Chapter 47
Sustainability in Infrastructure Asset Management

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Abstract The expectation to integrate sustainability aspects (social, environmental, and economic success) into the design, delivery, and operation of infrastructure assets is growing rapidly and globally. There are now several tools and frameworks available to benchmark and measure sustainable performance of infrastructure projects and assets. This paper briefly describes the infrastructure sustainability (IS) rating tool developed by the Australian Green Infrastructure Council (AGIC) that was launched in February 2012. This tool evaluates sustainability initiatives and potential environmental, social, and economic impacts of infrastructure projects and assets. The rating tool provides the following benefits to industry: a common national language for sustainability; a vehicle for consistent application and evaluation of sustainability in tendering processes; assists in scoping whole-of-life sustainability risks, enabling smarter solutions that reduce risks and costs; fosters resource efficiency and waste reduction, reducing costs; fosters innovation and continuous improvement in sustainability outcomes; and builds an organization's credentials and reputation in its approach to sustainability. The infrastructure types covered by this tool include transport, energy, water, and

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communication. The key themes of sustainability evaluation will be briefly presented in this paper, and they include management and governance; use of resources; emissions, pollution, and waste; ecology; people and place; and innovation.

47.1 Introduction

Civil infrastructure plays a key role in supporting and improving our current way of life. However, the construction, operation, and decommissioning of infrastructure assets can have significant impacts on society and the region around them, some positive (usually for the purpose they are built) and some negative (consequences and unintended effects). There is an increasing trend for society to place an importance on the role of sustainability to ensure that our world continues to be suitable for future generations. To achieve this, it is increasingly important to look at integrating sustainability outcomes into the way industry operates, including the infrastructure industry. Assessment using a sustainability rating scheme can be a highly effective means to build sustainability aspects into the design, construction, and operation of infrastructure assets. This can assist to drive outcomes and results that will benefit society and future generations and make operations more efficient.

47.2 Background

Civil infrastructure can be defined as the structural elements of economy and society which allow for production and distribution of goods and services without themselves being part of the production process. Such infrastructure includes roads, railways, bridges, tunnels, ports, airports, distribution grids/networks (such as pipes, poles, and wires used in water, sewage, electricity, communications, etc.), water and/or resource management, preparatory civil works, and more. Spending on infrastructure is massive and predicted to continue to increase. An example of the scale of spending is that across just 7 countries, there are plans or the need for nearly $5 trillion dollars' worth of investment [1].

Given the large amounts spent on infrastructure projects, the size and scale some projects can take on and the sheer volume of projects being undertaken, planned for or needed in the future (especially in countries undergoing modernization) civil infrastructure projects for better or worse will continue to have significant impacts on society, the surrounding environment, and communities, along with their residents.

With increasing awareness of sustainability and climate change in the community and increasing expectations of being more 'environmental friendly', organizations involved in delivery or operation of infrastructure assets (regardless of the stage) have to now take into consideration and face the challenge of also reducing the negative impacts and enhancing positive impacts from infrastructure assets on the environment and society, and hence, the idea of 'infrastructure sustainability' has been born.

Traditionally, the primary focus for an organization involved in an infrastructure project or asset has been to meet the needs/terms specified without exceeding a money or time limit (e.g., on time and on budget). The focus has been on economic performance and getting good value for money. More recently (gaining intensity over the last few decades), a shift toward also considering the environment has come about (often via government legislation) and many organizations now undertake activities such as environmental impact studies and assessments and aim to reduce negative impacts the infrastructure asset (and activities associated with it) may have on the surrounding environment. However, true sustainability considers not just the economic factors and environmental impacts, but also the impacts on society—the communities and people that will be affected, both positively and negatively, by the infrastructure asset or activities associated with it. This vision of sustainability (economic, environment, and social) is often known as the triple bottom line [2, 3]. Another version of sustainability also being put forward is the quadruple bottom line, which encompasses the same aspects as the triple bottom line, but also includes governance as a fourth aspect. The triple bottom line (or the quadruple bottom line) in itself is also just one part of a larger vision of corporate sustainability which includes relationships and responsibilities [4].

47.3 Key Issues in Sustainability

While it is becoming more important and critical for sustainability to be considered in the design, construction, and operation of civil infrastructure assets, it is also important to ensure that appropriate issues are taken into consideration when performing a sustainability assessment.

There are a small number of sustainability rating tools for infrastructure in existence globally and a selection were analyzed in [5], identifying some similarities and differences. Half the tools in the study were specific to the transport sector, while the remaining were more generic and suitable for all civil infrastructure (non-building). The rating tools showed a reasonable degree of alignment in terms of the key issues that were covered but differed in the weighting (value) assigned to each issue. The study in [5] also looked at decision support (tools to guide or help make a decision) in the transport sector and identified that of the 16 tool frameworks (which outline a decision-making process to follow, without assessing the final decision) included, only four included issues/criteria that combined covered all three aspects of the triple bottom line and that the majority of frameworks were heavily weighted toward environmental issues.

