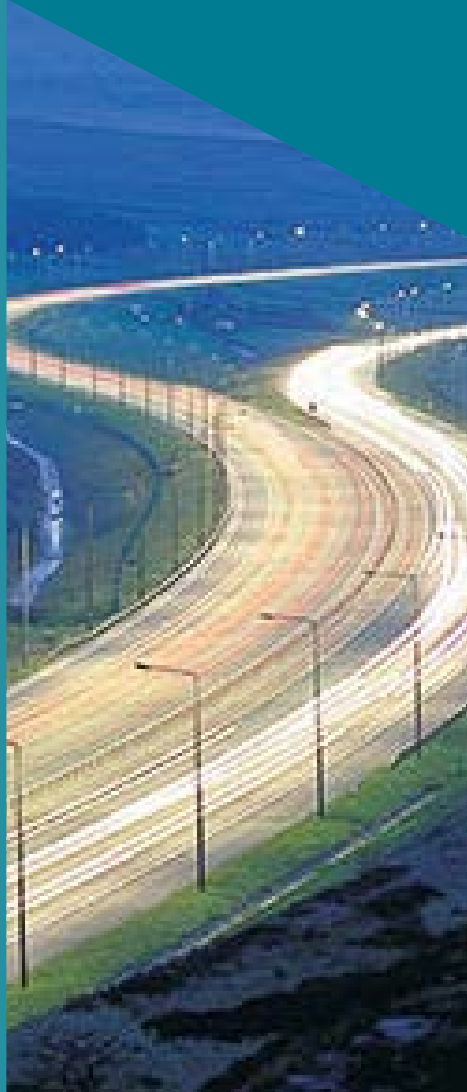




Major Infrastructure Projects: Key Front-end Issues



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Executive Summary

Infrastructure projects cost large amounts of money and have a major impact on society, the economy and the environment — and they are probably the most complex projects to conceive and manage well at the critical front end.

This paper summarises many of the key issues which senior people concerned with the development of major infrastructure projects need to think deeply about before a project is authorised to go ahead. It has been prepared by a working party of civil engineers and actuaries, known as the Risk Group, whose previous publications include the *RAMP Guide*, which can still be very helpful in managing risk throughout the development and construction phases.

It is believed that in practice some of these front-end issues are often being overlooked, and this could continue as new players become involved in future projects. Getting a big project wrong causes a waste of scarce resources and trouble for all concerned, and can undermine confidence in other projects. The front-end issues crucial to successful outcomes are presented here through a series of questions — hopefully these will stimulate your own thinking and help you to avoid difficulties.

If all these issues are fully considered, the chances of a project ultimately being considered a success will be much enhanced. The London Olympics of 2012 is an outstanding example of a successful project. It benefited substantially from strong front-end thinking, with clear objectives, good organisation and leadership, stakeholder involvement, much thought about all the complex details and requirements for operational success, and effective risk control and mitigation. Not only was the project and its infrastructure delivered to time and budget, but the anticipated benefits were fulfilled or even exceeded. The aim should be to reach this level of achievement in every major project.

Whether you are a politician, a planner, a senior civil servant, a local authority officer, or someone else who will be playing an important role in project development from the viewpoint of the sponsor, the front-end issues listed here are among those which you will need to ensure are properly addressed. In addition you will already understand the importance of the people dimension and the need for dedicated and determined leadership, to create an inspiring vision of what the project will achieve and to carry its development through all the difficulties which may be encountered. You will also realise the importance of ensuring that the team of people involved in the development process includes a sufficiently wide range of skills, experience and imagination to be able to envisage all the future circumstances which may arise and how they can best be managed. Having sufficient resources of competent people to undertake the front-end development process and explore all the issues thoroughly is critical for ultimate success.

