Delivering major infrastructure projects effectively and efficiently

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Part II: Enabling planning and execution

8

DELIVERING MAJOR INFRASTRUCTURE PROJECTS EFFECTIVELY AND EFFICIENTLY

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8.1 Introduction

The delivery of major infrastructure projects needs to consider and respond to the various factors within the project business environment for the project to be delivered effectively. Effective delivery should consider the time, cost and quality constraints, as well as ensuring that the project is fit for purpose. Some of the purposes to be considered should include meeting and resolving the national infrastructure deficit, the sustainable development goals (SDG) of the county, and value for money. Given the complex, multi-stakeholder and political changing environment within which major infrastructure projects are delivered, it is always important to ensure that such a project effectively delivers impact to socioeconomic, environmental, cultural and sustainability of a nation. Indeed, to achieve such an impact, the project needs to be aligned with developmental priorities, vision and goals of the country. The effective delivery and running of well-considered major infrastructure projects will in turn provide competitive economic development and sustainable advantages to the country. In this chapter, the author provides a critical account of key considerations that should be considered to ensure the effective delivery of major infrastructure projects that are fit for purpose and capable of delivering impactful gains to a country. The chapter sets out to achieve the following aim and objectives.

8.2 Chapter aim and objectives

This chapter aims to explore some of the challenges, issues and processes used by decision-makers and governments in the quest to deliver major infrastructure projects that are effective and efficient. The main objectives are to:

- Examine the approach used by various countries and decision-makers to appraise their current infrastructure situation and government needs.
- Explore the factors and key considerations for creating an infrastructure vision and goals for the future.
- Examine how major infrastructure projects are delivered effectively and efficiently, including the considerations for finalising plans and moving from planning to action.

8.2.1 Learning outcomes

The following learning outcomes have been identified for this chapter. Readers will be able to:

- Articulate the process of prioritising major infrastructure projects;
- Appreciate the value of prioritisation and cost-benefit analysis (CBA);
- Gain insight on current infrastructure situations and government needs;
- Comprehend how to create a vision and goals for the future infrastructure assets;
- Apply appropriate principles of ensuring major infrastructure projects are delivered effectively and efficiently;
- Demonstrate how to finalise a major infrastructure plan; and
- Gain insight on managing delays and cost overrun.

8.3 Prioritising major infrastructure projects

It is important to plan and prioritise infrastructure project investments in order to attain optimal productivity and as a means of engendering infrastructure contributions that will have long-term sustainable and economic growth. Indeed, the economic stage and progression of a country will affect the planning and prioritisation of infrastructure projects and the impact of investments on economic growth. This considerably varies the extent of attainment of the economic benefit from infrastructure investment and the way in which resources are allocated to infrastructure projects. For instance, developing countries will tend to invest in the delivery of capital projects with the aim of developing infrastructure to support its growth and global competitiveness. Conversely, for mature countries and ones moving towards developed status, capital functional infrastructure such as transportation, communication, sewage, water, and electric infrastructures are more likely to be already in place. The focus, therefore, tend to move more towards providing resources to sustain, improve, expand and maintain these functional infrastructures. Governmental preparedness on national economic infrastructure will help optimise the portfolio of infrastructure investments and allow governments to identify links between sectors in order to identify and increase the opportunities to expand the provision of infrastructure funded from users. The effective delivery of infrastructure will also create the greatest impact in terms of economic growth, social uplift and sustainability. It is generally assumed that for every dollar spent on public infrastructure investment the gross domestic product of the country will increase by approximately US $0.05 to US $0.25 (WEF, 2012).

Impacts from investing in infrastructure are wide and varied and often form the basis for prioritising economic major infrastructure projects. Impacts may, for example, relate to (i) costs, (ii) convenience, (iii) environmental aspects, (iv) strategic factors, (v) political factors and national prestige, (vi) alignment with policy goals and objectives, and (vii) income distribution considerations (Schutte and Brits, 2012). The prioritisation of infrastructure projects hinge on economic, technical, institutional, financial, social, commercial and benefit cases. A review of literature shows various methodological approaches for infrastructure investment prioritisation. First is the literature that focuses on criteria that play a major role in mitigating the infrastructure gap (e.g., Berechman and Paaswell, 2005, Karydas and Gifun, 2006). The criteria tend to focus on the identification and measurement of both direct and indirect benefits of the projects mainly focused on economic benefit and cost benefit analysis. In Andres, Biller, and Dappe (2016) a stepwise methodology was developed with a particular focus on infrastructure prioritisation in developing countries where demand for investment is huge and financial resources are limited. The methodological framework consists of three main steps: (i) identifying factors that affect infrastructure investment decisions, (ii) quantifying identified factors and (iii) ranking the infrastructure projects. The authors categorised the factors affecting infrastructure decision-making into project-level factors, economy-wide impacts, project-related market failures and a country's institutional system. In their report (PwC, 2016) they further drew on their experience of working on infrastructure projects and set out a set of principles to help the decision-making process. This included the objective identification of current and future needs to ensure that infrastructure decision meets a need (Flyvbjerg, 2008), while also fitting the broader policy agenda for government. They also emphasised the need to assess the financial viability of the project including assessing the availability of funds as well as developing an in-depth understanding of the link to wider economic benefits.

8.4 Major infrastructure prioritisation and cost-benefit analysis

One of the most commonly used method for prioritising major infrastructure projects is cost-benefit analysis (CBA). CBA is a systematic method used to evaluate the strengths and weaknesses of alternatives in order to determine options that provide the best approach to achieving benefits while ensuring savings (Boardman *et al.*, 2017). It assesses and totals up the equivalent money value of the benefits and costs to the community of projects to establish whether they are worthwhile. CBA is used for improving government decision-making on project prioritisation. However, several

problems undermine its use: the difficulties of capturing benefits; unrealistic cost estimations and lack of consistency in the approach used. These problems risk projects being approved incorrectly or turned down or delayed. For instance, Atkins *et al.* (2017) presented the CBA framework used by the United Kingdom's government to judge the net present value of an investment – whether benefits outweigh costs, discounted over time. In this framework, CBA forms an important part of government's project prioritisation, approval, and allocation of limited resources, with guidance provided by the Treasury's Green Book. It also forms part of the accountability framework that civil servants and ministers operate within. Within the frameworks, CBA is mainly used in three separate stages (see Figure 8.1).