This paper presents the framework of AGIC's infrastructure sustainability (IS) rating tool. This framework comprises six themes and fifteen categories incorporating issues that organizations involved in civil infrastructure assets need to consider when undertaking sustainability assessment [6, 7].

47.3.1 Management and Governance

Governance involves the establishment and oversight of an organization's or a project's purpose, systems, structure and processes, and their implementation for the effective delivery and operation of infrastructure. Good governance in the context of IS is vital and is sometimes referred to as the fourth pillar of sustainability under a quadruple bottom line approach. The three categories within this theme are as follows:

- Management Systems: Good management systems help to ensure consistent and efficient operations and support during decision making. Management systems alone do not guarantee the achievement of sustainability, but they are considered to be a critical component. This category encourages sustainability to be comprehensively addressed within management systems from the policy level down to detailed processes.
- Procurement and Purchasing: This category assesses the extent to which economic, environmental, and social aspects and impacts have been considered in the evaluation, selection, and final procurement of goods and services for an infrastructure project or asset.
- Climate Change Adaptation: Until recently, infrastructure was designed on the basis of historical weather records, assuming that the climate will remain the same. Climate change means that this assumption is no longer valid, so that long life span infrastructure now needs to be designed, constructed, and operated to cope with the projected much hotter, drier, and stormier climatic conditions, with higher sea levels. This category facilitates the self-assessment, and thus, rating of the appropriateness and effectiveness of how climate change risk and adaptation issues have/will be addressed.

47.3.2 Using Resources

The infrastructure industry is a large and intensive user of materials, energy, and water. The ultimate goal is to reach a state where finite natural resources are consumed no faster than the planet can replenish them. The resources of most concern are those that are non-renewable. The three categories within this theme are as follows:

- Energy and Carbon: The majority of energy (especially in Australia) is derived from non-renewable sources the consumption of which generates greenhouse gas (GHG) emissions. Such emissions are increasing and are being linked to climate change events, which can impact negatively on the environment and society.
- Water: Fresh water is becoming increasingly scarce, and excessive consumption threatens ecosystem function. In regard to water, the aim of all infrastructure assets at each stage of their life cycle should be first to avoid or reduce water consumption per service output and then to replace potable water with effective reuse and recycling of locally appropriate alternative water sources.
- Materials: Infrastructure typically involves the consumption of large quantities of materials, a significant portion of which are derived from natural resources. The supplies of some of these resources are limited and are becoming increasingly scarce. To fully assess materials in a sustainability context requires consideration of a complex set of environmental, social, and economic factors across a life cycle perspective [8]. The intent of this category is to encourage design and practice that minimizes the consumption of precious resources, optimizes resource efficiency, and reduces the environmental impacts of infrastructure.

47.3.3 Emissions, Pollution, and Waste

This theme focuses on understanding and measuring emissions, pollution, and waste and their impacts, identifying and implementing feasible opportunities to reduce those impacts, and restoration to reverse past impacts. The ultimate goal is to reach a state where wastes are emitted no faster than the rate at which the planet can absorb them and also support them to aim for zero emissions and zero harm to the environment and society. The three categories within this theme are as follows:

- Discharges to Air, Land, and Water: Discharges and emissions often have negative and harmful impacts on the environment and society. This category assesses the level and effectiveness of management practices for preventing and mitigating discharges to air, water, and land over the life cycle of a given piece of infrastructure. It also seeks to encourage initiatives to enhance natural capital.
- Land (usage, conditioning, etc.): In Australia, high-value environmental or social land is scarce, and often land is under pressure from different industries and uses. This category focuses on the project-level decisions that flow on from good strategic land-use planning in relation to infrastructure.
- Waste: Waste generation globally is increasing, and recycling and reuse are not increasing at the same rate. Waste from construction and demolition is significant in Australia, and currently, 45 % of this is disposed to landfill. This category assesses the level and effectiveness of waste management practices for achieving the goal of zero waste to landfill over the life cycle of a given piece of infrastructure through recycling, reuse, design, optimization, and contract management.

47.3.4 Ecology

Ecosystems are considered to have important environmental and social functions that cannot be replicated artificially. Furthermore, Australia is considered to have globally significant ecosystems. The intent of this theme is not just to minimize or mitigate the negative impacts on ecosystems through all stages of the project life cycle, but also to foster infrastructure decisions that enhance ecosystem functioning.