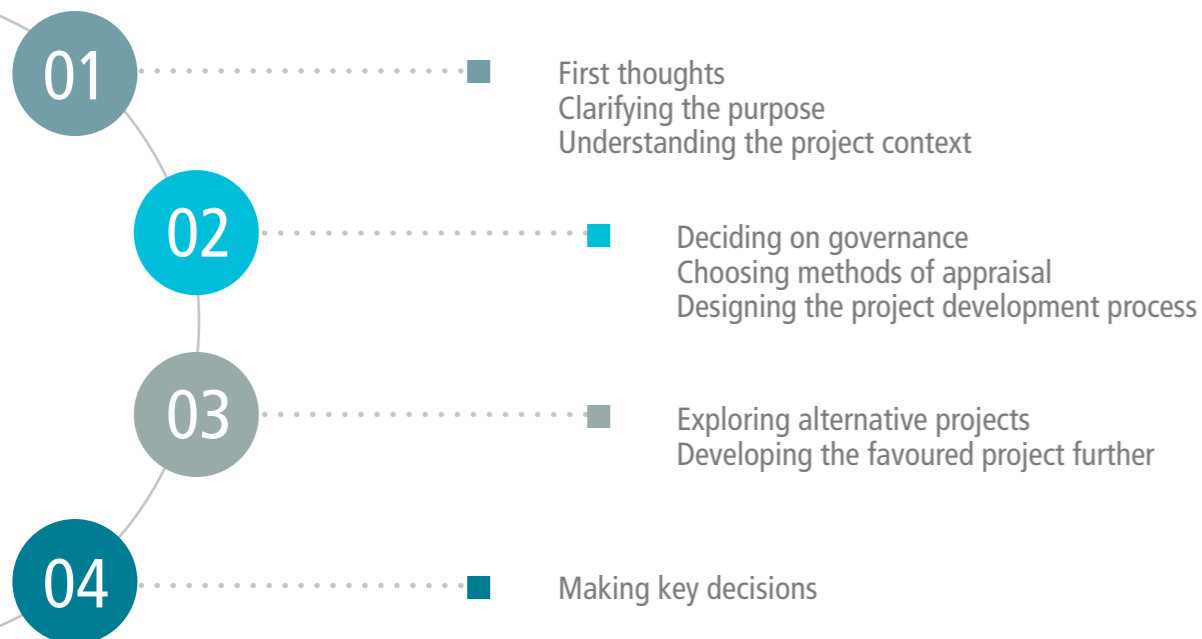
We suggest that all the issues be considered at the outset, before development work commences, and that they should be revisited in greater depth as the process continues.

Chris Lewin

Chair
Risk Group



Categories of Front-end Issues



Note: The case studies shown below are summarised versions of those reported on the website of the International Projects Leadership Academy at <http://calteam.com/WTPF/>. They illustrate some of the pitfalls which can arise if there is insufficient front-end thinking. We have not ourselves investigated the case studies and recognise that there may be differing viewpoints about them, but we have included these

reports because they illustrate a number of the key issues succinctly. There are also case studies of the challenges facing UK Infrastructure projects available on the Infrastructure & Projects Authority's website as part of their Project Initiation Routemap Tool at <https://www.gov.uk/government/collections/improving-infrastructure-delivery-project-case-studies>.

First Thoughts

1. Reasons

Why is new infrastructure being considered? Who is driving the project and what are their motivations?

2. Context

How completely do you understand the context, including any wider developments of which the infrastructure will form a part?

3. Aims

If new infrastructure were built, what would it be seeking to achieve? Has the problem it would solve, or the opportunity it would generate, been defined, articulated, understood and appreciated?

4. Wider Objectives

To which wider objectives would the infrastructure contribute, e.g. economic growth, environmental improvements or social justice?

