FC4S

FINANCIAL CENTRES FOR SUSTAINABILITY

Working paper

Policies to Enable Sustainable Infrastructure

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Authors and Acknowledgements

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About FC4S

The UN-convened Financial Centres for Sustainability (FC4S) Network is a partnership among the world's financial centres and is hosted by United Nations Development Programme (UNDP). The Network comprises 39 member centres as of January 2022. The objective of the FC4S Network is to enable financial centres to exchange experiences, drive convergence and act on shared priorities, including talent development to accelerate the expansion of sustainable finance. Through national and regional initiatives, the FC4S Secretariat works with members to achieve this objective by providing the tools and insights to measure progress, engage local institutions, inform policy, research on emerging issues, guidance on best practices, strategic advice and support services, including assistance with project development.

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Introduction

Infrastructure plays a critical role in the achievement of sustainable economic development. From transport systems to power generation facilities and water and sanitation networks, it provides the services that enable society to function and economies to thrive. This puts infrastructure at the very heart of efforts to meet the Sustainable Development Goals (SDGs). Encompassing everything from health and education for all to access to energy, clean water and sanitation, most of the SDGs imply improvements in infrastructure.

There is agreement both on the need for efficient infrastructure development to achieve sustainable development, and on the potential risks and impacts on the people and planet that ignoring sustainability considerations within the infrastructure development processes entails. Current global discussions on sustainable infrastructure have recognized the importance of adopting an integrated and systemic view, strategically considering the long-term aspects of preserving, restoring integrating the natural environment and supporting the sustainable and efficient use of natural resources, while considering social sustainability aspects. The COVID-19 pandemic has further limited governments' investment capacity, widening the infrastructure gap. Improving project preparation, management and design capabilities presents an untapped opportunity to increase investment in sustainable infrastructure.

The Inter-American Development Bank (IADB) (2018) defined sustainable infrastructure as the infrastructure projects that are planned, designed, constructed, operated and decommissioned in a manner to ensure economic, financial, social, environmental and institutional sustainability (including climate resilience) over the entire life cycle of the project. Sustainable infrastructure limits all types of pollution over the life cycle of the project and contributes to a low-carbon, resilient, and resource-efficient economy.

An estimated 55 percent of the world's population (4.2 billion people) currently lives in cities. By 2050, the urban population will have increased by around 60 percent to 6.7 billion people, and nearly 7 of 10 people in the world will live in cities (United Nations Department of Economic and Social Affairs, 2018). With more than 80 percent of global GDP generated in cities, urbanization, if managed well, can contribute to sustainable growth by increasing productivity, allowing innovation and new ideas to emerge. However, its speed and scale bring challenges, including meeting accelerated demand for affordable housing, well-connected transport systems and other basic infrastructure services. Failing to invest in making cities more resilient to natural disasters, shocks and stresses has been demonstrated to result in significant human and economic damages – with the urban poor bearing the brunt of losses. With conflicts on the rise and an urgent need for higher investment in infrastructure to solve these issues, also comes the need for a greater focus on resilience in the face of climate change.

The public sector has the utmost role in sustainable infrastructure development, from guaranteeing a robust institutional and governance framework to delivering well-developed project planning and development – including systemic feasibility studies based on social and environmental impacts – while helping mobilize finance and ensuring absolute value for money from infrastructure projects. As governments face dynamic socio-economic and environmental issues (such as migration, climate change, nature degradation and increasing inequalities) they need to integrate them in their projections and forecasts to properly consider national and global infrastructure resilience. In developing economies, multilateral development banks (MDBs), export credit agencies (ECAs) and governments play a significant role as financiers.

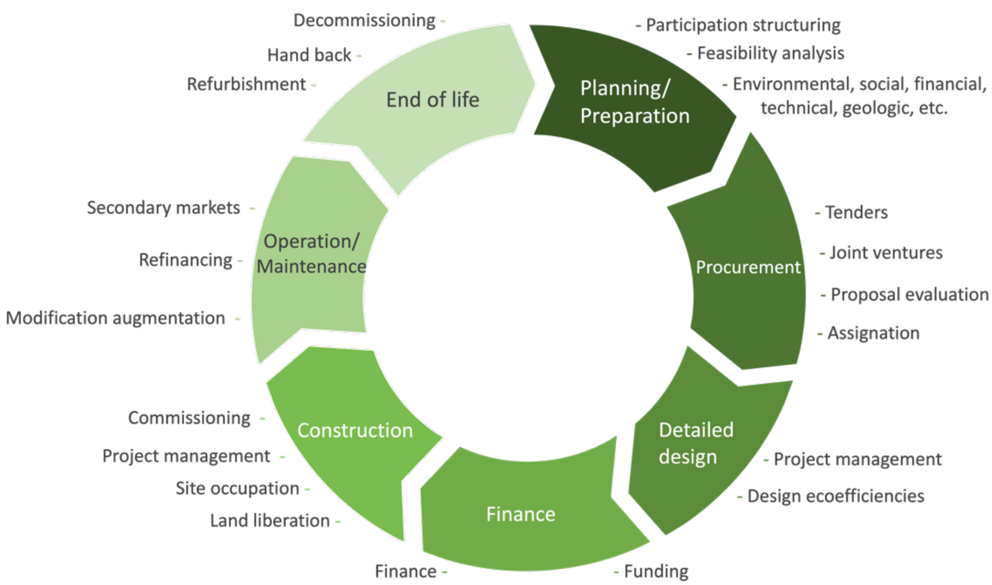
Adopting and mainstreaming sustainable infrastructure presents persistent challenges, which tend to be more pronounced in developing countries than in developed ones. They span the entire project cycle, the upstream environment for infrastructure projects, financing considerations, but also definitional questions as well as political economy issues nationally and internationally (Taras, 2020). Policymakers and decision makers need to address them to enhance sustainable infrastructure in an effective manner.

In this paper, we propose to adopt the infrastructure life-cycle approach to develop sustainable infrastructure projects. We also recommend considering the city level, since its infrastructure needs are a strong basis to not only select but finally deliver and manage infrastructure developments sustainably. This document describes challenges and opportunities on the application of a comprehensive life cycle infrastructure approach on a modern, sustainable and proactive policy, including transparently monitoring the projects and mitigating financial, operative and sustainable risks. It highlights actions initiatives and policies – by diverse stakeholders and at different implementation levels – for each infrastructure life cycle stage. It concludes with suggested considerations to provide robust risk management and sustainable capital mobilization for policymakers and investors within the complete infrastructure life cycle.

Sustainable infrastructure life-cycle: A city approach

The infrastructure life cycle includes all the aspects shown in Figure 1, but as governance involves a strong institutional framework, providing the necessary policy coherence and regulatory certainty, we focus on recommendations for policymakers and investors in the following seven life cycle stages for infrastructure projects. Integrating sustainability and considering it within each one of them is key to efficiently deliver the infrastructure developments for the future.

Figure 1: Infrastructure life cycle



The infrastructure life cycle should be considered in a long-term analysis as it may be designed to last for up to 100 years. Depending on the responsible execution of every life cycle stage, external unforeseen factors may result in off-budget expenditure, inefficient assets or a shorter lifespan. Moreover, critical infrastructure assets are vulnerable to funding, financing, bad planning and inefficient designs. A particular asset's vulnerability may vary according to its planning, location, age, design, adaptive capacity, maintenance, etc.

Cities become zones of opportunity as transportation hubs, connecting roads, rail and air transportation, and requiring infrastructure to this end. As cities invest in infrastructure, prosperity is spread through the improvement of infrastructure. Cooperation for a surrounding basic infrastructure should take place at all levels – between governments, between and within societies, and at the heart of cities. As a nexus in the matter, cities are in a core position to take on the infrastructure agenda.

Cities are growing at an unprecedented rate, and the number of megacities identified by the United Nations (UN) went from 3 in 1970, to 10 in 1990 and 34 in 2020. According to projections by Lossouarn *et al.* (2016), there will be 41 megacities by 2030, with some located in least developed countries (LDCs), which importantly increases infrastructure developments needs. Finance plays a crucial role at all the stages of the infrastructure cycle, while the financial flows are usually concentrated in cities. Financial centres, usually based in the largest cities of the world, are of primary importance to the structure, function and dynamics of the global economy. Particularly, the 39 members of the Financial Centres for Sustainability Network (FC4S) currently manage 82 percent of the global equity market.