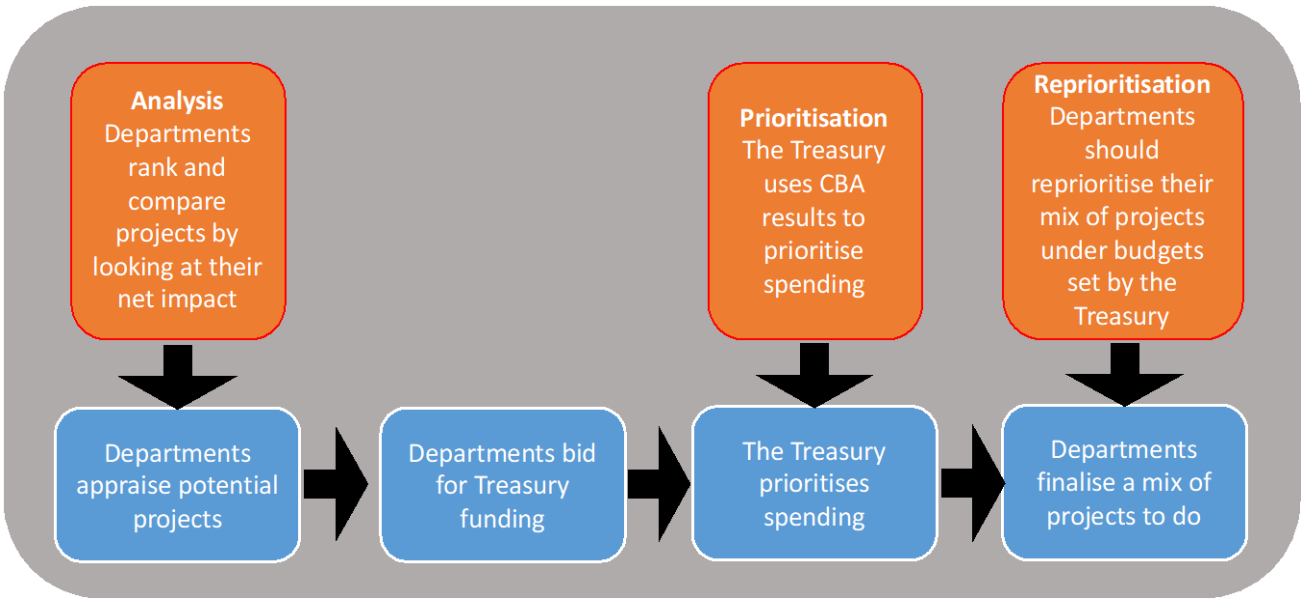

Figure 8.1 Cost-benefit analysis used by the UK government

Source: Original adapted from Atkins *et al.* (2017)

In the first instance, departments use CBA to value projects. Then the Treasury uses CBA results to help allocate spending under fiscal constraints. Finally, upon allocating the capital budget by the Treasury, departments then revisit their project selection and use CBA to reprioritise the optimal mix of projects. In all business cases, CBA is referred to as the "economic case," and is only one of five cases sitting alongside the strategic, commercial, financial and management cases. At both analytical and decision-making stages of infrastructure project prioritisation, the results of CBA, in particular the benefit–cost ratio, does not form the sole basis for an infrastructure project approval. Other factors such as the project's deliverability, affordability and the prevailing politics of the day also influence the prioritisation and decision-making process. The framework ensures that alignment with the government's policy priorities, outlined in the strategic case for a project, is usually the main reason for going ahead with a project. Nonetheless, decision-makers would require significant justification to proceed with a project if analysts thought that the costs exceeded the benefits. CBAs should be thorough in order to influence decision-making. So, what does a good CBA in government infrastructure prioritisation look like?

- It must include all applicable and relevant impacts. Some major projects have dynamic effects. They have transformational objectives in the form of increasing economic growth and provide job opportunities that a static analysis will not account for. Wherever possible, these dynamic effects need to form an integral part of the economic case so that they are subject to a high level of internal scrutiny.
- The cost estimation and analysis must be realistic. Estimates that are over-optimistic can lead ministers to undeliverable targets and erode public faith in government when these are not met. Government must try to mitigate this tendency wherever possible, using data from past projects.

- CBA needs to be applied in a consistent way across all projects within the prioritisation framework to ensure comparability when prioritising.
- It must be transparent, devoid of bias and well communicated. Any CBA analysis must represent the forecasting risks and be transparent enough to allow decision-makers to debate on key assumptions made.

8.5 Appraising the current infrastructure situation and government needs

The role of government in planning major infrastructure projects varies from appraising the national infrastructure situation, and directing investment decisions and their coordination, to creating a framework to attract private investment. To ensure that infrastructure investments make an impactful contribution to the developmental objectives of a country, politicians and officials need to understand which infrastructure project investments are able to address these objectives in order to invest in it. However, it is important to acknowledge that new investments are not always the answer. Decision-makers need to be able to identify many other aspects of their infrastructure package such as upgrades of existing infrastructure, developing robust and improved maintenance regimes or setting a demand management system. If decision-makers decide to invest in new infrastructure project, a needs assessment will be required and this should include:

- An assessment of the performances of the current national infrastructure system vis-a-vis the vision and developmental objectives of the government. This should include a gap analysis of the performance of the current infrastructure and its effects on different regions, social groups and economic sectors.
- Consideration should be given to the changing demand on the new investments, including population growth, demography, economic growth, climate mitigation and adaptation, and technological change.
- A strategic evaluation of the impact of the infrastructure investment options on the national economy. This will provide a long-term perspective to projects with high upfront costs and the economic impact such projects can make in the long-term, such that decision-makers are able to make informed decisions about the long-term benefits of such projects.
- An assessment of the threats, opportunities and uncertainties related to the different options.

To better understand the condition of infrastructure assets and the barriers to further investment, the World Economic Forum (WEF, 2012) has developed a framework to help governments familiarise themselves with the main drivers of infrastructure investment – the Strategic Infrastructure Planner Framework. The framework in Table 8.1 identified 14 parameters within the four drivers of infrastructure readiness: the condition of infrastructure assets in the country; whether government policies and actions are conducive to infrastructure investment; whether there is support from wider society to invest in infrastructure and engage in debate; and whether there is a competitive construction industry that can easily access labour, building materials and finance.

