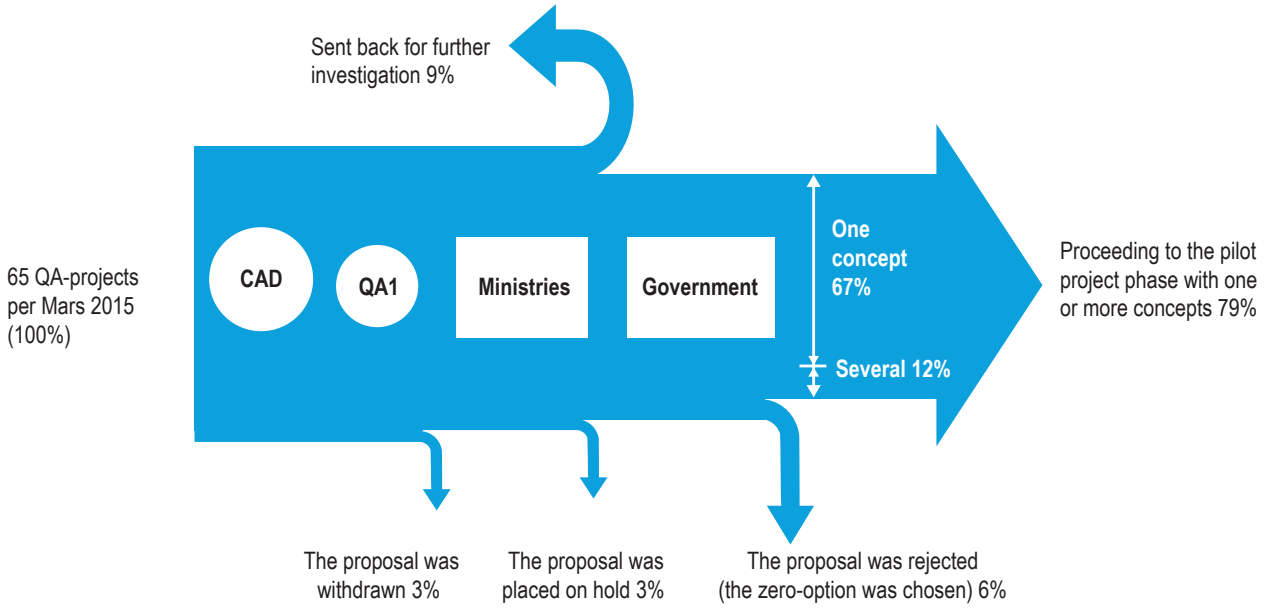
ing and evaluation program run by the Norwegian University of Science and Technology (NTNU) that has been put in place to accompany it.

As a result of the monitoring and evaluation carried out by the NTNU, the kind of analysis contained in Figure 9 is available. It shows the extent to which QA1 is successful in turning back weak or immature project proposals and how many projects get through to QA2. As Figure 9 shows, of the 65 projects put forward for QA1 up to March 2015, 21 percent did not proceed to QA2 for one reason or another. Of those that did proceed to QA2, 12 percent still had more than one concept and required further analysis to arrive at the final concept.

Few PIM systems in the world can generate this kind of feedback, with Chile and South Korea being notable exceptions. This is regrettable, as the information generated can be very useful in assessing system performance and in designing the systems' further development.