Governments need to answer this growing challenge. Currently, a few of them are using public consultation as a mechanism to address their national infrastructure priorities. The minority uses data analysis to decide where, when and how invest in this type of projects. This approach can help establish a sectoral and regional view inside the national projects' prioritization, resulting in a sustainable infrastructure approach to the country's needs.

Bhattacharya *et al.* (2019) highlight that infrastructure policies should be aligned with global and national strategies, ensure appropriate corporate governance and effective participation of stakeholders, and clearly define organizational sustainability roles: they should have procedures and systems that ensure social, environmental, economic and territorial compliance with existing national regulations and organizational requirements, while staying flexible. Infrastructure policies should establish a sustainability management system with a clearly defined strategy, policy, targets, metrics, monitoring, evaluation, individual capabilities and independent verification, appropriate to the nature and scale of the project and commensurate with the level of social and environmental risks and impacts. Infrastructure projects should build and maintain capacities to ensure the integration of technological and business innovations during project design and implementation, and increase project durability, flexibility, resource use efficiency and delivery effectiveness. Additionally, it should develop robust data collection processes and the capacity to monitor information for the project.

Cairney (2013) finds that, for every step of a policy-making cycle, there needs to be an agenda setting step, and a process of policy formulation, legitimation, implementation, evaluation, and maintenance, succession or termination. Understanding why, when and how governments and the private sector can participate effectively in infrastructure provision is essential to delivering an efficient policy environment and maximizing community gains from infrastructure policy.

Despite the compelling evidence in favour of sustainable infrastructure, significant challenges still prevent making existing infrastructure more sustainable and better designing future infrastructure. In the next chapters, we will explore examples of policies implemented at each stage of the infrastructure life cycle projects. Last, we will explore how policymakers can start (or improve) their infrastructure approach based on a sustainable view.

Key determinants of sustainable infrastructure policy success

1) Institutional and governance framework

Infrastructure projects can sometimes fail to meet their time frame, budget and service delivery objectives due to shortcomings in the country's infrastructure governance framework. Recent evidence shows that the quality of public governance correlates with the quality of infrastructure and public investment, and with growth outcomes at both the national and subnational level (OECD and IMF, 2019). Good infrastructure governance not only promotes value for money and affordability, but also helps to make the right projects develop in timely and efficient manner. Successful governance of infrastructure demands a clear regulatory and institutional framework, robust coordination across levels of governments and sustainable considerations throughout the life cycle of the asset (OECD, 2017).

Key challenges in countries for strong governance are inconsistent national and subnational priorities, coherent legal frameworks, and different institutional capacity between jurisdictions. Also relevant is a modern construction law in place, which embraces national and international sustainable commitments, and mechanisms for disclosing the infrastructure impact at any stage.

"Principle 6" of the G20 Principles for Quality Infrastructure Investment (2019) stablishes that well-designed and well-functioning infrastructure governance institutions allow countries to rigorously assess the financial sustainability of individual projects and prioritize among potential infrastructure projects, subject to available overall financing. Some G20 countries have adopted specific construction laws and mechanisms (regulations and permits) aligned with their national infrastructure priorities, or international commitments like the Paris Agreement or the SDGs. Indeed, 85 percent of the G20 countries adopted a strategic plan or an infrastructure programme. Recently, some countries have aligned their plans to sustainable goals: for example, Canada's Infrastructure Department (INFC) adhered to the Federal Sustainable Development Strategy Principles (Infrastructure Canada, 2020).

2) Policy planning and project prioritization

Public policy has a central role to play, as the public sector is a major investor in infrastructure, but more importantly, it signals and sets the regulatory and institutional frameworks that influence the actions of all actors. According to Qureshi (2015), public policy needs to play four key roles:

1) Articulating national strategies for sustainable infrastructure: Countries need to articulate clear and comprehensive strategies for sustainable infrastructure and embed them in overall strategies for sustainable growth and development. There is a need for a broader articulation of strategies on the direction of change and plans to address policy and market failures and other constraints to sustainable infrastructure development.
2) Addressing fundamental price distortions: The biggest distortions are fossil fuel subsidies and the lack of carbon pricing, which both strongly bias infrastructure investment towards high-carbon sources of energy and undermine efficient energy use.

3) Improving the enabling environment: There is a need to strengthen investment planning and project preparation and management capacities to build and implement a stronger pipeline of sound, investment-worthy projects. Countries need to improve the regulatory and institutional frameworks for private participation in infrastructure provision. Risks and transaction costs related to public policy are a major impediment to private investment in infrastructure.
4) Mobilizing financing: Doubling annual investment in infrastructure will present a major financing challenge. It will require strong, concerted mobilization of both public and private finance, especially through new and innovative mechanisms.

Governments need to assess the relative importance of project planning and development based on socio-environmental impacts, systemic viability, and financial/economic capacity. While being part of a long-term strategic plan, and entailing cost-benefit analyses for shortlisting and financing a project, political motivation is still usually a key driver of infrastructure investment decisions.

In developing regions, the changing investment landscape – including international aid – has shifted the focus of infrastructure decision-making from donors to governments. Infrastructure planning and implementation has decentralized in many countries. Subnational governments, regional entities and sector agencies have delegated responsibility for planning and project selection, though accountability for fund allocations may remain centralized. While these constituencies may propose numerous infrastructure projects, governments often have insufficient financial resources to implement all of them. This requires paring down the sets of proposed infrastructure projects, expanding the pool of resources, or both (Marcelo *et al.*, 2016).

3) Feasibility analysis

Feasibility studies are conducted to justify investments in infrastructure projects. Despite their vital importance in supporting public spending on infrastructure decisions, the studies prioritize focus on financial aspects, leaving a sustainability perspective in a second level of decision. The massive expenditures on infrastructure projects need to be weighed against the expected benefits to the public and the national economy resulting from these projects, and this needs to consider sustainability aspects.

Before implementing new strategies, policies or projects, cities and governments need to provide stakeholders with an analysis of the initiative's impact and viability of implementation in order to assess the environmental, societal and economic consequences, minimizing risk and optimizing the costs of project development. A well-designed feasibility study should offer a historical background of the business or project to ensure a project is legally and technically feasible as well as economically justifiable.

4) Participation scheme structuring

According to the OECD (2016), the decision makers are responsible to ensure public infrastructure is affordable. This requires a strong link between the project development phase and the country's fiscal framework. The overall infrastructure expenditure of a country, as well as the fiscal risks it faces in terms of guarantees, should be based on medium and long-term fiscal forecasts that are revised on a regular basis. If the project is intended to be user-funded, a thorough examination of the users' ability and willingness to pay is required. Overall value for money should be thoroughly analysed using a combination of quantitative (cost-benefit analysis) and qualitative approaches that objectively strive to determine the overall societal return on investment.

Table 1 shows a detailed classification of countries that had established a formal process or legal requirement to ensuring absolute value for money from infrastructure projects, up to 2016.

Table 1: Participation scheme structure in OECD countries

Yes in all cases	In all cases above a certain value threshold	No	Only PPP Projects	On an ad hoc basis
Australia France (1) Germany Italy United Kingdom of Great Britain and Northern Ireland	Hungary Ireland Japan New Zealand Norway Republic of Korea Turkey	Austria Chile Estonia Luxembourg Slovenia Spain Sweden	Mexico	Czech Republic Denmark Finland Switzerland Belgium
5	7	7	1	5

Total respondents: 25, (1) excluding projects financed by local authorities
Source: OECD, 2016

According to Gurara *et al.* (2018), infrastructure in low-income developing countries (LIDCs) is largely provided by the public sector; private participation is mostly channelled through public-private partnerships (PPPs). Grants and concessional loans are an essential source of infrastructure funding, while the complementary role of bank lending is still limited to a few countries. Bridging infrastructure gaps would require a broad set of actions to improve the efficiency of public spending, mobilize domestic resources and support from development partners, and crowd in private investment. Additionally, countries may have other options than borrowing to meet increased infrastructure spending needs. They can: (i) raise more revenues or lower non-capital spending; (ii) increase private sector participation; and (iii) make public infrastructure spending more efficient.