Table 8.1 Strategic Infrastructure Planner Framework: 14 economic infrastructure readiness parameters

Drivers of infrastructure readiness	*Key parameters*
Infrastructure quality	• Quality of land transport (road and rail) • Quality of ports and air transport • Availability and reliability of energy grids and power supplies • Availability and reliability of telecommunications networks • Quality of waste and water infrastructure
Government readiness	• Rule of law and effectiveness of law-making bodies • Government's openness and impartiality

	• Government's track record of infrastructure projects government's willingness to engage with private sector
Societal readiness	• Maturity of civil society • Government or public willingness to pay
Market readiness	• Competitiveness of construction industry and the supply chain – access to labour and materials • Access to finance

Source: Original adapted from WEF (2012)

These parameters serve as the basis for information collection about the condition of both privately and publicly owned economic infrastructure and evaluating a country's infrastructure readiness. Governments can obtain a comprehensive overview of the current state of infrastructure readiness in the country, which can then be used to assess and plan future requirements. This can be achieved by engaging different government departments and representative stakeholders drawn from public-sector organisations, private companies, financiers and investors, civil society, academia and non-governmental organisations (NGOs). The engagement activities are placed within the institutions that form a framework within which individuals, firms and governments interact to generate infrastructure project ideas, income, investments, etc. The framework also has a strong bearing on competitiveness and growth ambitions of a country and plays a central role in the ways in which societies distribute the benefits and bear the costs of infrastructural project strategies and policies, and it influences investment decisions and the organisation of production (Itani *et al.*, 2014). Government attitudes towards markets, freedoms and the efficiency of its operations are also very important when it comes to appraising infrastructure situations and developing a strategic understanding of government needs. Excessive bureaucracy, overregulation, corruption, dishonesty, lack of transparency and trustworthiness impose significant constraints on the appraisal process (Soto, 2001).

The appraisal of infrastructure situation and development of any plan needs to withstand the effects of changing political and governance landscapes such as elections and changes in government. The goal, therefore, is to develop an infrastructure plan that enjoys strong consensus by the government agencies involved, helps to set priorities, and identifies programmatic initiatives that go beyond elections such that it provides some level of certainties to stakeholders such as financiers and investors. A progressive and stable policy framework, therefore, supports the development of an agile and supportive infrastructure project and programme ecosystem, ensuring that contractors, developers, and investors remain positively responsive to opportunities. Government's appraisal of infrastructure needs must provide plans that set directional momentum to address infrastructure deficits. Such a plan must also signal priority reforms and the institutional activities that are vital to eliminate obstacles to infrastructure investment. They force a holistic and integrated view of infrastructure needs beyond the boundaries of line departments and potentially help the resolution of overlaps and gaps in policies, institutions and programs to tackle infrastructure deficits.

8.6 Creating a vision and goals for the future infrastructure assets

In many instances, infrastructure assets are delivered to last for many decades. Therefore, the infrastructure vision over a long term should be the starting point for governments that are planning their infrastructure strategies. This vision must identify and develop an understanding of what they are trying to deliver, to whom and why. This process of establishing a national infrastructure project vision is important because it provides a point of reference on what needs to be achieved. Without it, there is a real risk that national infrastructure plans are little more than a collection of unrelated projects, all pursuing different goals and making little systematic impact on a country's infrastructure systems. Furthermore, a national infrastructure vision ensures that infrastructure decisions are aligned with sustainability goals, including the provision of inclusive development, mitigation of

carbon dioxide emissions and adaptation to the impacts of climate change (Hall *et al.*, 2017). Before discussing the specifics of creating infrastructure vision, let us review the interlink between infrastructure and SDGs.

8.6.1 Creating an SDG-based vision

Infrastructure includes networked systems that deliver services such as energy, water, waste management, transport and telecommunications. In a broader context it also includes social infrastructure, such as social protection systems, healthcare systems (including public health), financial and insurance systems, education systems and law enforcement and justice (Thacker *et al.*, 2019). All these systems interact with the socioeconomic systems of society and are imbedded dynamics of human and environmental sustainability. For instance, a highways project will affect preferences for modes of transport and lock in patterns of urban development (Erickson *et al.*, 2015). Most infrastructure has a positive impact on society and, hence, an intertwined relationship with the SDGs. The access to transportation, energy, water, sewage systems, healthcare, education, etc., is underpinned by the provision of infrastructure to support the delivery of these services. Infrastructure also delivers vital factors of production (energy, water and access to labour markets).

Conversely, unreliable infrastructure systems limit the productivity of businesses and public services (Steinbuks and Foster, 2010). Indeed, whilst there is a positive side to infrastructure projects intertwined with SDGs, the construction and operation of infrastructure can also be profoundly harmful (Thomson and Koehler, 2016). The construction lifetime operation and maintenance of an airport, for example, can displace people. Even though it offers employment, it can expose people to hazardous working conditions. Fossil-fuel power used by airplanes is responsible for harmful air quality and greenhouse gas emissions. Furthermore, the construction of the airport infrastructure (runways, terminals, access roads, etc.) can destroy and fragment habitats and provides access that enables the over-exploitation of natural resources. However, there is increasing interest in sustainability infrastructure development aimed at substituting “grey infrastructure” with “green infrastructure” (Thacker et al., 2019), for instance, by utilising ponds and reed beds to treat sewage, wetlands to help recharge groundwater aquifers, and substituting afforestation for flood protection (Dadson *et al.*, 2017; Scholz and Lee, 2005; van der Kamp and Hayashi, 1998).

Figure 8.2 SDGs

Figure 8.2 shows the UN SDGs. Thacker *et al.* (2019) analysed the extent to which infrastructure systems influence sustainable development outcomes, as defined by the targets of the SDGs. They found that infrastructure either directly or indirectly influences all 17 of the SDGs, including 121 of the 169 targets (72 percent). For 5 of the 17 SDG goals (SDGs 3, 6, 7, 9 and 11), all of the targets are influenced by infrastructure, whereas for 15 of the SDGs more than half of the targets are influenced by infrastructure. The water and energy infrastructure sectors were found to have the largest direct influence on individual SDGs: 6 (clean water and sanitation) and 7 (affordable and clean energy). Transport infrastructure enables access and participation in society and the economy, and has, therefore, a wide indirect influence. The increasing role of digital communications in enabling delivery of a wide range of services, from hazard warnings to remittance transfers, is demonstrated by this sector having the largest overall influence across the SDGs when also considering indirect effects. Thacker *et al.* (2019), however, observed that badly planned tendencies will have negative effects on the SDGs – for instance, when badly planned infrastructure leads to pollution, water and soil contamination, or disease transmission (SDG 3) or affects aquatic and terrestrial ecosystems (SDGs 14 and 15) and destroys culturally important sites (SDG11).

8.6.2 Understanding the tensions of infrastructure vision and goals

With every delivery of any type of infrastructure project we can recognise potential "winners." These winners could be, for example, a community that benefits from the expansion of a new road network; improved healthcare of a society from a new hospital; a business that developed enhanced capabilities because of the installation of a 5G network; and a local community with access to a new freshwater supply system. These winners are individuals, organisations and communities whose positions, activities, work quality or general well-being are enhanced by the delivery of infrastructure(s). Similarly, there are potential "losers" – persons, organisations or communities who miss out or are negatively affected by the emergence of an infrastructure. Examples are towns or communities bypassed by the expansion of a network, the loss of jobs from automation strategies, and the loss of farmland from the construction of residential homes. Emergent infrastructures function as redistribution mechanisms by reorganising resource flows across scales ranging from the local workplace to the global economy (Edwards *et al.,* 2007).