5. Beneficiaries

Who would benefit from the

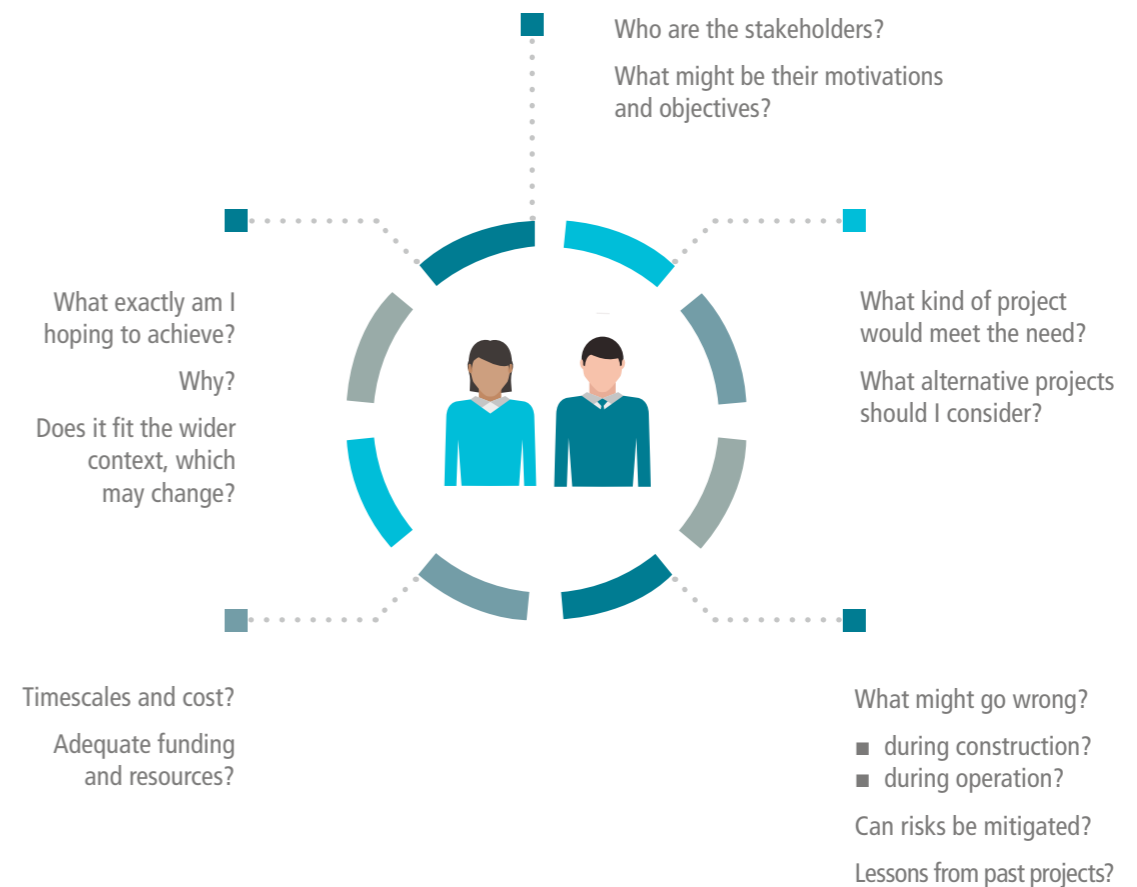
infrastructure and how? Can the benefits be measured or assessed?

6. Risks

What are the principal risks which could lead to project failure, or make it redundant or unwelcome? How can the risks of failure be mitigated?

These issues and others should be considered in depth as outlined in the rest of this paper.

First Thoughts about a Project



Clarifying the Purpose

Clarity about the overall purpose of any new infrastructure which might be decided upon is essential at the outset, as well as knowledge about the identity of the main parties and their likely attitudes.

7. Overall Impacts

What are the intended policy impacts (e.g. economic growth, spatial development, environmental improvement, social justice) of the changes which new infrastructure would assist?

8. Core Purpose

What would any infrastructure project be seeking to achieve — what is its central purpose? What services are to be provided? What are the problems to be solved or opportunities to be generated? What will constitute success? Is new infrastructure needed at all and, if so, to what extent? Might there be a better way of achieving the required purpose?

9. Sponsor

Who is the project sponsor — which Authority? If there is joint sponsorship, how can unresolvable disagreements in future be avoided? What experience does the sponsor have of carrying out similar projects before? Does it need to review the competence of its staff to undertake the present project successfully?