Life cycle stages of sustainable infrastructure

Life cycle stage 1: Project planning and preparation

This stage is designed to help achieve best practices in capital project management and ensure project consistency. Infrastructure pre-planning stage needs to assess community readiness for the project, integrate an infrastructure planning team, conduct a stakeholder analysis and develop a work plan, a budget and a schedule. Background information needs to be gathered, issues and opportunities related to infrastructure services identified, and the community's vision and goals should be considered, to identify and prioritize infrastructure needs and with that create an implementation strategy.

The feasibility analysis is essential in this stage because it provides information on the financial, technical, environmental and social project potentialities, to identify the benefits and the negative externalities. A feasibility analysis evaluates the project's potential for success; therefore, objectivity is an essential factor in the credibility of the study for potential investors and lending institutions. According to the IADB's Framework to Guide Sustainability, feasibility should include:

Economic and financial sustainability

– Economic and social returns
– Financial sustainability
– Policy attributes

Environmental sustainability, including climate resilience

– Climate and natural disasters
– Pollution
– Preservation of the natural environment
– Efficient use of resources

Social sustainability

– Poverty, social impact, and community engagement
– Human and labour rights
– Cultural preservation

Institutional sustainability

– Global and national strategies
– Governance and systemic change
– Management systems, accountability

Well-developed infrastructure plans – including climate impact, disaster risk assessments and resilience, as well as social assessments to provide a long-term vision – are needed to address infrastructure gaps. This vision will allow countries to avoid having costly stranded assets or impaired essential infrastructure assets during and after natural disasters (United Nations, 2020).

Challenges

The main causes affecting the schedule and cost of infrastructure projects are mostly related to the following:

- Changes in specifications, scope and drawings,
- Addition of scope during later stages of the planning or construction phase because of wrong definitions,
- Length of the project development phase,
- Cost underestimation used strategically by the project promoters to make the project viable and get the approval for construction of public project,
- Improper planning or incomplete planning,
- Planning or design mistakes, and
- Unexpected foundation or weather conditions.

Policy implementation example

France

To address the economic consequences of COVID-19, on 3 September 2020 the French government set out its "France Relance" recovery plan (Ministère de l'Europe et des Affaires Étrangères, 2020), with a EUR100 billion investment plan representing the equivalent of one-third of the annual state budget, of which EUR40 billion are provided by the European Union to support businesses, rethink production models, transform infrastructure and invest in training.

Construction and projects in France: overview of environmental impact assessments (EIAs)

The French equivalent of an EIA is the environmental study (*évaluation environnementale,* EE). An operator intending to carry out works that may cause an environmental hazard must prepare an EE before undertaking these works (Article L. 122-1, Environmental Code). Typically, an EE includes (Article R. 122-5, Environmental Code) a description of the project, and in particular:

- The location of the project,
- The physical characteristics of the whole project and land use requirements during construction and operation,
- The main characteristics of the operation phase of the project, relating to the manufacturing process, energy demand and use, nature and quantities of materials and natural resources used,
- An estimate by type and quantity of expected residues and emissions resulting from the construction and operation of the proposed project,
- An outline of the main alternatives studied by the developer and an indication of the main reasons for choosing the proposed project, considering the environmental impacts,
- A description of the relevant aspects of the current state of the environment, referred to as the "baseline scenario", and their evolution in the event of implementation of the project, as well as an overview of the likely evolution of the environment without the implementation of the project,
- A description of the likely impact of the project on the population, human health, biodiversity, land, soil, water, air, climate, tangible property, landscape and cultural heritage, including architectural and archaeological aspects,
- A description of the possible significant impacts of the proposed project on the environment resulting from the: construction and the existence of the project; use of natural resources; emission of pollutants, creation of nuisances and disposal of waste; risks to human health, cultural heritage or the environment; cumulative impacts with other existing or approved projects; impact of the project on climate and the project's vulnerability to climate change; and technologies and substances used,
- A description of the forecasting methods used to assess the impacts on the environment,
- A description of the measures proposed to prevent, reduce and, where possible, offset, or compensate for, any significant adverse impacts on the environment, and
- A non-technical summary of the information listed above.

The results of the EE are submitted to the competent environmental authority (Minister for the Environment, General Council for the Environment and Sustainable Development or prefect in the department) for its opinion. The competent authority, which is either the mayor or the prefect, considers the EE and the opinion of the environmental authority. Recent reforms have been implemented to ensure public information and participation in decisions that may have an impact on the environment. For instance, information on projects that are likely to have an impact on the environment and access to the EEs has been available on a dedicated website[1] since March 2018.

Life cycle stage 2: Bidding and procurement

All bidding and procurement processes should maximize the value of all goods and services received for the amount spent. Therefore, competitive bidding and procurement processes need to be clearly documented. Public procurement is highly complex and customized and often requires economic, political and social considerations from a long time horizon (Estache *et al.*, 2009).

Tendering is a critical activity in a capital works project and is normally the accepted means of obtaining a fair price and best value for undertaking construction works. It falls under the oversight of a governance group, which should be familiar with the requirements of the policy or act stated by the country or region. Reference should be made to the project's documents to ensure compliance with all requirements.

Using public procurement as a strategic governance tool can help shape an effective infrastructure delivery, and help address risks of inefficiency and corruption that are often associated with major infrastructure projects due to their complexity. Some countries have developed national guidance on infrastructure delivery to further mitigate risks, considering specific delivery modes. For instance, guidelines for public-private partnerships exist in Germany, Latvia and Norway and on national alliance contracting in Australia (OECD, 2017).

Challenges

Public procurement practitioners will always face many challenges when each country has its own economic, social, cultural and political environment. Opaque public procurement processes, off-budget expenditure and limited public access to information on investment projects all create vulnerabilities to corruption (OECD & IMF, 2019).

Infrastructure governance is especially important in the current context where many countries have large infrastructure needs to achieve sustainable and equitable economic growth, while facing limited fiscal space due to elevated public debt (OECD & IMF, 2019). According to the Infrastructure Transparency Initiative, between 10 percent and 30 percent of investment in infrastructure is lost due to corruption, mismanagement and inefficiency. Governments, the private sector and civil society need to promote the disclosure, validation and interpretation of data from infrastructure projects to inform and empower citizens, ultimately enabling them to hold decision makers to account.

Thai *et al.* (2005), identified the following key challenges related to this stage:

[1] https://www.projets-environnement.gouv.fr/pages/home/

a. Internal factors:

Interactions between elements of the public procurement systems;

Types of goods, services and capital assets required for an agency's missions;

Professionalism or quality of procurement workforce;

Staffing levels (ratio of procurement practitioners to contract actions) and budget resources.

b. External factors:

Market environment

Market conditions are very favourable in industrialized countries, while they may be unfavourable in developing countries. Also, as markets become more globalized through regional and international trade agreements and treaties, public procurement practitioners face a greater challenge.

Legal environment

A broad legal framework that governs all business activities including research and development, manufacturing, finance, marketing, personnel and contracts.

Political environment

Interest groups are involved in the public procurement system in several ways such as lobbying legislative bodies to pass or alter procurement statutes, influencing implementation of these statutes, and influencing budget authorization and appropriations processes.

Social, economic, and other environment forces

Most governmental entities prefer national or local firms over others. Public procurement practitioners may be in a favourable economic environment or market (with many competing tenderers) or an unfavourable economic environment (imperfect competitive market).

c. Environmental protection concern or green p

Environment protection has been present in every country – developed and developing – and environmentalists have placed a great deal of pressure on public procurement practitioners.

d. Other influencing forces:

Culture can influence the public procurement system, as it is sometimes difficult to distinguish between gifts and bribes. Technology also plays a role, since rapidly advances have forced public procurement to adopt new methods, such as the use of e-signature and purchase cards, and to be knowledgeable in how to procure information technology.