47.3.5 People and Places

The people and place categories focus on effects on the well-being of communities and the users of the infrastructure, how infrastructure integrates with and enhances the surrounding urban and landscape environment, how the past is recognized and conserved and how stakeholders participate in infrastructure design, construction, and operation. The four categories within this theme are as follows:

- Community Health, Well-being, and Safety: The quality of both natural and built environments along with other factors has significant effects on the general well-being, health, and safety of communities. The design, construction, and operations practices of infrastructure can dictate a community's behavior which contributes to their health, well-being, and safety.
- Heritage: Heritage is the cultural significance that we inherit from the past that we value and want to pass on to future generations. This category focuses on how heritage is assessed and then managed through design, construction, and operation of infrastructure.
- Stakeholder Participation: Stakeholder participation refers to the processes and mechanisms that enable stakeholders who have a direct or indirect interest in infrastructure development to be part of decision making. This category focuses on developing a strategic and planned approach to stakeholder participation, managing, and monitoring implementation of the participation process, achieving a high level of participation for negotiable issues, effectively communicating, and effectively addressing community concerns.
- Urban and Landscape Design: Urban and landscape design is a process, and an outcome concerned with the arrangement, appearance, and function of places in suburbs, towns, cities and regions. This category focuses specifically on the analysis, planning, and design of the infrastructure asset within its community and environment.

47.3.6 Innovation

Often the sustainability issues facing industry and society are difficult and complex due to their interwoven social, economic, and environmental aspects. The innovation category supports pioneering initiatives, methods, processes, procedures, technologies, etc. in sustainability that assist in transforming the market or industry sector toward a more sustainable approach and answering the challenges faced.

47.3.7 Summary

The IS rating tool provides the following benefits:

- Provide a common national language for sustainability in infrastructure.
- Provide a vehicle for consistent application and evaluation of sustainability in tendering processes.
- Help in scoping whole-of-life sustainability risks for projects and assets, enabling smarter solutions that reduce risks and costs.
- Foster resource efficiency and waste reduction, reducing costs.
- Foster innovation and continuous improvement in the sustainability outcomes from infrastructure.
- Build an organization's credentials and reputation in its approach to sustainability in infrastructure.

It provides industry with a means to voluntarily assess performance and to be recognized for good performance. The assessment is facilitated by using the IS rating tool which consists of this technical manual and the tool scorecard (downloadable from www.agic.net.au). The tool builds on current guidance and practices by providing industry with an incentive and protocol for assessing, benchmarking, and 'labeling' the sustainability performance of infrastructure projects or assets at the planning and design, construction, and/or operations phases.

47.4 Sustainability and Infrastructure Phases

The typical infrastructure asset life cycle broadly includes planning and design, construction, operation (with maintenance), and decommissioning (see Fig. 47.1). For most infrastructure assets, the operations phase is the longest and may not have a predetermined ending date. An infrastructure asset will have an impact on the environment and society from the moment construction starts to the end of decommissioning (and perhaps beyond if the asset is not disposed of) and economic impacts in all phases, even during design.

In order to achieve the best sustainable outcomes, sustainability implications need to be considered at each phase. An infrastructure asset can be designed to be sustainable (and assessed during the design phase as having a sustainable design), but it could be constructed in such a manner that has large negative impacts on the

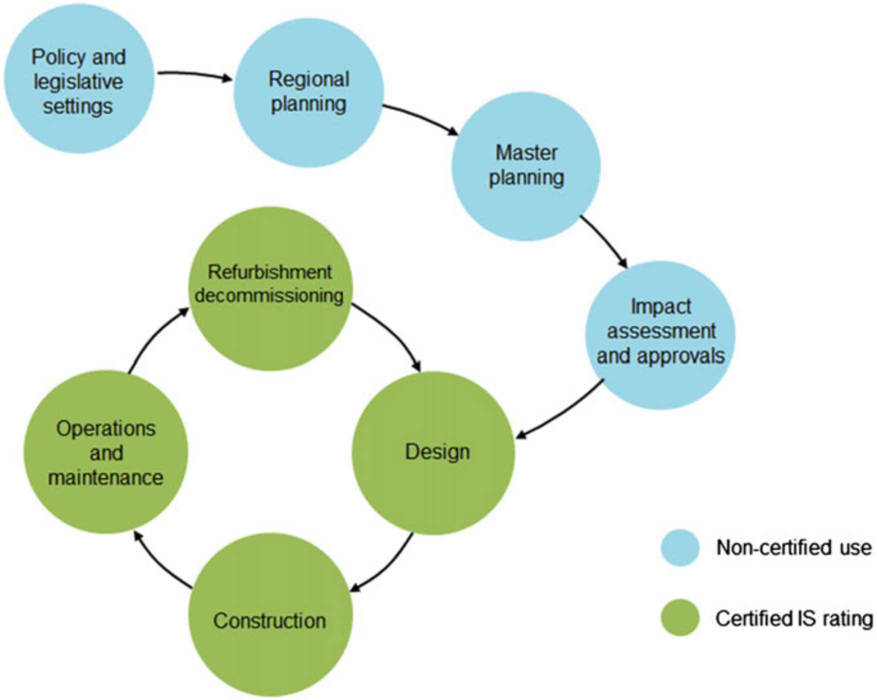

Fig. 47.1 Infrastructure asset life cycle and the phases rated by the IS rating tool (reproduced from Australian Green Infrastructure Council sources)

environment or society (such as the use of carbon-intensive materials, large-scale land, and community disturbance) or could be operated using a process that harms the environment (e.g., energy-intensive procedures and socially disruptive activities).