10. Stakeholders

Who would be the main stakeholders — what are their objectives and agendas? Do they include those who will operate the completed project? Would stakeholders be involved in project development from an early stage and, if so, how?

11. Risk Tolerances

How tolerant are the sponsor and other key stakeholders likely to be of significant risks, such as delays, cost over-runs and low demand, or even project cancellation after incurring expenditure? If the project runs into serious trouble, who would rescue it and would they want to?

CASE STUDY

The opening of St. Helena Airport (cost £285 million) was postponed indefinitely because of safety concerns about wind shear when test flights into it took place in June 2016. Reports indicate that warnings were given about the wind shear issue prior to the project being approved. Those warnings were apparently ignored (or misjudged) and it appears the project team failed to conduct appropriate environmental / flight operations studies prior to construction. A report in October 2016 indicated that intensive work was continuing to mitigate the wind shear challenges before the introduction of scheduled passenger services.

Understanding the Project Context

The next stage is to consider the context for the possible projects which will be studied, including information about the principal constraints and Government requirements.

12. Context

What is the development context — is there a development plan and / or land use strategy? What is the sector context — is there a sector policy, strategy or plan? What will be the role of the project within these contexts? Will decisions actually have to be guided by the content of existing plans? What relevant studies exist and what is the status of their recommendations? What is the environmental context, for example the need for decarbonisation?

13. Constraints

What are the constraints e.g. public sector affordability, other project commitments, political considerations, and possible lack of human and physical resources?

14. Government Requirements

How do central government requirements influence what will be done (statutory plans, policies, environmental / social processes, identification / appraisal methods, funding requirements, procurement methods)? To what extent will the project need support from all sectors of government and will it be at risk on a change of government?

Note: The UK Government's National Infrastructure Delivery Plan and pipeline sets out the strategic context and policy drivers for sectors. The overall impacts and core purpose of UK projects should be checked against the Plan, the latest version of which can be found here: <https://www.gov.uk/government/publications/national-infrastructure-delivery-plan-2016-to-2021>.

15. Project Objectives

What would be the objectives of the infrastructure project (both benefits and costs) and related wider developments? What would be the success criteria for the achievement of these objectives?

16. Beneficiaries

Who would be the intended beneficiaries from any project and what benefits should each group of them derive from it?

17. Allocation of Resources

What is going to determine (and how) whether resources of money, labour and materials should be expended on this project rather than on other projects, possibly in totally different fields?

18. Decision-making Environment

What is the nature of the decision-making environment — turbulent / uncertain or predictable / stable?

19. Other Projects

What other relevant projects are already committed or planned, and what is their status?

20. Future Projects

What future projects are planned (is this the beginning of a network or an area strategy)?

21. Key Assumptions

What key assumptions are appropriate for forecasting — population, employment, incomes, economic prospects, etc.? Are these assumptions realistically benchmarked?

22. Uncertainties

What are the major uncertainties?



What work should be undertaken to acquire more knowledge in order to reduce them?

23. Lessons from the Past

What is the record of success of other comparable projects, here and elsewhere? What lessons have been learned?

24. Integration

How should the project be integrated into its development and sector environment?

25. Complementary Needs

What complementary actions / projects / policies would be necessary to secure the project's benefits? To what extent should these form part of an integrated package?

26. Funding Availability

What steps will be taken, before there is significant expenditure on project development, to ensure that sufficient funding is likely to be available (from either public or private sources) if a project is authorised?

CASE STUDY

SNCF bought 2,000 new trains. In 2014, after delivery of the first trains, it was discovered that, although they were compatible with newer stations, they were too wide for many of the stations built over 30 years ago to different standards. They were also too tall to fit some tunnels in the Alps.

Contributing factors as reported in the press:

Bad assumptions. Failure to address details. Communications breakdown between organizations.

Deciding on Governance

The aim of a governance framework is to ensure that the project development process takes place in an orderly and unbiased manner, with firm linkages to succeeding phases of the project if it is authorised to proceed. The framework should act as a link between management and leadership, assessments and decisions, information and wisdom, enabling all concerned to ask the right questions and get good answers.