Policy implementation example

Australia

The Department of Health of Victoria (2020) states in the Ministerial Directions the accepted methods to be used for tendering by government departments and public bodies in Victoria. The Code sets out specific principles and standards of behaviour that underpin best industry practice. It applies to all parties involved in public construction, including new building, maintenance, rehabilitation, alteration, extension, or demolition of any improvements on land by or on behalf of departments or public bodies. The government procurement principles that apply to the building and construction industry sector are contained in the Financial Management Act (FMA).

The procurement principles are the following:

Value for money:	Accountability:	Probity:	Scalability:	Capability:	Risk management:
Procurement is to represent a balanced judgement of relevant financial and non-financial factors. This principle applies for the estimated life of the facility.	Authority and responsibility are matched with appropriate levels of accountability.	The application of integrity and ethical behaviour in the conduct of procurement processes.	The procurement governance and process arrangements applied are aligned with the complexity and significance of the procurement undertaken.	The application of resources, skills and experience are appropriate to the specific procurement process undertaken.	The application of the principle where the risks are assigned to the party best able to manage them, following the application to remove or mitigate risks where possible.

United States of America

The Council of the District of Columbia published laws to: establish statutory purposes and policies for the procurement of goods, services and construction; authorize supplementary general principles of applicable law; require an obligation of good faith; establish the statutory applicability of the delineated procurement requirements; authorize severability of statutory provisions; establish the Office of Contracting and Procurement; establish criteria for review by the Council of multi-year contracts and contracts in excess of US$1 million; and establish and authorize a Chief Procurement Officer of the Office of Contracting and Procurement.

Life cycle stage 3: Detailed design

Infrastructure development is highly resource-consuming. Since infrastructure installations have long life spans, their impact on resource utilization, the quality of the environment and overall quality of life will last long into the future. Preliminary and detailed designs are vital in achieving cost efficiency, improving performance of infrastructure systems, and reducing negative social and environmental impacts of infrastructure facilities. The design of infrastructure facilities needs to consider not only construction stage aspects but also post-construction impacts (Haupt & Nuramo, 2017).

Traditionally, the main concerns among design professionals had been functionality, aesthetics, safety, reliability and, in some instances, the economic viability of infrastructure. Recent global developments called for a notable paradigm shift to make sustainability a substantial component of designs. Sustainable design is an alternative approach that leads toward a less consumptive mindset that embraces global interdependence, environmental stewardship, social responsibility and economic viability, and considers the impacts of design choices at the local, regional and global levels (Blizzard, 2011). Sustainable design is the philosophy of designing physical objects, the built environment, and services to comply with the principles of social, economic and ecological sustainability.

According to ARUP, a firm dedicated to sustainable design, engineering, architecture, planning and advisory services across every aspect of the built environment, sustainable infrastructure design is not limited to new infrastructure. Rehabilitation, reuse or optimization of existing infrastructure (including the protection of existing infrastructure from environmental degradation, material selection taking into account quality, durability and energy conservation, minimizing waste and materials, and considering the remediation of environmentally damaged soils and water, among others) are also consistent with the principles of urban sustainability and global sustainable development.

The literature provides a set of general principles that apply to the design of sustainable cities and infrastructure by engineers, architects, planners and policymakers. The principles are applied to the design process as follows:

Figure 2: Whole system design – components of an engineering framework

Source: Blizzard, 2011

Challenges

A key difficulty is insufficient skills and resources to deliver resilient infrastructure and ensure it is properly maintained. To address this, contractors, planners, engineers, and operators all need to have the required skills, including those to collect, model and interpret risk information (for example climate- and hydrology-related information) so that it guides infrastructure investment choices and subsequent design.

Besides planning and design, a key aspect of the resilience of infrastructure is how it interacts within a bigger infrastructure system and how this impacts sustainability both at the community and national levels. This is particularly important as major infrastructure investment can have positive and negative impacts on the resilience of its surroundings, which implies setting the context for selection and design, and involve the stakeholders that will be affected.

There are many standards for designing resilience into infrastructure. However, for some risks, including climate change, resilience should be considered at a much earlier stage, when infrastructure investment decisions and strategic planning choices are made. According to Gallego-Lopez and Essex (2016), instead of a standards-led approach, a process that links technical specification with climate and disaster impacts and local communities is paramount.

Even though it is essential to find the best development patterns to limit the adverse impacts of urbanization on ecological connectivity in the design stage, a harmonized analysis to measure the co-benefits between biodiversity and the sustainable design and management of infrastructures is still missing (Soubelet *et al.*, 2019).

Policy implementation example

Asia

The Asian Development Bank (ADB) has recently taken stock of its experience with climate risk management and resilient investments in the past five years, and has identified priorities for improving their climate risk management framework and the integration of resilience. Among the areas identified for improvement are: (i) the provision of climate services, including climate data and information relevant to resilience investment decision-making; (ii) the economic analysis of resilience interventions in investment projects; and (iii) professional development and training for key project partners.

ADB has started updating its guidance on climate risk and adaptation assessment, to enhance the climate-proofing of new investments, improve the guidance on climate risk screening and resilient project design, and provide more targeted supporting material and case studies. These activities will help improve the resilience of the existing and new project portfolio, and ensure that infrastructure investments are climate-smart (Lu, 2019).

United States of America

The General Service Administration states that utilizing a sustainable design philosophy for real estate encourages decisions at each phase of the design process that will reduce negative impacts on the environment and the health of the occupants, without compromising the bottom line. Such an integrated approach positively impacts all phases of a building's life cycle, including design, construction, operation and decommissioning.

Life cycle stage 4: Funding, financing and investment

City governments need to develop urbanization strategies across sectors with an assigned budget, while national governments need to assist them in the development of sustainable urban infrastructure by establishing legal frameworks that favour them. Other means to further empower cities include providing subnational governments greater fiscal autonomy and creating channels to engage directly with national development banks (Godfrey & Zhao, 2016). However, it is fundamental to build up assertive administrations that can be autonomous and well positioned to make effective use of the financing instruments at their disposal. In this sense, local administration and its financial base need to be strengthened; private capital for urban infrastructure mobilized and international financing of development and climate mitigation coordinated and geared consistently towards sustainable urban development (World Bank, 2016).

Substantial benefits can be realized by better managing public infrastructure investment through the life cycle of an asset and across levels of government. To ensure public infrastructure is affordable, governments usually set up different participation schemes to finance their projects. The benefits of participation will depend on the return investment and tax legal framework of the country.

Infrastructure investments are long-term and require large upfront investments, but generate cash flows after many years. They are subject to high risks, especially in the initial phases, since they are typically complex and involve many parties, and vulnerable to policy and political risks. Moreover, they require appropriate regulation, since they are often natural monopolies. Last, spillover effects, externalities and social benefits of the investment may be large but difficult to measure. Consequently, markets alone cannot provide effective and sustainable infrastructure services (Bhattacharya, Nofal *et al.*, 2019).

Fiscal reporting has been developed significantly in the recent past. The comprehensiveness and coverage of reports have increased as governments have sought to solve fiscal problems and make better use of their resources. New accrual-based international statistical and accounting standards have been developed. Likewise, many governments have chosen to prepare additional reports on risks, the long-term sustainability of public finances and other issues (Cangiano *et al.*, 2013).

Analysing infrastructure investment in developing countries is a challenging task due to the lack of systematic and comparable data. Moreover, the public sector provides the bulk of infrastructure in these countries (Gurara *et al.*, 2018).

In 2021, the Climate Policy Initiative (CPI) developed a first-of-its-kind assessment of Jakarta's climate investments focusing on urban ones, aiming to help identify key sources of funding for urban climate projects, provide stakeholders with better understanding of the necessary type of climate financing, and supporting government agencies in formulating policy guidance. This kind of assessment provides essential insights for the development of public policy for investment in sustainable infrastructure. Considering Jakarta's particularities, the document developed three recommendations: (i) to have a more explicit and clear alignment of its climate priorities with both the national government and Jakarta's satellite cities; (ii) to develop an improved climate policy framework, integrating climate budget tagging and enhanced strategies to scale up financing for climate investments; (iii) to scale up catalytic and innovative financing models and leveraging municipal budgets to mobilize private investment.

