T20 INDONESIA 2022 THINK

Policy Brief

THINKING 'OUTSIDE THE BOX' ON INFRASTRUCTURE PLANNING: LESSONS FOR DEVELOPMENT OF NEW CAPITAL CITY OF INDONESIA

Task Force 8

Inclusive, Resilient, and Greener Infrastructure Investment and Financing

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Abstract

Infrastructure enhances connectivity, integrates markets, promotes trade and investment and facilitates social progress. Since infrastructure projects involve high costs, a long gestation period, high perceived risks and strong developmental impact, planning infrastructure development should ideally reflect all the dimensions of engineering solutions and socio-economic prerogatives. However, dominant urban planning models focus heavily on engineering solutions, e.g. design and beautification, rather than the city's organic social and economic life. Unless addressed, the rapid pace of urbanisation and ensuing climate change could put tremendous pressure on the infrastructure space and funding. Extreme weather events, coastal erosion, mangrove losses, etc., are manifestations of the negative effects of construction in cities, especially in coastal cities. New cities or expansion of existing cities need to factor these concerns in planning. This policy brief attempts to capture the need, importance and utility of 'out of the box' thinking in infrastructure planning, and draws lessons for the new capital city of Indonesia that is being developed.

Challenges

Infrastructure remains at the core of the development process as it unleashes the untapped economic potential of countries across the world. Infrastructure-development linkages are manifested in business expansion, industrial production, job creation and the integration of rural-urban markets. Given the strong multiplier effects on economies, most Group of 20 (G20) countries assign high priority to promoting infrastructure investments in different sectors of the economy. Demand for urban infrastructure, in particular, has grown significantly due to the rapid expansion of cities and the attraction of cities as centres of business and employment. The proportion of the population living in cities is expected to rise from 55 to 68 percent by 2050 (UN, 2018). Unlike the existing built-up area of cities, the expanded areas of existing cities or the new cities need investment in digital infrastructure like cable lines, optical fibre networks and internet facilities. Besides demand for new infrastructure and maintenance of ageing infrastructure, infrastructure development schemes often miss important planning caveats resulting in the greater vulnerability of cities to natural disasters, environmental pollution, and improper solid waste management. Infrastructure planning in coastal cities needs specific attention as it brings the additional risks of coastal erosion, sea level rise and marine litter, among other issues.

It is not surprising that besides climate change related impacts, unplanned construction, especially in urban areas, also amplifies the adverse impact of extreme weather events, if not as the root cause itself. By not having adequate protection infrastructure, extreme weather events such as floods, cyclones and storms leave a devastating impact in the form of loss of life and economic damage. India, for example, incurred US$6.1 billion in damages resulting from the droughts, floods and storms that occurred in 2018 (OECD, 2021). When Hurricane Dorian made landfall in the Bahamas in 2019, it caused at least 70 deaths, with losses and damages estimated at a quarter of the Bahamas' gross domestic product (GDP) (Zegarra et al., 2020). Table 1 presents the magnitude of losses caused by climate change-induced disasters during the period 1970-2019.

Table 1: Regional losses and damage due to climate-change induced disasters (storms and floods), 1970-2019 (cumulative)

Region	Losses and Damage	
	Economic (in US$ Billion)	Human (lives lost)
Africa	5	731, 747

Asia	2000	975,622
South America	39.2	34,854
North America, Central America & the Caribbean	1700	74,839
South West Pacific	163.7	65,391
Europe	476.5	159,438

Source: UN (2021)

In addition to climate change, population growth and urbanisation can also contribute to losses from floods, through damage to flora and fauna, destruction of water bodies in coastal cities and forced community relocations etc, to the magnitude of US$52 billion per year by 2050, averaged across 136 of the world's largest coastal cities (OECD, 2018). It is predicted that by 2050, over 570 low-lying coastal cities will face sea level rise of at least 0.5 meters resulting in over 800 million people living in areas with an increased risk of storm surge (IUCN, 2020). According to the World Cities Report 2020, the combined threat of rising sea levels and storm surge in coastal cities could result in the loss of more than US$1 trillion every year by 2050 through the destruction of key infrastructure, assets and property.