27. Framework

What will be the formal framework to control the project development process?

28. Decision-makers

Who will make the key decisions and on what basis?

29. Making Decisions

What will be the decision-making process?

30. Project Board

Will a project board be formally appointed, to bring a full range of skills and objective experience to bear on the project development and analysis process, and to make recommendations to decision makers?

31. Project Team

Who will provide policy advice to the project team; and who will manage the project team's technical work? To what extent will the team need to be strengthened, to ensure that it has sufficient skills and experience (for example, if it has not undertaken similar projects previously)?

32. Stakeholders

How will stakeholders be engaged with and managed? Will this be done in the earliest development phases and, if so, how?

33. Public Relations

What will be the public relations plan to proactively make information available to interested parties, with a view to obtaining helpful comments from other stakeholders and members of the public about development options and risks?

34. Premature Public Commitment

What steps will be taken to ensure that there is not a premature public commitment to a particular project or to a cost which has not yet been properly evaluated, or to an over-ambitious timescale?

35. Success Focus

Has success been properly defined? How will a focus on sustainable operational success and achievement of planned benefits be maintained?

36. Regulations

What steps will be taken in designing the project to ensure that, once it is operational, it complies with all relevant regulations (including any possible future regulations not yet promulgated)?

37. Documentation

What methods will be used to document all the steps taken during the development process, including the reasons for decisions and the evidence on which decisions are based?

38. Learning Lessons

Will a *post hoc* 'before-and-after' study be carried out to establish the project's success and inform future policy? If so, is there a need to collect at an early stage some additional data relating to the present situation?

39. Forecasts

Appraisals are usually based on forecasts and estimates for many years ahead. Has a method been identified to validate these forecasts and estimates with confidence?



CASE STUDY

In 2008 a project commenced in Port Elizabeth, South Africa, to introduce a new bus rapid transport system. Eight years later there was still no operational system in place. Reports indicate that flaws in the design process have resulted in bus lanes that are impractical, zebra crossings that obstruct traffic flow and design flaws that represent a danger to users of the system. 60 buses were bought but they turned out to be too big for the driving lanes and the doors were on the wrong side of the bus to enable passengers to be dropped off on central “islands”.

Contributing factors as reported in the press:

Lack of oversight. Poor requirements management and a lack of attention to detail (resulting in faulty requirements). Dysfunctional decision-making. Failure to engage stakeholders. High staff turnover levels.

CASE STUDY

An automated baggage handling system at a new airport in Denver, USA was intended to be the most advanced in the world. However, it suffered severe problems and resulted in the completed airport sitting idle for 16 months. Despite efforts to remedy the problems, it never worked properly and in 2005 it was scrapped altogether, because it was found that using a manual system would cut ongoing costs.

Contributing factors as reported in the press:

Underestimation of complexity. Complex architecture. Changes in requirements. Underestimation of schedule and budget. Dismissal of advice from experts. Failure to build in backup or recovery process to handle situations in which part of the system failed. The tendency of the system to enjoy eating people’s baggage.

Choosing Methods of Appraisal

The appraisal methods to be used may have to include those specified by the Government but thought should be given to whether additional appraisals should be made, in order to get greater insight. “We have always done our appraisals this way” may not be sufficient. Correct appraisals will lead to correct decisions. The appraisal method will need to evolve from one which is suitable for early-stage strategic assessment, to the more detailed process needed for appraisal of shortlisted options.

40. Analysis Models

Which business models and appraisal frameworks will be employed to analyse projects? To what extent will impacts be expressed in monetary terms? Will risk-adjusted net present values be calculated? How will environmental and social factors be assessed? How will opportunities for better than expected outcomes be identified and assessed? Will the appraisal cover all costs and benefits throughout the construction, commissioning, operation and de-commissioning stages?

41. Risk Management

What method will be used to identify, analyse and manage risks, as well as the possibility of outcomes better than expected?