G20 countries consider PPP schemes for large projects differently, in accordance with the legal framework, and throughout the complete local infrastructure life cycle.

Two common approaches have been used by governments for the implementation of public-private partnerships: a finance-based approach that aims to use private financing to satisfy infrastructure needs, and a service-based approach that aims to optimize the time and cost efficiencies in service delivery.

Challenges

Although the governments of many advanced economies have either moved to full accrual accounting or plan to do so soon, doubts may arise questioning whether benefits are worth its costs, or whether it needs to be made more comprehensive, for example to ensure recognition of more contingent liabilities.

Budgetary institutions are a major source of rent-seeking and rent-providing behaviour in developing countries and thus exercise a strong influence on the budget process while constraining its modernization. Reforming these institutions is difficult because the changes involve political willingness, and incentives for reform among policymakers are weak. This is why public sector reform programmes and poverty reduction plans often mirror donor preferences.

The impact on infrastructure of crises such as COVID-19 varies depending on the infrastructure sector and on the procurement and financing models. In general, assets that are less dependent on user tariffs and with project finance structures are more resilient, but cases diverge depending on the country context and the support governments can provide. A common factor across most countries is that infrastructure is expected to play a key role in the crisis recovery period, given its well-documented impact on productivity, growth and job creation (World Bank, 2020).

Optimizing and innovating the financing structures related to capital deployment in infrastructure will continue to be challenging. The legal technology underlying some of the debt investments in infrastructure assets remains antiquated and needs to be updated, in part by incorporating elements of leveraged finance to provide additional flexibility for equity investors (Kirkland & Ellis LLP, 2020).

Life cycle stage 5: Construction

According to the World Bank (2018), cities generate 2 billion tonnes of solid waste annually, with construction materials accounting for about half of this waste; by 2050, cities are on course to generate 3.4 billion tonnes of waste each year. If the construction industry adopted green and socially responsible building practices, including zero waste policies, it would significantly cut back on the amount of solid waste coming out of cities.

Since the construction industry has a direct influence on society, the environment and the economy, it can have a large impact on environmental sustainability (Xia *et al.*, 2016, 2015). Following the Environmental Protection Agency of the United States, green building is the practice of "creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction."

The implementation of sustainable construction methods in the project life cycle, such as planning of land use, design of environmentally friendly projects, utilizing sustainable building materials, the efficient use of water or natural resources, and production of minimal construction waste can maximize the resilience of project development to disaster (Ismail *et al.*, 2017).

Requirements to implement sustainable construction include the following:

- Commitments to, and knowledge of, sustainable concepts that are transferred and adopted into new ways of working, thinking and learning to boost stakeholders' performance and motivation. Project management should incorporate knowledge and skills to sustainable construction, since it is an essential prerequisite to the designing, delivering and managing of this environment.
- Innovation and technology enhancement.
- Regulations of green practices for all types of projects, which should also be formally monitored for compliance.
- A strict waste management strategy, including mitigation of water wastage and enhancement of efficient water use in construction sites.

- Measurement tools, such as strategic metrics to analyze sustainable construction practices, rating systems to evaluate whether impacts on the environment, and a buildings sustainable index to assess whether there is a potential improvement in the long and short term.

The requirements for implementing sustainable construction highlight the importance of budget allocation for education and training, and a holistic approach to project management methodology and technology, all of which are supported by the interrelated roles and responsibilities of construction project stakeholders, to strongly ensure that projects are built based on sustainability principles.

Challenges

Sustainable construction requires the integration of environmental and social impact mitigation processes. If this is not done at an early stage, all project stages may suffer important delays. Construction programmes are considered a critical performance criteria of construction projects. Construction delays will often increase the cost of the project and affect the overall performance and the impact on all stakeholders.

As the revenue of any construction project is the main objective for investors and developers, the implementation of sustainable construction practices is a critical consideration for policymakers. Public awareness of institutional, environmental, social and economic issues is an important aspect for the success of sustainable construction practices, but still, there is a resistance among different players of the construction industry to change the conventional construction methods and processes to more sustainable ones (Saleh & Alalouch, 2015).

Policy implementation example

South-east Asia

In Indonesia, sustainable construction is in urgent need of implementation (Willar *et al.*, 2020). There is a basic regulation of the Indonesian Ministry of Public Works and Housing (No. 05/PRT/M/2015) relating to sustainable construction in infrastructure project execution, providing a direction for sustainable construction implementation, which will eventually contribute to sustainable development. However, there are still gaps between the regulations and their implementation in infrastructure construction projects.

The implementation of principles of sustainable construction has been spreading in other developing countries, such as in Malaysia, and promoted in others. Sri Lanka has focused on policies, resources and education for successful adoption of sustainability in its construction, and Nigeria and South Africa have considered an awareness of using sustainable construction materials (Willar *et al.*, 2020).

Life cycle stage 6: Operation and maintenance

Operation and maintenance (O&M) have been identified as the key to enhancing the sustainability of existing infrastructure and assets (Sohail, Cavill and Cotton, 2005). For governments, this responsibility consists in "secur[ing] maximum value for money from O&M of a country's existing infrastructure assets" (World Economic Forum, 2014). Three broad strategies are available to governments for managing their infrastructure assets and maximizing the return on those past investments:

- Increase the utility of the existing infrastructure asset, by maximizing its utilization and enhancing its quality for each user,
- Decrease the total costs of providing the infrastructure service – not just by reducing internalized O&M costs but also by mitigating the environmental and social externality costs, and
- Increase the lifetime value, either by extending the asset's life to maintain the benefits over an extended period, or by organizing a rehabilitation, replacement or upgrade plan that takes whole life cycle considerations properly into account.

The United States Environment Protection Agency (EPA) lists four key technical points to maintain a functional and secure asset:

- The type of maintenance to be performed,
- The frequency of maintenance and available personnel to perform it,
- The cost of component replacements, and
- Sufficient and dedicated funds to cover operation and maintenance activities, including cost of replacement components.

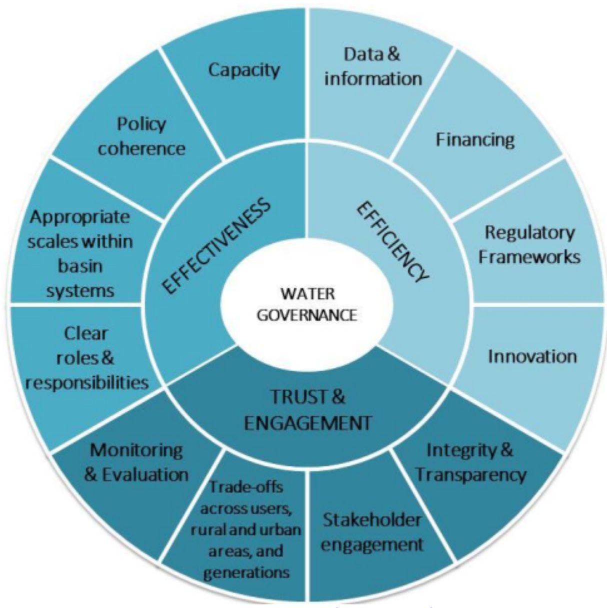
According to the EPA, maintenance plans and strategies will vary depending on the type of infrastructure project. Proper maintenance is essential to maximizing the environmental, social and economic benefits of the infrastructure, as well as ensuring that projects perform as expected.

Also, a good governance, tight stakeholder involvement, a consistent legal framework and good funding could be considered in the whole infrastructure cycle.[2]

To illustrate the breadth of this life cycle stage, Figure 5 shows key aspects to consider within water-infrastructure O&M activities.

[2] As illustrated in OECD (2015), which could be referred for others infrastructure investments and types.

Figure 5: Overview of OECD principles on water governance



Source: OECD, 2015

A regulatory framework (efficiency) and policy coherence have been shown to be two key elements for a proper O&M of public assets. However, there is no straightforward evidence for a O&M legal framework in the G20 countries – naturally nor a one based on a life-cycle infrastructure approach – but only construction's acts, permits, procurement rules and other regulations for PPP and non-PPP infrastructure investments.