The perceptions of benefits and loss will influence the support (or otherwise) of any infrastructure's vision and goals and, hence, shape the environment within which the infrastructures emerge from. A receptive environment is such that allies (e.g., communities, financiers and funders) provide their support and innovation to extend the reach, quality and fit of infrastructure while a hostile environment is such that important user groups and audiences fail to be cooperative, undermine the vision, and refuse or oppose rival projects. "Failing to think proactively about the distributional consequences of infrastructure is not only bad politics, but bad business" (Edwards *et al.,* 2007, p. 22). A distinctive kind of tension emerges with groups that feel entitled by the emergence of infrastructure. These individuals, groups, and communities are stakeholders in advancing the development of infrastructure such that its emergence supports and extends their strengths. The historical constitution of powerful classes of infrastructural users, both individual and collective, may constitute a powerful conservative force confronting and constraining new infrastructural development. In this instance the tension exists when infrastructure is subject to "capture," in which powerful established constituencies exert their interest such that it overwhelms or constrains the potential development of favourable vision. This takes form when interests are exerted to effectively grasp infrastructure goals, resisting infrastructure initiatives and developments that favour new, less organised or less favourably placed actors, limiting the scope and vision of new infrastructural possibilities (Bowker *et al.,* 2010; Karasti *et al.,* 2010).

8.6.3 Drafting an infrastructure vision

Through the work of Thacker *et al.* (2019), we have seen a balanced illustration of the interlink between infrastructure and SDGs. Additionally, Edwards *et al.* (2007) provided some insight into the tension that exists in the context of setting and developing infrastructures. Therefore, it is essential for policymakers to establish long-term visions for sustainable national infrastructure systems but also factor in the tensions in order to ensure that the right infrastructure is built. Such a vision needs to be informed by the SDGs, and any infrastructure plan emanating from this vision must consider both the positive and negative impact of infrastructure projects (and operations) on the SDGs, as well as "winners" and "losers." Additionally, decision-makers must understand what infrastructure they are trying to deliver, to whom and why. Although final prioritisation decisions rest firmly with government, there is the need to invite key stakeholders to give their views and perceptions of the long-term vision and requirements. With the infrastructure vision drafted, the subsets of outcome-based, i.e., short-term, medium-term and long-term infrastructure goals, can then be prepared. This involves a methodological assessment of critical infrastructure gaps in order to identify critical priorities needed to drive socioeconomic transformation, create alignment with SDGs, set actionable goals around these priorities and identify infrastructure projects to aid the realisation of the goals.

Indeed, every country has specific infrastructure needs and priorities that are related to its history, level and ambition of economic development, socioeconomic and geographical considerations and domestic political choices. For instance, Norway and many oil-rich Gulf States are currently prioritising the diversification of their economies. Also, post-apartheid South Africa has focused on integrating rural, non-white communities into the national economy. Setting infrastructure vision, therefore, needs to be context specific to the country. In some instances this can also be linked to regional visions, as seen in the European Union (EU) and the Economic Community of West African States (ECOWAS). Objectives also change over time as a country moves through stages of development. Hence, vision needs to be reviewed consistently for relevance and benefits. For instance, over the post-war period, Singapore and Hong Kong both evolved from the provision of basic services like water and sanitation to a more strategic importance of provision of good quality of life, equality of opportunity and social cohesion.

8.7 Ensuring major infrastructure projects are delivered effectively and efficiently

For a national major infrastructure vision to be achieved, government and investors must ensure that the major infrastructure projects are delivered effectively and efficiently. This entails developing a strategic plan by converting the needs assessment into a viable plan aimed at improving the national infrastructure system and realising the set vision. A strategic plan will typically include a prioritised list of investment infrastructure projects and a package of related interventions aimed at improving the performance of the infrastructure system. The interventions could include the development of policy and regulatory changes. A strategic plan should ideally envisage the uncertainties inherent in a multi-decade timeframe and develop an approach that ensures the sustainable implementation of the infrastructure vision. It should also develop a framework for coordination with any regional, subnational, and sectoral plans, while also considering the funding and financing options. A process should be established to measure the progress of delivery against milestones and evaluate the success of the strategic plan in delivering the desired strategic effects (ICE, 2020); consideration must also be given to the opportunity of efficiently utilising scarce resources. The work of Ochieng *et al.* (2017) illustrates how efficiency can be achieved. This was expanded to include:

(i) **Transparent and effective governance:** The creation of effective governance structure, staffed by skilled professionals, will aid the successful delivery of major infrastructure projects. Such a structure must include a clear division of responsibilities between the political executive, the national legislature, permanent officials and any expert independent infrastructure commission or body.

(ii) **Institutions and institutional capabilities:** Institutions form the backbone of the effective delivery of major infrastructure projects. They provide the processes and skills, implement policies, and regulate and govern the

infrastructure delivery environment. Their input does not only affect the delivery of infrastructure projects but also impacts the operations and the life cycle of the delivered asset. Ambituuni *et al.* (2019), for example, showed the need to assess institutional capabilities with respect to owning, operating and regulating infrastructure, and the need to align the capabilities of both the regulator and operator to ensure robust conceptualisation, delivery and operation of infrastructures. Indeed, when countries invest in infrastructure and this is accompanied by reforms to strengthen institutions and regulation, they experience relatively stronger impacts on productivity and economic growth. Institutional actions should be aimed at removing barriers to infrastructure investments, such as bureaucratic bottlenecks, corruption, conflicting priorities, etc. (Ambituuni *et al.*, 2014). This should ideally be anchored centrally by an institution as seen in countries like Rwanda, Sweden and the UK. In the UK, for instance, the National Infrastructure Commission (NIC) provides expert, independent analysis on pressing infrastructure issues, and is charged with preparing the National Infrastructure Assessment (NIA) to set an overarching, long-term vision and recommendations taking a 30-year perspective, while the Infrastructure and Projects Authority (IPA) prepares medium-term plans for a five-year period and also manages and provides regular updates to the National Infrastructure Pipeline. Such an approach provides a central converging point for infrastructure planning and can potentially help resolve overlaps and gaps in policies and programs to tackle infrastructure deficits.