42. Risk Mitigation

How will risk mitigation be managed? How will the options for risk mitigation be identified and costed, and how will decisions be made on which of these options represent good value for money?

43. Analysis Resources

What up-to-date resources exist to assist analysis — data, models, appraisal processes, plans, reports?

44. Scenarios

How will alternative scenarios be used for forecasting? How will these scenarios be chosen?

45. Audit

What provision is there for an independent audit of appraisals and the inputs to them before key decisions?

Note: HM Treasury’s guidance for UK projects states principles to be applied during project appraisal which should be considered. This often provides more flexibility for innovative approaches than is sometimes appreciated, provided that the methodology adopted is within the overarching principles. See: <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>.

Designing the Project Development Process

The details of the project development process should now be worked out, in the light of the governance rules and methods of appraisal which have been decided upon.

46. Nature of the Process

What project development process is proposed? What is the nature of the project environment? Is the proposed development process practical for the anticipated project environment?

47. Timescales

What will be the main phases of technical work and key decisions? What will be the series of 'decision gateways' through which the project must pass before entering the next stage of development? Will a relatively short timetable for the development process be established at the outset to ensure that momentum is maintained? If so, how can the danger of not paying enough attention to important factors be overcome?

48. Gateway Decisions

Who will make the gateway decisions and what criteria will they employ? Will they be presented with a risk analysis and mitigation strategy?

49. Scope Creep

What steps will be taken to ensure that unnecessary features are not included in each project considered? How late should project specifications be 'frozen'?

50. Extent of Development Work

How much development work should be done before authorisation of a specific project is sought? To what extent should design details be left to the post-authorisation phase? Will there be a development budget?

51. Influence of Operator

When will the identity of the eventual operator be known? How will the operator influence decisions? Will he

be involved from the earliest days to avoid problems later, and if so, how?

52. Emerging Uncertainties

What studies will be carried out as project development proceeds, to identify and manage emerging areas of uncertainty for the project and its context, additional to those identified at the outset?

53. Identification of Need for Changes

What mechanisms will be employed to identify in a timely way, and act on, the need for changed objectives for the project as development proceeds, if there is a change in the overall context within which the infrastructure will sit? — For example, new political considerations, changes in economic circumstances, new regional development plans, altering social considerations, emerging uncertainties, etc.

54. Validation of Forecasts

How will forecasts and estimates be validated ('reality-checking' costs, demand and benefits)?

55. Roles for Private and Public Sectors

How will decisions be made on what roles there should be for the private sector and for the public sector?

CASE STUDY

In 2014 a new computer system for managing welfare benefits was introduced in Canada (cost \$214 million). Known as the SAMS system, it was plagued with problems, including overpayments totalling \$20 million to 17,000 recipients and cheques being sent to wrong addresses. The predecessor of SAMS, introduced in 2004, had suffered somewhat similar problems, but there was a failure to learn from this past experience.

Contributing factors as reported in the press:

Lack of quality control. Launching the product before it was ready. Challenges in defining the requirements fully. Ineffectual training.

Exploring Alternative Projects

Before deciding upon which particular project will best meet the needs of the situation, it is crucial to identify and study all the potentially high-value alternatives. Any failure to find the best project will result in a sub-optimum solution.

56. Identification of Alternative Projects

How will all potentially viable project concepts be identified in the early studies? How will a determined and focussed search for opportunities be undertaken? What expertise will be required? What time and budget is provided for this identification process?

57. Feasibility

How will preferred project concepts shortlisted for feasibility study be validated?

58. Appraisal of Alternatives

To what degree of depth will the alternative projects be appraised to reveal their differences and respective benefits, and the risks involved in each? How will each project's flexibility, adaptability and resilience be assessed?

59. People Adversely Impacted

What work will be undertaken to identify groups who would

be adversely impacted by each project and how their concerns would be managed?

60. Uncertainties

Will there be a continuing search for additional knowledge about each project and its risks, to reduce the uncertainties surrounding it? If so, how should this be undertaken?