Good regulatory design and delivery are necessary to ensure sustainable and affordable infrastructure over the life of the asset. Information asymmetries between governments and operators on capital costs, asset depreciation and consumers' preferences can make tariff setting challenging. If tariffs do not cover the long-term depreciation of capital assets, for instance, investment decisions could be short-sighted, and infrastructure could fail to be appropriately maintained and upgraded (OECD, 2016).

Challenges

From a sustainable perspective, many challenges need to be solved if countries want to preserve their infrastructure assets in the long term. Some of these recommendations could be used in the construction of a proper law.

As stated, there is a need to make O&M-specific regulation for national projects and include it in the strategic pipeline. It could contain, at least, mechanisms to guide how the infrastructure can improve market accessibility and productivity, ensure balanced regional economic development, create employment, promote labour mobility and, in the case of transport, connect communities, and ensure multi-stakeholder participation in the asset maintenance. However, establishing national regulation might take time and resources, presenting a challenge, especially for developing countries.

Additionally, key stakeholders should be involved not only in the planning, design and construction phases, but also in the O&M activities. There is a general lack of understanding by stakeholders about the role of operation, maintenance and sustainability in the context of good governance. It is necessary to conceive the O&M from a community-based approach. Establishing a dedicated source of funding that will cover the costs associated with maintenance, staff, equipment, and the repair and replacement of infrastructure components can help ensure the continued success of an O&M programme, according to the EPA.

Policy implementation example

Mexico

In 2018 Mexico's government formalized the rules for social impact assessment (SIAs) in the energy sector, making them a compulsory part of the permitting process for project developers in the electricity and hydrocarbons sectors, including upstream operators and pipeline companies. These SIAs are relevant for the O&M stage because they demand a full description of the activities involved in the O&M process of the project and the infrastructure created.

Life cycle stage 7: End of life

Historically, limited attention has been placed on the end of life, or decommissioning of infrastructure assets, which involves a process of withdrawing the infrastructure from service, and then dismantling and deconstructing the asset (Invernizzi *et al.*, 2018). Facilities' life extension is not an easy decision to take, especially if it refers to safety critical systems and installations, including nuclear power, offshore oil and gas, petrochemical, renewable energy and rail transport.

In G20 countries, there is no evidence for an act, regulation or national programme designed to address public infrastructure at the final stage. Nowadays, the financial and physical health of the actual assets need to be monitored and evaluated. Many infrastructure assets are approaching the end of their useful life: for example, about half of the main water pipes in London are more than 100 years old, and one-third could be even older than 150 years, and in the United States, the equipment in electricity substations is on average 42 years old, with an estimated original lifespan of 45 to 55 years. As the OECD describes, infrastructure policy is limited in monitoring phases. This is related with a low consensus about what should integrate an end-of-life infrastructure policy or regulation (OECD, 2016).

In order to adequately evaluate and dispose of an infrastructure in its final stage, one of the main aspects is to prevent and monitor its risks along its complete life cycle. It is important for policymakers, for engineers and designers, to take this into account. This risk evaluation needs to consider all stages and the stakeholders involved to prevent and mitigate the consequences of the infrastructure assets ahead to natural disasters due to climate change or human interventions.

Governments could implement international standards in at the national and subnational levels. The ISO 55000 provides a management framework for the coordinated activity of an organization to realize value from its assets to support the delivery of its strategic plan and objectives. The focus is placed on "strategic" asset management, mainly on optimization and prioritizing assets for repair and replacement based on a combination of condition, risk and performance metrics. Some of the key elements of this standard encourage improved management in the following ways:

- Development of a clear and concise asset management policy, strategy and approach to strategic planning,
- Defining levels of service and linking these to interventions and desired outcomes,
- Evidence of proactive external stakeholder engagement and management,
- Integrating outsourced activities with the asset management system,
- Implementing strategic and asset risk management and demonstrating its use in influencing asset management decision making,
- Business case development and integrated investment planning over multiple time horizons, and
- Whole-life costing and governance.

Challenges

Governments could conduct a whole life cycle cost-benefit analysis for each infrastructure stage, including the end of asset life. However, decommissioning encompasses a vibrant and interdisciplinary research agenda of interest to many branches of academia and industry. Policymakers and regulators should provide clear strategy, guidance, and funding mechanisms with the objective of minimizing the impact of the whole infrastructures' lifecycle, and not just during the operational generation phase. The interplay between decommissioning challenges triggers the need to balance the array of all stakeholders' social, organizational, and cultural needs and demands. This is necessary to ensure that decommissioning projects positively contribute to sustainable development.

Decommissioning projects tend to be long, complex and expensive. Moreover, the costs for most projects usually experience significant increases from their established budgets. While it is widely known that costs will increase, there is limited understanding why this is repeatedly occurring during the decommissioning process (Invernizzi *et al.*, 2018).

Reusing, remanufacturing and recycling old infrastructures to address the increasing sustainable energy assets through the application of circular economy principles is necessary. Designing and building new infrastructure aligned with these principles could be promoted by public policies, since it will add further complexity to decommissioning projects (Invernizzi *et al.*, 2020).

Policy implementation example

Europe

In Europe, more than 200 nuclear power reactors have been constructed in the last decades, but only three have been decommissioned, with two of these being experimental nuclear power plants. Similarly, in the oil and gas industry, only around 10 percent of the oil and gas platforms installed across the North Sea have been decommissioned and less than 5 percent of pipelines.

United Sates

In the United States, more than 100 nuclear power reactors have been constructed, but only 13 have been decommissioned. In the case offshore oil and gas decommissioning projects, the Bureau of Safety and Environmental Enforcement indicated that a yearly average of 130 offshore platforms have been decommissioned over the last decade and around 65 percent of the 7,000 structures installed have been decommissioned to date (Invernizzi *et al.*, 2018).

When Portland General Electric proposed to decommission a 90-year-old hydropower project in a scenic area close to Portland, few models existed for how to do it in an environmentally sensitive and cost-effective way. It took the initiative to form a Decommissioning Working Group, composed of representatives of government agencies, businesses and public interest groups to jointly examine the complex policy, science and engineering issues and develop a plan for the decommissioning.

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Key takeaways

Sustainable and quality infrastructure plays a crucial role in society and economy. It is indispensable for delivering better and more inclusive economic, social and environmental conditions, and for supporting growth by expanding access to vital services and improving economic opportunities for all. If executed well, infrastructure can lead to equitable and sustainable economic growth, skill development, employment, income growth, labour productivity, business competitiveness and trade.

We propose to adopt sustainable infrastructure from a life cycle approach at the city level, since considering their infrastructure needs as a starting point can help not only to select but ultimately to deliver and manage infrastructure developments in a sustainable manner.

The following questions should be understood as triggers to address sustainable infrastructure development. Their aim is to clarify to policymakers how to include sustainability considerations throughout the entire infrastructure life cycle. Furthermore, by addressing them, each set of questions will also function as a guide to correctly complete each stage of the life cycle approach.