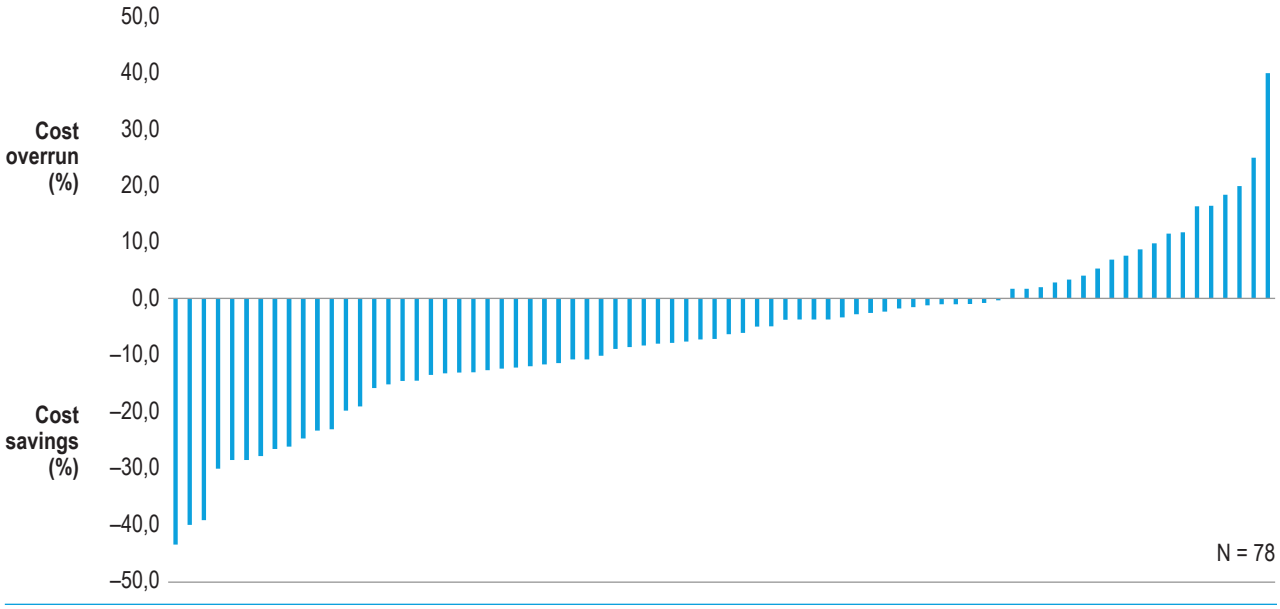
Further evidence from the monitoring and evaluation program shows cost overruns and cost savings by project compared to P85 (Figure 10). Out of a sample of 78 projects, 17 experienced cost overruns; the rest, representing around 80 percent of projects, experienced costs savings. This is in line with the definition of P85 and suggests that the approach has been working. A similar analysis in relation to P50 shows roughly as many overruns as underruns, as should be expected. It is estimated that net savings of about 6 percent of total investment cost have been made.

FIGURE 9 SYSTEM PERFORMANCE AT QA1



Source: Holst Volden (2016).

FIGURE 10 SYSTEM PERFORMANCE AT QA2



Source: Holst Volden (2016).

6

Some General Lessons for Megaproject Management

The discussion in this paper points to the following important lessons for countries, especially in Latin America, that are considering the establishment of specialized arrangements for megaproject management:

- Opinions differ on what defines a megaproject, but a definition should probably take account of country context.
- Problems with megaproject management are a worldwide phenomenon and are an order of magnitude greater than for large-scale projects.
- A sound (long-term horizon) fiscal framework is necessary when programming megaprojects, together with an in-depth analysis of fiscal contingencies.
- Allocative efficiency of public resources to megaprojects under institutional constraints is highly exposed to political interference. The governance and transparency framework therefore becomes key to influencing the decision-making process from a technical standpoint.
- Few countries have established systems specifically for managing megaprojects, and there are no tried and tested ways to do so.
- Megaproject management must first involve assiduous application of generally agreed PIM principles and functions.
- Additional methodological approaches and enhanced governance arrangements will be required to tackle the dual distortions of optimism bias and strategic misrepresentation. These are:
  - Adoption of reference class forecasting – the 'outsider view';
  - Additional layers of high-level, independent review feeding into critical decision steps. The example of the Major Projects Review Group in the United Kingdom is a good starting point in emerging markets, with the development of a specialized institution, like the Infrastructure and

Projects Authority, as a possible second-stage development;
    - Risk-based implementation monitoring with triggers and processes for reassessment and closure; and
    - Dedicated and sustained capacity building aimed at senior public servants involved in megaproject management.
- Monitoring and evaluation of system performance are an important requirement for controlling costs and achieving outcomes.

Finally, there are two important issues in megaproject management research. First, investigation of whether some problems are best solved by megaprojects or through an investment program made up of smaller projects is still pending. Second, more evidence-based research, using quantitative and qualitative methods, is needed to assess megaproject performance, especially ex post. Even if megaprojects are late and over budget, they may still add value. For this purpose, a unique, open-access database about megaprojects that cover different aspects is required.

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Annex 1: Three Levels of Scrutiny for United Kingdom Treasury Approval Points by Project Scale and Riskiness

Level of Scrutiny	Criteria	Participation
Major Projects Review Group (MPRG) Panel	• Whole-life cost over £1 billion • High risk and complex in their procurement and delivery of benefits • Sets a precedent, or are highly innovative • Other projects of concern (as agreed by Chairs of MPRG; may be recommended by HMT, IPA)	• Joint-Chair: DG Public Finance and Spending HMT and CEO Civil Service CO • Panel of experts from public and private sectors drawn from a pool to review major projects • SRO and project director (minimum), plus other members of the project team
Treasury Approval Point Panel	• Whole-life cost under £1 billion • Novel, contentious or repercussive spending • Potentially risky in fiscal, operational, or reputational terms • Potential to set a precedent and create future additional costs • Significant interdependencies	• Chair: Director/Deputy Director HMT • Panel members from HMT – spending team and general expenditure policy team - and CO, including IPA • SRO plus a maximum of five members of the project team
Desk-based review	• Project and programs not matching the criteria for MPRG or TAP Panel	• Spending team


IDB