61. Project Boundaries

How will the boundaries of each project be determined and investigations made into what work (if any) needs to be done outside these boundaries to ensure the success of the project in achieving its objectives?

62. Selection of Favoured Project

What criteria will be used to select a favoured project from among those considered? To what extent will project riskiness and relevant environmental and social factors play a part in the selection decision?

Some Criteria for Selecting a Favoured Project

✓ Extent to which the purpose would be fulfilled	✓ Funding considerations
✓ Resource availability	✓ Political and public acceptability
✓ Timescales	✓ Within sponsor's risk tolerance?
✓ Economic efficiency	✓ Any requirement for additional infrastructure
✓ Size of risk-adjusted financial Net Present Value	✓ Flexibility, adaptability, resilience, sustainability
✓ Environmental factors	
✓ Social considerations	

CASE STUDY

Flint Michigan changed its water supply in order to save money. However, there was a failure to add corrosion inhibitors into the new water supply, as had happened previously. The result was that the city's pipework started to corrode and residents were exposed to dangerous levels of lead. The city switched back to the original supply but serious damage had been caused to the pipework, much of which now needed to be repaired or replaced. In January 2016 Flint was declared an official disaster area.

Contributing factors as reported in the press:

Cost cutting (putting money ahead of quality). Failure to apply appropriate quality standards. Cavalier attitude towards safety risks. Failure to heed warnings from stakeholders. Lack of effective governance. Leadership failures.

CASE STUDY

In Montreal an overpass opened only a year previously was demolished in 2016, because its positioning was found to be incompatible with the redesign of the road access to a nearby bridge.

Contributory factors as reported in the press included:

Failure to co-ordinate across multiple projects. Lack of long-term planning. Lack of internal communications.

Developing the Favoured Project Further

Once a favoured project has been chosen for further development, considerable thought and effort will be needed to develop it so that it is the best project that could be undertaken.

63. Flexibility, Adaptability and Resilience

How will flexibility, adaptability and resilience to cope with changing future conditions be built-in to the selected project, and can a certain level of extra cost to achieve this be justified?

the sponsor and key stakeholders? Will some risks be borne by parties other than the sponsor? Are there options to mitigate some of the risks and would these be cost-effective? Which of the mitigation options will be recommended for adoption?

64. Costs

How will cost estimates be refined so that there is full confidence in them?

71. Impacts of Other Projects

Will the project be affected by other projects under construction or being planned by the sponsor or other parties?

65. Robustness

How will it be determined whether extra capital cost should be expended in order to make the assets more robust physically once they are in operation?

72. Emerging Doubts

If significant doubts about the likelihood of success emerge during this further development process, will there be a willingness to look at aborting the project and reconsidering an alternative?

66. Scope Creep

How will 'scope creep' in this further development phase be managed, to avoid unnecessary extra cost?

73. Checks on Meeting Requirements

Once the further development process is complete, what checks will be made to ensure that the selected project does in fact meet the sponsor's core strategic requirements?

67. Integration into Environment

How will the integration of the project into its environment be managed?

68. Complementary Projects

Will the commitment decisions be linked to decisions about the complementary policies and project investments that together (within or outside the project's boundaries) create conditions for project viability?

69. Contingencies

How will allowances be made in the estimates for adverse contingencies which could lead to extra cost or delays?

70. Will the Risks be Tolerable?

What will be the key risks if the project goes ahead? To what extent will these risks fall within the risk tolerances of

Making Key Decisions

Decisions to authorise a project and the adoption of risk-mitigation options need to be taken by people with significant experience who are thoroughly familiar with the project, its prospective benefits, and its risks. They must understand and accept the methods of appraisal which have been used, and the assumptions on which they are based.

74. Basis of Authorisation

What will be the main figures and other considerations, including political factors and funding, on which the decision to authorise the favoured project or not will depend?

75. Final Check

Will there be a final independent check of the figures being presented to decision-makers and the validity of the assumptions on which they are based? Will the final estimates be reality-checked against the experience of comparable operational projects?