Suggested triggering questions by life cycle stage

Life cycle stage 1: Project planning and preparation	a. What are the most important reasons and causes for cost overruns and schedule delays in the planning phase of infrastructure projects? And which of the identified causes are traceable to improper planning or improper planning stages of infrastructure projects? b. Which processes in the planning phase or procedures lead to cost escalations and time delays, and consequently need an optimization? c. How far can the entire planning process be optimized with modern management techniques and approaches?
Life cycle stage 2: Bidding and procurement	a. What mechanisms can be implemented to advise on public procurement matters? b. How can procurement training and specifications across institutions be standardized? c. How can lessons learned, knowledge exchange, best practice and critical skills be documented and shared? d. How can technology implementation be accelerated and effectively applied in procurement processes?
Life cycle stage 3: Detailed design	a. What consultation mechanism with engineers specialized in hazard-resistant construction can take place in the initial stages of construction projects? b. Does the risk evaluation include an identification of locations most likely to become unsafe/harmed? Does it assess the land use and the ability of local construction to resist potential identified hazards?

	c. How does the authority involve local stakeholders all the way through the project design and implementation in order to deliver wider development outcomes? And what is it doing to ensure that the infrastructure development is responding to user needs?
Life cycle stage 4: Funding, financing and investment	a. How to summarize long-term fiscal projections in a way that clarifies their implications and their relationship to the government's main financial statements? b. How has the government facilitated access to alternative pools of funds for key infrastructure operators to ensure the continuity of essential services? c. Is the local development bank playing a key role in coordinating the financing How? d. Has the country taken measures to ease financing for the corporate sector in general (with an emphasis on SMEs), considering that this could have an indirect impact on the restoration of value chains for infrastructure?
Life cycle stage 5: Construction	a. Are tenders for construction specifying sustainable processes for qualification? b. How can policy ensure contractors and construction staff are informed on how to improve sustainability on construction sites? c. How can the government promote that construction projects commit to sourcing materials from local and regional suppliers? d. Should there be fiscal incentives from the government in implementing sustainable practices during the construction stage of infrastructure projects? Which ones prove more efficient?
Life cycle Stage 6: Operation and maintenance	a. Is there a strategy for ensuring the performance of the asset throughout its life? b. Are the line departments, sector regulators or supreme audit institution responsible for monitoring asset performance? c. Are there programmes in place for training relevant institutions on O&M? d. Do PPP or concession contracts state the required output and performance?
Life cycle Stage 7: End of life	a. What mechanisms will enable knowledge sharing between various areas to engage and enact in the process of decommissioning? b. How can governments be more proactive in preparing and implementing policies and solutions to enhance the circular economy for future infrastructure?

References

Abdel Aziz, A. M. (2007). Successful delivery of public-private partnerships for infrastructure development. *Journal of construction engineering and management*, *133*(12), 918-931.

Bhattacharya, A., Casado, C. C., Jeong, M., Amin, A.-L., Watkins, G., & Zuniga, M. S. (2019). *Atributos y Marco para la Infraestructura Sostenible*.

Bhattacharya, A., Meltzer, J. P., Oppenheim, J., Qureshi, Z., & Stern, N. (2016). Delivering on sustainable infrastructure for better development and better climate. *Brookings*. https://www.brookings.edu/research/delivering-on-sustainable-infrastructure-for-better-development-and-better-climate/

Bhattacharya, A., Nofal, B., Krueger, L., Jeong, M., & Gallagher, K. (2019). Policy and Institutional Framework for Delivering on Sustainable Infrastructure. *T20 Policy Brief. More Information*.

Blizzard, J. (2011). *A design framework for sustainable infrastructure*.

Cairney, P. (2013). *Policy Concepts in 1000 Words: The Policy Cycle and its Stages* [online]. https://paulcairney.wordpress.com/2013/11/11/policy-concepts-in-1000-words-the-policy-cycle-and-its-stages/

Cangiano, M., Curristine, T., & Lazare, M. (2013). Public Financial Management and Its Emerging Architecture. En *Public Financial Management and Its Emerging Architecture*. INTERNATIONAL MONETARY FUND. https://www.elibrary.imf.org/view/IMF071/20033-9781475531091/20033-9781475531091/ch10.xml?redirect=true

Chancellor of the Exchequer. (2020). *UK National Infrastructure Strategy*. GOV.UK. https://www.gov.uk/government/publications/national-infrastructure-strategy

Chimhowu, A. (2018). *Five things we've learnt about National Development Plans*. National Planning in the Global South. http://www.nationalplanning.org/index.php/en/2018/02/08/5-things-about-national-development-plans/

Chimhowu, A., Hulme, D., & Munro, L. T. (2019). The 'New' national development planning and global development goals: Processes and partnerships. *World Development*, *120*, 76-89. https://doi.org/10.1016/j.worlddev.2019.03.013

Commonwealth of Australia. (2017). *National Infrastructure Data Collection and Dissemination Plan*. https://www.bitre.gov.au/sites/default/files/documents/National_Infrastructure_Data_Collection_and_Dissemination_Plan-draft.pdf

Department of Health, Victoria, Australia. (2020). *Home—Department of Health, Victoria, Australia* [Guidelines]. c=AU; st=Victoria; o=State Government of Victoria; ou1=Department of Health. http://www.capital.health.vic.gov.au/

Economic Commission for Latin America and the Caribbean. (2020). *Regional observatory on planning for development in Latin America and the Caribbean: Conceptual framework*. CEPAL. https://www.cepal.org/en/publications/42181-regional-observatory-planning-development-latin-america-and-caribbean-conceptual

Estache, A., Iimi, A., & Ruzzier, C. (2009). Procurement in infrastructure: What does theory tell us ? *The World Bank, Policy Research Working Paper Series*.

Gallego-Lopez, C., & Essex, J. (2016). *Designing for Infrastructure Resilience*. Evidence on Demand. https://doi.org/10.12774/eod_tg.july2016.gallegolopezessex2

Gurara, D., Klyuev, V., Mwase, N., & Presbitero, A. F. (2018). Trends and Challenges in Infrastructure Investment in Developing Countries. *International Development Policy | Revue Internationale de Politique de Développement*, *10.1*, Article 10.1. https://doi.org/10.4000/poldev.2802

Haupt, T., & Nuramo, D. (2017, agosto 16). *Key elements for sustainable infrastructure design in developing countries*.

Hyari, K., & Kandil, A. (2009). Validity of Feasibility Studies for Infrastructure Construction Projects. *Jordan Journal of Civil Engineering*, *3*.

Infrastructure Australia. (2008). *Infrastructre Australia Act 2008* (au). Attorney-General's Department. https://www.legislation.gov.au/Details/C2014C00639/Html/Text, http://www.legislation.gov.au/Details/C2014C00639

Infrastructure Canada. (2020). *Departmental Sustainable Development Strategy 2020 - 2023.* https://www.infrastructure.gc.ca/alt-format/pdf/other-autre/DSDS-2020-23-INFC-EN.pdf

Inter-American Development Bank (2018). *What Is Sustainable Infrastructure. A Framework to Guide Sustainability Across the Project Cycle.* https://publications.iadb.org/publications/english/document/What_is_Sustainable_Infrastructure__A_Framework_to_Guide_Sustainability_Across_the_Project_Cycle.pdf

Invernizzi, D. C., Locatelli, G., Velenturf, A., Love, P. E. D., Purnell, P., & Brookes, N. J. (2020). Developing policies for the end-of-life of energy infrastructure: Coming to terms with the challenges of decommissioning. *Energy Policy*, *144*, 111677. https://doi.org/10.1016/j.enpol.2020.111677

Invernizzi, D., Locatelli, G., & Brookes, N. (2018). *Decommissioning Projects in Europe: What Can the Offshore Oil & Gas and Nuclear Industries Learn from Each Other?*

Ismail, F. Z., Halog, A., & Smith, C. (2017). How sustainable is disaster resilience? *International Journal of Disaster Resilience in the Built Environment*.

Khanna, P. (2016). *Connectography: Mapping the future of global civilization*. Random House.

Khanna, P., & Blossom, J. (2020). *Exploring the world of Connectography*. http://worldmap.harvard.edu/maps/connectography

Kirkland & Ellis LLP. (2020). *Private Infrastructure Investment and the COVID-19 Pandemic*. https://www.kirkland.com/publications/blog-post/2020/03/private-infrastructure-investment-covid-19

Kozlov, S. (2020). *Russia—The Environment and Climate Change Law Review—Edition 4—TLR - The Law Reviews*. https://thelawreviews.co.uk/edition/the-environment-and-climate-change-law-review-edition-4/1215737/russia

KPMG. (2012). *Cities Infrastructure: A report on sustainability*. 32.