(iii) **Process:** Optimised infrastructures are delivered with optimised project decision-making, financing conception, and a planning and execution framework. Furthermore, processes that are standardised provide consistency in delivery and therefore save time and resources. They ensure consistency in performance matrices which allow for comparison across different projects. Optimised processes include effective adaptation of technologies and project management methodologies to reduce the risk of cost overruns, scope creep and delays. Moreover, funding processes further offer opportunities for optimised project delivery. For instance, for projects funded by taxpayers, a way to manage overall costs is to secure efficient sources of finance. Governments have two main options to pay for the construction and operating costs of the project: (i) using their own resources, either by spending existing cash reserves, selling government assets, raising taxes or issuing government bonds to fund the investment, or (ii) with PPP approaches, using project finance solutions and paying for the operational assets over years (WEF, 2012).

(iv) **Public involvement:** The views of people and organisations likely to be affected by a major infrastructure project has well been established as critical in the delivery of the projects (UNECE, 1998). Such involvement is aimed at ensuring both fairness in decision-making and also to divulge information sources and viewpoints that technical analysts may have overlooked or misinterpreted. For certain elements of major infrastructure project such as environmental decision-making, public participation is a requirement of the 1998 Aarhus Convention 12. Public participation can help to improve the technical quality of the project processes. However, it is important to recognise that for public participation to be effective and enhance project delivery, objectives of engaging the public must be clear, and the method adopted for the engagement should be specifically designed to meet the set objectives.

(v) **Risk management:** Major infrastructure projects are subject to both positive and negative risks. Negative risks can lead to inefficient and ineffective delivery of infrastructure projects due to resulting in their cancellation, serious project delays and cost overruns. The risks to major infrastructure projects can take the form of:

- **Inaccurate identification of the need for infrastructure:** For example, forecasters may overestimate demand, in which case benefits are lower than expected and poor value for money.
- **Policy uncertainty:** This could result in project sponsors, lenders and contractors deferring or abandoning projects in favour of opportunities elsewhere. Financing charges for projects may rise as investors and lenders perceive policy uncertainty as a risk.
- **Failure to assess the cumulative impact on consumers of funding infrastructure through user charges:** This increases the risk of financial hardship for consumers or the need for unplanned taxpayer support.
- **Taxpayer exposure to losses:** This could happen if the government guarantees to bear or share project risks and a risk subsequently materializes (e.g., cost overruns).
- **Delivery costs are higher than they should be:** This could result in higher costs for taxpayers and consumers and fewer projects going ahead than planned.

Assessing risk is at the heart of delivering effective infrastructure. Risk assessment should be underpinned by the financial analysis of a project or opportunity because each risk should be allocated a theoretical cost. In reality, however, this cost is likely to be a range of estimates within a probability function rather than a point estimate. The simple calculation is shown in the following equation:

$$\textit{Expected cost of risk} = \textit{probability of risk occurring} \times \textit{cost if risk occurs}$$

Indeed, further consideration should be given to the impact of uncertainties. This is because while it is easier to put a price on risk, it can be very difficult, if not impossible, to put a price on uncertainty. Investors and lenders will consider the risks they choose to accept based on historical performance and specialist advice. But they will struggle to accept some particular events that may be regarded as uncertainties. This is because these events are beyond their control or management abilities. Consequently, it is possible, and perhaps more suitable, for the government to "own" and manage these uncertainties, especially where there is a joint public-private partnership in the delivery of major infrastructure projects (Lam, 1999). In managing the risk events, a number of options could be exploited including contract, finance, insurance and portfolio options.

8.8 Finalising the plan for major infrastructure projects

Once major infrastructure projects are prioritised and approved, governments can begin to address the practicalities of project delivery with the assurance that (i) the projects are aligned to the infrastructure vision, and (ii) the project will deliver the expected benefits and therefore proceed. A delivery plan can be developed in order to have visual insights on construction programmes and steps can be taken to start securing land use planning approvals. Some projects may also be subject to finalisation of statutory processes. Figure 8.3 illustrates how the UK government moves from vision to delivery of infrastructure projects and finalises project plans in Step 2. At Step 2, the portfolio choice and master plan are prepared. Drawing from the CBA earlier discussed in this chapter, the government reviews each CBA report to confirm that the recommended project represents best value for money. The Step 2 process will further determine which projects are the most appropriate to address social, economic and soft infrastructure deficiencies. These projects will usually have a cost-benefit ratio of more than 1. If the government is certain about which deficiencies to address first, the planning process in step 2 will result in fine-tuning the selected projects and considering the funding options.

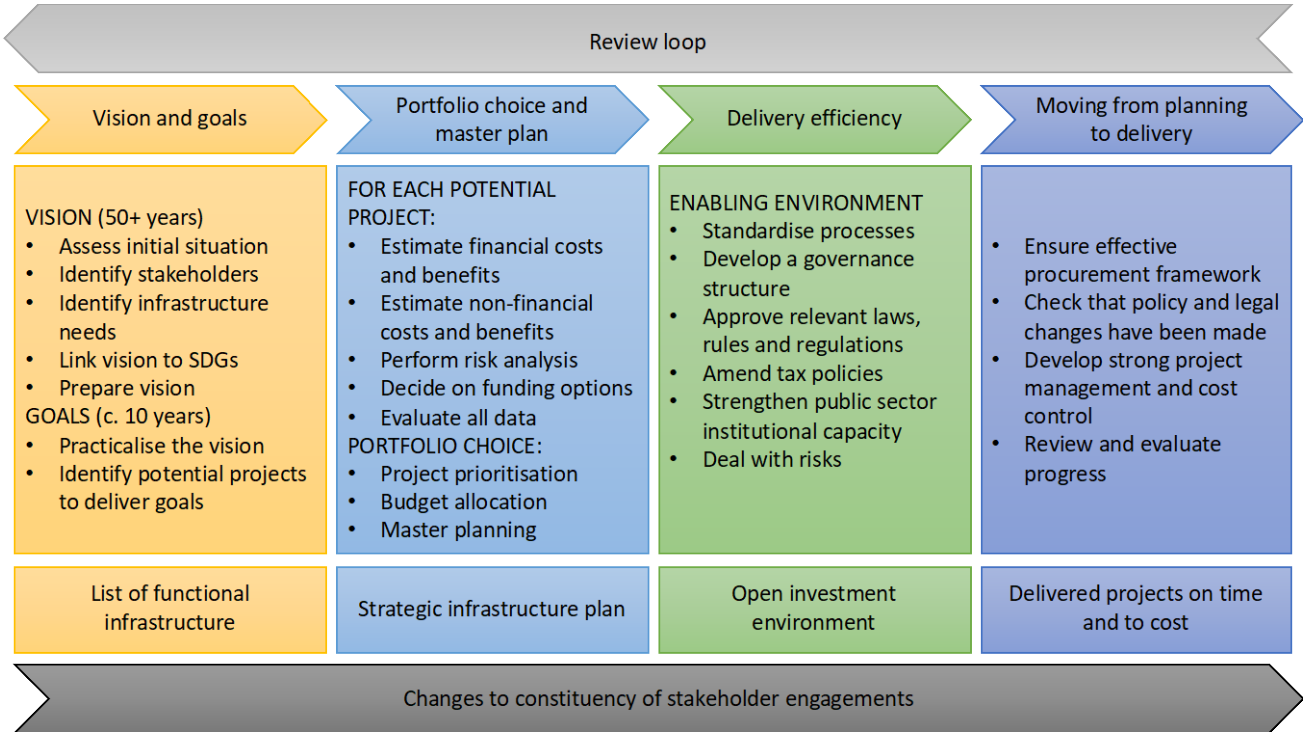

Figure 8.3 Moving from vision to delivery of major infrastructure projects

Source: Original adapted from (WEF 2012)