76. Optimism Bias

Will an "optimism bias adjustment" have to be taken into account in the investment appraisal, or can this adjustment be reduced or eliminated, because realistic costs and contingency allowances have been used in the appraisal and sufficient risk analysis and risk mitigation has been done?

77. Risks

Will the results of a full risk analysis and mitigation strategy be presented to decision-makers, at least in summary? Will this include a check on whether the residual risks, before and after risk mitigation, fall within the risk tolerance of the sponsor and key decision-makers?

78. Risk Mitigation Decision

If a decision is made to authorise the project, will a separate decision be taken on whether the recommended risk mitigation strategy should go ahead in whole or in part, and on what considerations should this decision be based?

79. Complementary Work

What steps will be taken before project authorisation to ensure that any necessary work outside the project's boundaries will in fact go ahead?

80. Involvement of Operator

Before authorisation is given, has the eventual operator of the infrastructure confirmed that they have been sufficiently involved and that they back the project?

81. Support for the Project

Has sufficient support for the project been garnered from a coalition of interests? Would the project have support right across the political spectrum or should information be obtained on whether it might be delayed or cancelled if there were a change of Government?

82. Management of Political Realities

How will the political realities of the decision to authorise the project or not be managed?

Note: If the project is authorised to go ahead, its implementation must take place in ways which are compatible with the appraisals on which the authorisation was based, and the governance framework must be expanded to cover this and other matters. Steps will have to be taken to ensure that the project implementation team is competent, sufficiently briefed and held to account through periodic reviews during the procurement, construction and commissioning stages, so as to ensure that risks are

appropriately mitigated and controlled, and that there is tight control of costs, scope creep, detailed design, and risks arising from people's unexpected actions. Procurement decisions will be needed, possibly in accordance with the code of conduct recommended by

the Construction Clients' Group, and appropriate mechanisms will need to be put in place to control change effectively and release contingency allowances when appropriate. However, project implementation is outside the scope of this paper.



Conclusion

Thinking deeply about all these issues and how to put them into practice is vital for success. So also is the need for inspirational, visionary, resolute and tenacious leadership, at the head of an experienced team of fully competent people.

Selected Bibliography on Front-end Thinking

Many of the items listed below describe how important steps are often overlooked or not handled thoroughly in the development of major infrastructure projects. For example:

- Projects often set out without criteria for systematic evaluation of success (NAO, 2014);
- Projects are often judged by their short term 'tactical' success, rather than their long term 'strategic' success (Samset & Volden, 2015).

- The project development process often fails to focus on the requirement to put in place the conditions for sustainable operational success, as operators are often not involved early enough to be influential in developing plans (Allport, 2015).
- Very few projects do enough feasibility work to develop a robust understanding of what is needed (NAO, 2011).
- Early project estimates are not checked against the performance of comparable operational projects, resulting in disappointment later (Allport, 2015).

Lord Browne of Madingley (2013) pointed out that “there is insufficient attention given prior to the initiation of projects to identifying options and risks”, and that “the lowest standards that are set at the start of a project are the highest standards that can be expected for the rest of the project”.

Lessons learnt from past projects have been published by the National

Audit Office (2014) and the Infrastructure and Projects Authority (2016a). Miller and Lessard (2000) and Merrow (2011) recommend that sponsors of major projects should be proactive in the “strategic shaping” process of the project’s development path. The ICE and the Actuarial Profession have published the *RAMP guidance for project risk* (2014) and the *STRATrisk approach on strategic risk* (2006), which focus on uncertainties and the management and control of risks.

The Infrastructure and Projects Authority (2016b) has published the *Project Initiation Routemap*, which emphasises the need to assess the complexity of the project and the capability of the sponsor and others to develop and manage it effectively. Miller and Lessard (2000), Edkins et al. (2013) and Winch & Leiringer (2016) all provide outline frameworks for the project sponsor to undertake self-assessment for its capability before committing to major projects.

Sponsors will get better value from the construction process if they observe a specified code of conduct (Construction Clients’ Group, 2013), many of the components of which originate from the development process which has taken place prior to authorisation of the project.

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