Liu, Y., van Nederveen, S., Wu, C., & Hertogh, M. (2018, septiembre 25). *Sustainable Infrastructure Design Framework through Integration of Rating Systems and Building Information Modeling* [Research Article]. Advances in Civil Engineering; Hindawi. https://doi.org/10.1155/2018/8183536

Lossouarn, C., Pangare, V., Fenghua, S., Lentini, E. J., Loftus, T., Dickinson, M. A., Ngoc, T. D. T., Perset, M., Strady, E., Phan, T. S. H., Vachaud, G., Quertamp, F., Gratiot, N., Ozturk, I., Altay, D. A., Oteri, A., Rasheed, A. A., Parker, J., Hagekhalil, A., … Daigo, Y. (2016). *Water, Megacities and Global Change*. UNESCO & ARCEAU-IdF. https://hal-enpc.archives-ouvertes.fr/hal-01449109

Lu, X. (2019). *Building Resilient Infrastructure for the Future: Background paper for the G20 Climate Sustainability Working Group*.

Marcelo, D., Mandri-Perrott, C., House, S., & Schwartz, J. (2016). An Alternative Approach to Project Selection: The Infrastructure Prioritization Framework. *World Bank Working Paper*.

McInerney, L., Nadarajah, C., & Perkins, F. (2007). Australia's infrastructure policy and the COAG National Reform Agenda. *Economic Round-up*, *Summer 2007*, 17.

McLennan, J. F. (2004). *The philosophy of sustainable design: The future of architecture*. Ecotone publishing.

Ministère de l'Europe et des Affaires Étrangères. (2020). *France Relance recovery plan: building the France of 2030*. https://www.diplomatie.gouv.fr/en/french-foreign-policy/economic-diplomacy-foreign-trade/promoting-france-s-attractiveness/france-relance-recovery-plan-building-the-france-of-2030/

Murray, S. (2019). The Critical Role of Infrastructure for the Sustainable Development Goals. *The Economist Intelligence Unit [en línea] https://content. unops. org/publications/The-critical-role-of-infrastructure-for-the-SDGs_EN. pdf*.

OECD. (1996). *Information Infrastructure Policies* (OECD Digital Economy Papers N.º 20; OECD Digital Economy Papers, Vol. 20). https://doi.org/10.1787/237347378543

OECD. (2015). *OECD Principles on Water Governance. https://www.oecd.org/cfe/regionaldevelopment/OECD-Principles-on-Water-Governance-en.pdf*

OECD. (2016). *Getting Infrastructure Right A framework for better governance*. https://www.oecd.org/gov/getting-infrastructure-right.pdf

OECD. (2017). *Government at a Glance: A Lighthouse for our Public Services*. https://doi.org/10.1787/gov_glance-2017-en

OECD. (2020). *Strategic Policies for Sustainable Infrastructure*. http://www.oecd.org/finance/sustainable-infrastructure.htm

OECD & IMF. (2019). *Governance of Quality Infrastructure Investment*. https://infrastructuregovern.imf.org/content/dam/PIMA/Knowledge-Hub/Publications/OECD_IMF_RefNoteGovernanceofQualityInfrastructureInvestment.pdf

Oke, A. E., Aigbavboa, C. O., & Semenya, K. (2017). Energy savings and sustainable construction: Examining the advantages of nanotechnology. *Energy Procedia*, *142*, 3839-3843.

Qureshi, Z. (2015). The role of public policy in sustainable infrastructure. *COP21 at Paris: What to Expect*.

Qureshi, Z. (2016a, febrero 24). *Infrastructure for a Sustainable Future | by Zia Qureshi*. Project Syndicate. https://www.project-syndicate.org/commentary/infrastructure-investment-climate-change-by-zia-qureshi-2016-02-by-project-syndicate-2016-02

Qureshi, Z. (2016b). Meeting the challenge of sustainable infrastructure: The role of public policy. *Brookings*. https://www.brookings.edu/research/meeting-the-challenge-of-sustainable-infrastructure-the-role-of-public-policy/

Saleh, M. S., & Alalouch, C. (2015). Towards Sustainable Construction in Oman: Challenges & Opportunities. *Procedia Engineering*, *118*, 177-184. https://doi.org/10.1016/j.proeng.2015.08.416

Serebrisky, T., Watkins, G., Ramirez, M. C., Meller, H., Melo, R., & Georgoulias, A. (2018). *IDBG Framework for Planning, Preparing, and Financing Sustainable Infrastructure Projects: IDB Sustainable Infrastructure Platform*. Inter-American Development Bank. https://doi.org/10.18235/0001037

Shen, L., Tam, V., Tam, L., & Ji, Y.-B. (2010). Project feasibility study: The key to successful implementation of sustainable and socially responsible construction management practice. *Journal of Cleaner Production*, *18*. https://doi.org/10.1016/j.jclepro.2009.10.014

Shurrab, J., Hussain, M., & Khan, M. (2019). Green and sustainable practices in the construction industry. *Engineering, Construction and Architectural Management*.

Silverwood, A. (2019). *The spread of megacity clusters requires infrastructure connections*. RICS. https://www.rics.org/es/wbef/megatrends/urbanisation/the-spread-of-megacity-clusters-requires-infrastructure-connections/

Sohail, M., Cavill, S., & Cotton, A. P. (2005). Sustainable Operation and Maintenance of Urban Infrastructure: Myth or Reality? *Journal of Urban Planning and Development* Vol. 131, Issue 1. https://doi.org/10.1061/(ASCE)0733-9488(2005)131:1(39)

Taras, D. (2020). *Transitioning Towards More Sustainable and Quality Infrastructure* [Text]. ISPI. https://www.ispionline.it/en/pubblicazione/transitioning-towards-more-sustainable-and-quality-infrastructure-26539

Thai, K. V., Araujo, A., Carter, R. Y., Callender, G., Drabkin, D., Grimm, R., Jensen, K., Lloyd, R. E., McCue, C., & Telgen, J. (2005). *Challenges in public procurement: An international perspective*. PrAcademics Press Boca Raton, FL.

Thornton, A. (2019). *10 cities are predicted to gain megacity status by 2030*. World Economic Forum. https://www.weforum.org/agenda/2019/02/10-cities-are-predicted-to-gain-megacity-status-by-2030/

UNCTAD. (2020). *Global foreign direct investment projected to fall 40% IN 2020, says UN report | UNCTAD*. https://unctad.org/press-material/global-foreign-direct-investment-projected-fall-40-2020-says-un-report

United Nations. (2020). *Closing the infrastructure gap | United Nations*. https://developmentfinance.un.org/closing-the-infrastructure-gap

United Nations Department of Economic and Social Affairs (2018). *World Urbanization Prospects: The 2018 Revision*. https://doi.org/10.18356/b9e995fe-en

Willar, D., Waney, E. V. Y., Pangemanan, D. D. G., & Mait, R. E. G. (2020). Sustainable construction practices in the execution of infrastructure projects: The extent of implementation. *Smart and Sustainable Built Environment*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/SASBE-07-2019-0086

Wilson Yu, A. (2018). *With buildings and infrastructure, it pays to take a life-cycle perspective* [Concrete Sustainability Hub]. MIT News | Massachusetts Institute of Technology. https://news.mit.edu/2018/life-cycle-perspective-for-buildings-infrastructure-0330

World Bank. (2016). *Investing in Urban Resilience Can Save the World's Cities Billions Each Year and Keep Millions out of Poverty*. World Bank. https://www.worldbank.org/en/news/press-release/2016/10/12/world-bank-investing-in-urban-resilience-can-save-the-worlds-cities-billions-each-year-and-keep-millions-out-of-poverty

World Bank. (2018) *What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050.* https://openknowledge.worldbank.org/handle/10986/30317

World Bank. (2020). *Infrastructure financing in times of COVID-19: A driver of recovery*. http://pubdocs.worldbank.org/en/424911600887428587/Infrastructure-financing-in-times-of-COVID-19-A-driver-of-recovery.pdf

World Economic Forum. (2014). Strategic Infrastructure: Steps to Operate and Maintain Infrastructure Efficiently and Effectively. http://reports.weforum.org/strategic-infrastructure-2014/

Xia, B., Rosly, N., Wu, P., Bridge, A., & Pienaar, J. (2016). Improving sustainability literacy of future quantity surveyors. *Smart and Sustainable Built Environment*.

Xia, B., Zuo, J., Wu, P., & Ke, Y. (2015). Sustainable construction trends in journal papers. *Proceedings of the 19th International Symposium on Advancement of Construction Management and Real Estate*, 169-179.