The planning also needs to align with the budgetary cycles of government; ideally, the funding of projects within the budget should be for a longer period of time, beyond the tradition of annual budgetary allocations. Such an approach will reduce bureaucratic bottlenecks and enhance the procurement processes of the projects. It will also boost the confidence of investors and contractors. Any strategic infrastructure plan developed by governments and planners should provide a chronological visualisation for how infrastructure is delivered and developed over time. A master plans can, therefore, be used in this instance to guide national infrastructure decisions as well as other matters, such as the provision of social infrastructure (WEF, 2012). Such a plan also needs to be flexible and adaptive to the economic and sociocultural environment. For instance, a power plant designed to generate 100 megawatts based on a projected 20 years' demand can be planned to be delivered in stages. If the current demand is 30 megawatts, a phased delivery of the project will allow the project to meet the immediate needs of national demand while allowing capacity for expansion as the needs arise.

8.9 Moving from planning to delivery

Prioritised major infrastructure project plans will need to be published and marketed to stakeholders and potential investors. To further ensure that the projects are delivered effectively, new government policies may need to be developed to support the project context. For example, new public-private partnership (PPP) laws can be established to provide a legal funding framework that supports the project in a clear, reliable and assured way in order to boost investor confidence. The Lekki Toll Road in Nigeria is an example of how government established a PPP framework to support the delivery of a major infrastructure project. The Lekki Concession Company Limited was a special purpose vehicle set up specifically to execute the Eti-Osa Lekki Toll Road Concession Project. The project was designed to deliver essential road infrastructure on the Lekki Peninsular of Lagos state. Lekki Toll Road Concession was conceptualized in 2007 as a PPP scheme and uses the build-operate-transfer (BOT) model of infrastructure delivery. The concession was initially for a period of 30 years; after that, the assets will be transferred to Lagos' state government. In addition to establishing a suitable legal and policy framework for the project, detailed project preparation work should be commissioned to get projects ready for tendering. This should be aimed at making the procurement system very open and transparent.

8.10 Managing delays and cost overrun

Delays and cost overruns are an inherent part of many major infrastructure projects despite the multitude of research and case examples to learn from. In moving from planning to the actual delivery of these projects, one must be aware of the potential causes for delays and cost overruns, plus the possible mitigating actions to be taken. One factor that has been identified as a reason for cost overruns in many major infrastructure projects is design errors (Adam *et al.*, 2017; Narayanan *et al.*, 2019; Pinto and Slevin, 1987). It is important to note that proper representation of project requirements and the blueprint for achieving good technical input to project execution are usually mapped out based on project designs; thus, designs with errors involve incorrect or insufficient representations of project deliverables. They will lead to the wrong application of techniques in achieving results, and also lead to delays and cost overruns. Another way design errors could lead to cost overruns and delays is the intersection between design and project estimations such that having errors in design in a form of omission or misrepresentation will mean that the estimation for the project costing also includes these omissions, thereby leading to extra work and change orders (Singh, 2010). Similarly, designs that are done without extensive investigation of a site could contain potential errors that emerge at the construction phase of the project. This could lead to additional work, revision of the scope of work, and contract revisions, which all affect the overall project

delivery time and cost. Bordat *et al.* (2004) cited the typologies of design errors in projects as errors from inadequate field investigation, errors in specifications, planning errors and errors in design changes. In controlling project delays and cost overruns due to design errors, key consideration should be given to the involvement of professional and technical skills and application of competent tools in the project. Achieving error free design entails good communication with the entire design team and integrating a design process that is properly planned, giving enough time for corrections, extensive investigation, reviews and utilising incremental project implementation methodologies (Fathi *et al.*, 2020). Similarly, effective project planning, controlling and monitoring should be established to enhance project performance throughout the project life cycle. Proper site investigation should be done to ensure that all site conditions are noted in the design.

Delays and cost overruns in major infrastructure projects could also result from scope changes. Scope defines the entire deliverable expected at the end of a project. Therefore, logically, it can be said that all project plans, estimation, schedule, quality and baseline are usually part of the initial project scope. Thus, any change in the project scope during execution will mean a change in the initial project plan leading to budget and schedule reviews. With each scope change, precious project resources are diverted to activities that were not identified in the original project scope, leading to pressure on the project schedule and budget (Amadi, 2019; Morris, 1990; Preuß *et al.*, 2019). Project scope changes can result from an incorrect initial scope definition, inherent risks and uncertainties, sudden change of interest, or project funding changes. They can lead to change requests that result in changes in project deliverables, budget or even the entire project team. Poor scope change management can lead to disputes that may require spending time and money on arbitration and litigation between the contractor and the client. Hence, to achieve a proper control for scope change, it is important to first recognise that change is inevitable and could be beneficial to the entire project success. Therefore, major infrastructure projects should have an integrated and adequate change management process in place, taking a proactive approach to change, involving key stakeholders and incorporating their needs throughout the project life cycle. Similarly, to avoid disputes, it is important to always seek approval for changes from relevant project authorities and communicate changes in a timely way. For highly evolving projects, the scope could be frozen so as to concentrate on the expected deliverables.