By assessing an asset and/or the associated project at each phase, an organization can ensure that it is designed with sustainability in mind, constructed in a manner that is sustainable with good practices used, operated, and maintained in a manner that ensures sustainability, and decommissioned in a sustainable manner. Failure to assess and monitor assets and projects during construction and later operations could easily result in an asset that was designed to meet sustainability outcomes, but then was constructed in a manner, where no concern was given to the environment or society and thus undermine the sustainable design and reduce the benefits achieved.

To help avoid this, rating schemes cover more than one phase of an asset's life cycle. From the study in [5], all but one of the rating schemes covered the design and construction phases. However, only one rating scheme (AGIC's IS rating tool) also covered the operations phase. The coverage of the operations phase is one of the strengths of the IS rating tool, as it gives greater coverage of an asset's life

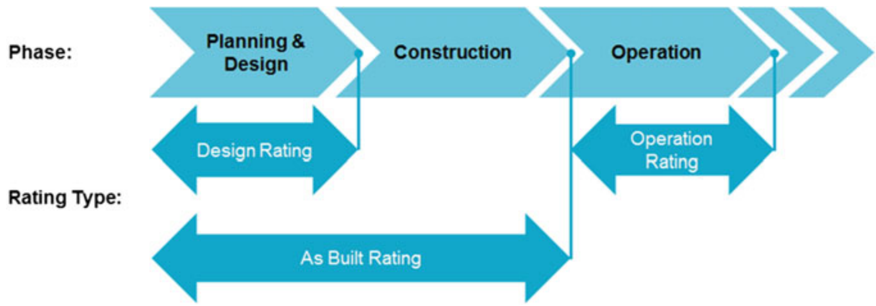

Fig. 47.2 Infrastructure life phases and IS rating types available (reproduced from Australian Green Infrastructure Council sources [9])

under a single consistent rating scheme. Figure 47.1 shows the stages that are assessable by the IS rating tool.

To align with the typical infrastructure asset life cycle phases, AGIC offers the rating types shown in Fig. 47.2. Note that the 'As Built' rating covers not just the construction phase of the asset, but also its design phase and thus looks at not only whether it was designed to be sustainability friendly, but also whether it was constructed in such a manner.

47.5 Conclusion

Infrastructure is such a vital part of the workings of society. It is all around us and involved in so many things that we do. Therefore, ensuring infrastructure is 'done' in a sustainable way is important for its contribution to sustainable outcomes and its symbolic role in a greater move toward sustainability. Over the years, sustainability has become increasingly more important to individuals, organizations, communities, and governments. Given the scale and impact of the infrastructure industry and the physical assets involved, it should not be a surprise that there is a real need for sustainability to become integral to the way the industry operates. In order to achieve real sustainability in the area of civil infrastructure projects and assets, it is necessary to perform sustainability assessment, with associated measures, metrics, and indicators, across all of the key areas and at all phases of a project's or asset's life. AGIC's IS rating tool represents a robust, comprehensive, and industry-supported means to achieve this.

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References

1. Urban Land Institute (2011) Infrastructure 2011: a strategic priority
2. Elkington J (1997) Cannibals with forks: the triple bottom line of 21st century business. Capstone Publishing Limited, Oxford
3. Group of 100 (2003) Sustainability: a guide to triple bottom line reporting. Melbourne
4. Stapledon T (2004) Offices as tools for organisational sustainability. PhD, The University of Sydney
5. Shaw G, Kenny J, Kumar A, Hood D (2012) Sustainable infrastructure operations: a review of assessment schemes and decision support. In: 25th ARRB conference. Perth, Australia
6. Australian Green Infrastructure Council (2012) Infrastructure sustainability rating scheme [Online]. Australian Green Infrastructure Council. Available: http://www.agic.net.au/ISratingscheme1.htm
7. Australian Green Infrastructure Council (2012) Fact sheet 1 infrastructure sustainability rating framework [Online]. Australian Green Infrastructure Council. Available: http://www.agic.net.au/fact_sheet_1.pdf
8. DTI 'Strategy for sustainable construction'—consultation events. Available: http://www.bis.gov.uk/files/file37172.pdf
9. Australian Green Infrastructure Council (2012) Fact sheet 2 rating types [Online]. Australian Green Infrastructure Council. Available: http://www.agic.net.au/fact_sheet_2.pdf