The delivery of major infrastructure projects can take a long time and also be complex. This makes such projects susceptible to inappropriate or inadequate procurement and a faulty contractual management system (Flyvbjerg, 2014; Flyvbjerg *et al.*, 2004). Contracts spells out every aspect of project agreement, including payment terms, pricing, service levels, and discounts. Therefore, a contract that has not highlighted the entire project scenario may lead to dispute in the contract system. For instance, if the initial contract does not completely specify every relevant aspect of the project work, this may lead to long chains of negotiations, arbitration and/or mitigation due to work change orders and reviews of contractual agreements with new budgets and schedules. Similarly, ambiguous contractual agreements with unclear clauses can be of potential dispute, thereby generating project delays and cost overruns. Also, delays and cost overruns can result from poor contractor selection and unethical contract behaviours. Since the majority of major infrastructure projects are executed using contractors, it is important to note that the procurement process and contract management are critical to the successful completion of the projects. Thus, poor selection of contractors due to low bids, with no technical capability to handle the project, will lead to cost overruns, schedule delays, poor quality, and an unacceptable final result (PMI, 2018). Also, a poor contract management system with clients on a slow payment schedule can lead to the slowing down of project activities. To solve these problems, the ethical thing to do is identify the most qualified contractor and draft out the most suitable contract type as applicable to the conditions of the project and also explicitly define the terms and conditions that govern the contract in clear clauses. These clauses should spell out the penalties for delays and the party to bear risk associated with these events. Similarly, all important potential dispute (and dispute resolution) contract clauses should be

stated in clear, unambiguous terms. The use of generic contract templates should be avoided and careful consideration should be given when forming the contracts.

Many major infrastructure projects tend to have a relatively long implementation period when compared to small projects. Consequently, the delivery of major projects are affected by inflation, a change in material prices and changes in exchange rates, so the initial budget may need to be supplemented to achieve completion. The result can be cost overruns and long chains of negotiation leading to delays. Similarly, projects with a high degree of complexity usually result in complex plans, schedules and estimates, and are therefore susceptible to omissions that can later lead to increased costs. Project complexity can also be defined in terms of the diversity of the stakeholders, all with different interests and an extensive communication channel (Cerpa and Verner, 2009). Capturing and considering stakeholder interests can take a lot of time and resources, which when overlooked can also result in conflicts and disputes. To eliminate or reduce the effect of delays and cost overruns due to project complexity, vigorous planning should be done that incorporates every important aspect of the project scope, milestones, detailed Work Breakdown Structure (WBS), delivery time, stakeholders and methodology to be used. Managing complex projects needs experience, expertise and exposure. It is therefore important to build an experienced team with the project's best interests and chance for success at heart.

The post-execution phase (closure) of a major infrastructure project is often ignored. Slow closure involves dragging the various handover activities caused by unresolved disputes. Disputes can be linked to contracts and procurement complexities, change order issues not resolved, final change orders not issued, a poor closure of the final account, poor documentation of project success and lessons learnt, and slow client acceptance and failing to close the work order, which can result in unexpected delays and stray charges made to the project. For instance, if the project team is not decommissioned on time after the project work has been completed, there is a tendency to run an idle team that may incur extra project expenses due to overhead; this may overrun the project costs. Similarly, delays in payments to contractors and suppliers after project completion can lead to disputes and a delay in signing the certificate of final completion of the project. The following suggested actions should be considered during a project closure phase:

- **Completion:** Ensure that the project is 100 percent completed to avoid disputes and payment delays.
- **Documentation:** Detailed documentation will ensure that future changes are made with little extraordinary effort.
- **Project system closure:** This includes closing the financial systems, including all payments, work termination, etc.
- **Project review:** This step can help the transfer of tangible knowledge of time and cost, know-how and know-why.
- **Project Team Management** Disband project team as soon as possible to avoid cost overruns due to extra overhead.
- **Stakeholder satisfaction:** Provide all the necessary information required by stakeholders to avoid conflicts. This information can include a timeline showing the progress of the project from the beginning until the end, the milestones that were met or missed, the problems encountered and a brief financial presentation.

8.11 Chapter summary

This chapter examined some of the challenges, issues, processes and tools used by infrastructure decision-makers and governments to effectively and efficiently deliver major infrastructure projects in alignment with a country's developmental objectives. The chapter began with an insight into how the prioritisation of major infrastructure projects is achieved by showing the different approaches used, especially cost-benefit analysis. The chapter then discussed the issues and challenges of appraising major infrastructure projects in recognition of the need to ensure that infrastructure investments make an impactful contribution to the developmental objectives of a country. Furthermore, the chapter provided a review of the issues and factors to consider in the development of a national vision for major infrastructure projects. This focused mainly on the need to align national infrastructure vision with the SDGs and needs of stakeholders and beneficiaries. As shown

in this chapter, a good major project infrastructure vision must be informed by the SDGs, align with the short- and long-term developmental objectives of the country and consider both the positive and negative impact of infrastructure projects (and operations) on the "winners" and "losers" in the context of the proposed infrastructure projects.

The key factors that will ensure major infrastructure projects are delivered effectively and efficiently were discussed. They include ensuring that a transparent and effective governance structure is in place, enhancing institutional capabilities, optimising the project procurement and delivery processes and methodologies, involving the public and effectively managing the risks associated with the project. Once major infrastructure projects are prioritised and approved, processes need to be put in place to ensure effective delivery. Governments can begin to address the practicalities of project delivery with the assurance that the projects are aligned to the infrastructure vision and the project will deliver the expected benefits. The project delivery plan can then be put in place, the budget allocated and the project initiated. The project will at this point proceed from planning to delivery. The delivery needs to consider the procurement approach to be used as well as the methods of project delivery to avoid delays and cost overruns and ensure that the project is delivered efficiently.

8.12 Chapter discussion questions

1. What other factors beyond the economic case can influence the prioritisation of infrastructure projects?
2. A CBA should be thorough and credible in order to influence decision-making. So, what does a good CBA in government infrastructure prioritisation look like?
3. What are the drivers of infrastructure readiness and how do they influence infrastructure prioritisation?
4. What are the SDGs? And how can the SDGs influence the creation of effective infrastructure?
5. What tension exists in the development of infrastructure vision and goals?
6. How can efficiency be achieved in the delivery of major infrastructure projects?
7. What are the causes and effects of delays and cost overruns in major infrastructure project delivery?

8.13 Case studies

8.13.1 Case 1: Country-based comparison of project appraisal processes in decision support

In this case study, the appraisal processes used in decision-making across Germany, Sweden, and the US are presented as a basis for comparison (Mackie and Worsley, 2013). The discussion focuses on the appraisal practice of transport-related major infrastructure projects.

Germany: Germany provides an example of a federal system with some differences between the methods of cost-benefit analysis used by the different tiers of government. The German approach is based on ranking schemes according to their benefit-cost ratios (BCRs) after taking full account of nonquantifiable impacts on habitats and on the environment. The appraisal of these impacts serves to establish what mitigation measures or alternatives will be implemented in order to protect natural resources and whether this is feasible and affordable. No analysis of the impacts of a scheme on the economic performance of the state or the region is carried out, although additional "points" are attributed to schemes which serve low income regions. Projects are ranked by their BCRs; projects with BCRs below 1 are not proceeded with.

Sweden: The principles of cost-benefit analysis are widely accepted as a means of delivering transport policy objectives in Sweden. Appraisal takes place in the context of a Ten-Year Transport Plan that is updated every four years. Schemes included in the plan generally have BCRs in excess of unity. The understanding that schemes with BCRs below unity are unlikely to be included in the plan influences the choice, design and specification of projects put forward for inclusion and therefore

serves as a valuable tool for sifting out weak options. Evidence on how the ranking of schemes in the plan on the basis of their BCR influences decision-makers when they decide on which schemes to fund is more mixed. Decisions delegated to officials generally show that ranking by BCR is the norm. However, where the decision is made by politicians, other criteria, primarily those related to their perception of the local, regional or national economic impacts, tended to influence the decision. Road schemes approved by ministers tend to show higher BCRs than rail schemes funded. Analysis of the decisions made on transport schemes shows that the BCR has become more dominant over the past 20 years in the decision-making process and that the appraisal process is better suited to highway schemes than rail projects.

United States: The US, a country with a federal government, has adopted processes for making decisions that differ according to whether the source of funding is through a discretionary federal grant or through state funding supplemented by a formula-based federal contribution. The US Department of Transportation requires projects it funds to be appraised using a traditional cost-benefit analysis, with most environmental impacts valued in monetary terms. Interestingly, there is no guidance about those environmental capital impacts that European countries tend to measure on a qualitative scale, since, under US law, heritage is protected against any incursions. Objectives related to gross domestic product have recently been taken into account the guidelines for applications for funding under the Transportation Investment Generating Economic Recovery. There is no mandatory appraisal method required for projects funded by individual states. Each US state uses an appraisal process, but the information provided to decision-makers differs between states. Some states use multi-criteria analysis, identifying factors of particular importance to that state and its transport users, effects on productivity, and the degree of public support, and then these criteria are weighted to provide a summary table and score. Others use cost-benefit analysis supplemented by an analysis of the impact on the local economy, while other states focus most on the impact on the local economy.

The three countries discussed above were aware of two limitations of the cost-benefit analysis approach and attempted to ensure that decision-makers were provided with information that helped to ensure a more holistic process (Mackie and Worsley, 2013). The first limitation occurs because of the extent to which cost-benefit analysis, as practised there, is restricted to the impacts whose effects can be measured and valued in monetary terms. Most countries had adopted a means of scoring other significant impacts against a qualitative scale to ensure that the welfare economic framework that underpins cost-benefit analysis was more comprehensive than a process that omitted all non-monetised impacts and that these impacts were therefore drawn to the attention of decision-makers. However, the process for assessing the weights that were given to these impacts was largely judgemental and not documented. A second limitation is the policy priority given to the potential impacts of transport schemes that fall outside the welfare-based economic cost-benefit framework. This has resulted in public investment being targeted on productivity and growth. Decision-makers need to know how far the investment in transport schemes that they approve will contribute to increased productivity and to redressing the regional imbalance in output.

8.13.1.1 Case 1 discussion questions:

1. The countries that employed cost-benefit analysis were aware of two limitations of the approach.
   a. What are the limitations?
   b. How can they ensure that infrastructure decision-makers are provided with data that will create a holistic decision-making model?
2. Identify key differences between the German and US approaches.

8.13.2 Case 2: Delivering an SDG-based major infrastructure projects: The Indonesian case

Financing and delivering sustainable infrastructure often require cross-sector collaboration. This is the case in Indonesia, where a financing facility is bringing together a number of global public- and private-sector stakeholders to foster investments in renewable energy and improved management of forests, biodiversity and ecosystem restoration services throughout the country. The Tropical Landscapes Finance Facility (TLFF) was launched in October 2016 by the Indonesian government and is a partnership between the UN Environment Programme, World Agroforestry, ADM Capital and BNP Paribas. With two sources of capital—a lending platform run by ADM Capital and BNP Paribas and a grant fund run by UN Environment and World Agroforestry—the TLFF provides technical assistance and co-funds early-stage development costs, enabling donors and foundations to harness private-sector funding.

TLFF funds South East Asia's first corporate sustainability bond, a multi-tranche, long-dated sustainability bond arranged by BNP Paribas and issued by TLFF Pte Ltd for the Royal Lestari Utama (RLU), a joint venture between Indonesia's Barito Pacific Group and France's Michelin. ADM Capital acts as facility and ESG manager for TLFF. It offers funding for climate smart, wildlife friendly, socially inclusive production of natural rubber in Jambi, Sumatra, and East Kalimantan provinces of Indonesia. Out of a concession area of 88,000 hectares, 34,000 will be planted with commercial rubber, while more than half will be set aside for community livelihoods and conservation. The project will also include 9,700 hectares for a wildlife conservation area. At maturity, the plantation will provide 16,000 jobs for local communities, while at the same time the commercial plantations in Jambi will serve as a buffer zone to protect the 143,000 hectares of Bukit Tigapuluh National Park, replete with important biodiversity and endangered species such as Sumatran elephants and tigers. Annual project monitoring includes an assessment against an environmental social action plan. Beyond direct employment, community livelihoods will be supported by the establishment of 7,000 hectares of smallholder plantations with smallholder financing and other livelihood programmes falling under a community partnership program. This also includes training in best practice in rubber production and the purchase of rubber from community program participants at a slight premium. As of September 2019 the project reported the following performance metrics (see Table 8.2):

Table 8.2 Project performance metrics

Core objectives	*Output and impact indicators*	*Value (as provided by RLU or source)*
Forest Retention	Hectares of actively managed forest	Jambi – 2,000 hectares East Kalimantan – 6,500 hectares
Improved Rural Livelihoods	Number of smallholders rubber farmers engaged as part of the community partnership program	Jambi: 18 Kalimantan: 300 Training: 266 Total: 584
	Number of smallholder households impacted by the project	584 out of estimated 10,000 families living in and around the concessions
	Number of farmers selling into the RLU supply chain	300 in East Kalimantan
	Number of direct jobs created	Jambi: 3,579 East Kalimantan: 851
Reduced Emissions	Number of trees planted	18,622
	Carbon footprint (in tCO_2e)	12,836*

	Greenhouse gas emissions absorbed by protected forest and planted trees (in tCO_2e)	Plantations: 365,106 Forests: 123,286
Biodiversity Protection	Conservation programmes implemented	Protection forest Wildlife conservation area Human-wildlife conflict Wildlife monitoring
	Species protected in the concessions	Critically endangered species: elephants, tigers, orangutans, mitred monkeys, Malayan tapirs

8.13.2.1 Case discussion questions

1. Drawing on the outlined SDGs in this chapter, discuss the SDGs that the RLU joint venture forest infrastructure project will impact.
2. What lessons can be learned from the RLU joint venture forest infrastructure project in terms of stakeholder engagement?

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