Table 2: Top 20 countries (settlement area) by flood hazard level

Netherlands	Vietnam	Laos	Bangladesh	Fiji
Bhutan	Japan	Switzerland	Egypt	China
North Korea	Austria	Bosnia & Herzegovina	Croatia	Montenegro
Sudan	Slovenia	South Korea	Myanmar	Albania

Source: Rentschler et al. (2022)

A study by Rentschler et al (2022) suggests that urban settlements across the world are expanding into hazardous flood zones. Using data from the World Settlement Footprint Evolution (WSF-Evo), the study finds disturbing trends including in advanced countries. As per the study, urban settlements across the world grew by 85 percent between 1985 and 2015 while expansion into areas with the highest flood hazard level increased by 112 percent in the same period, characterising a phase of urbanisation called 'risky growth outpacing safe growth'. Table 2 lists the top 20 countries with settlement areas that are highly exposed to flood hazards. While this pattern could be attributed to congestion in safe areas, migration to urban areas, behavioural biases, market failure and information constraints as possible factors of known planning flaws, the problems in city management often to be blamed as most of these developments originate from locally determined patterns of urbanisation and spatial development. Instead of adapting to climate shocks, cities are expanding into riverbeds and flood plains. In the Indian city of Chennai, unusually high rainfall in 2015 and 2021 caused severe floods in the city choking the city drainage system and causing a number of deaths and human suffering. Many attribute this failure to the expansion of the city in low lying areas. New Orleans in the United States and coastal towns in Vietnam are some examples of unplanned (or under-planned) expansion. It matters for infrastructure as floods and other natural disasters could wash away physical infrastructure. Some of these challenges are real, hence necessitate a paradigm shift from a “business as usual” approach to infrastructure planning and development to a new integrated narrative. Infrastructure planning across sectors like roads, railways, ports, urban utilities and industrial areas needs to suitably factor in the major drivers of change – rapid urbanisation, the threat of environmental pollution and climate change, demographic change, digitalisation, among others.

As many countries are planning new capital cities or new cities, including the new capital city of Indonesia, some of the challenges that are discussed here could perhaps be addressed in those cities.

Proposals for G20

Taking into account the challenges mentioned above, infrastructure development needs to follow a well-crafted roadmap including a blend of engineering solutions, environmental concerns, dependence on infrastructure, etc that supports cities as centres of economic activity and addresses societal concerns like inclusivity and disability-friendly solutions. Indonesia's new capital city could offer some solutions to these challenges and form a basis for replication and further reflection in other countries. Resilient and adaptive infrastructure needs to include systemic thinking, flexibility and inclusive decision making. Robust safeguards to protect the environment and affected communities are needed amid the risk of climate change-induced extreme events. The nature of the construction of buildings, physical infrastructure and utilities; the resettlement of people and financing solutions at the federal, sub-national and local levels need to be effectively dealt with. This should include inclusive urban planning and design in coastal regions as well.

A new paradigm of infrastructure planning should envisage cities as "engines" of the economy and incorporate mitigation and adaptation procedures like land management, reducing the disaster risk cycle, confronting extreme weather events and sustainable territorial development (UN-ECLAC and UN Habitat, 2016). A future urban "green" city needs to rethink the classic infrastructure project life cycle and incorporate "out of the box" solutions. With this perspective, we suggest some of the following ideas for the G20 to act upon.

Smart Infrastructure

Cities should function as an integrated system and support zero-carbon policy, through integrating various technologies and optimising the infrastructure performance by promoting eco-friendliness and improving socio-economic outcomes (Riffat et al., 2016). The Global Infrastructure Hub provides a "green planet" strategy that suits this concept. Environmental preservation is the primary determinant of social and economic values, driving the infrastructure industry to revolutionise the circular economy (CE) principle (Global Infrastructure Hub, 2020).

"Green" city development needs to consider the extension of the life cycle of the built environment by implementing proper maintenance and retrofitting to sustain it as long as possible (Institute for Human Rights and Business, 2019) (see Figure 1):

Stage-1: Land acquisition processing should consider the indigenous people and cultural rights with principles of free, prior and informed consent (FPIC) applied in urban and rural areas. The spatial plan should put environmental factors as the main priority.

Stage-2: Next stage follows planning and financing adequate residential areas, transportation and public infrastructure, climate change and disaster resiliency with transparent funding. The planning and design phase should emphasise the need to follow the United Nations Declaration on Human Environment to achieve urban sustainability. Human dwellings and activities should be planned to circumvent negative impacts and augment social, economic, and environmental benefits (Fu et al., 2017).

Stage-3: Civil architecture infrastructure design should consider social awareness, low energy consumption, affordability and lifecycle of the infrastructure itself.

Stage-4: Managing the construction process is key so that it promotes healthy business conduct, transparent supply chain contracts, minimal disruption to local communities and ensures that infrastructure has structural integrity and is disaster risk resilient and environmentally friendly.

Stage-5: The operation, management and maintenance of the infrastructure system should mitigate all risks related to environmental pollution, human rights exploitation, misuse of technology, safety and security risks, and the breaching of privacy and data protection.

Stage-6: Demolition and redevelopment should incorporate CE principles to take into account the project legacy and end-use phase.

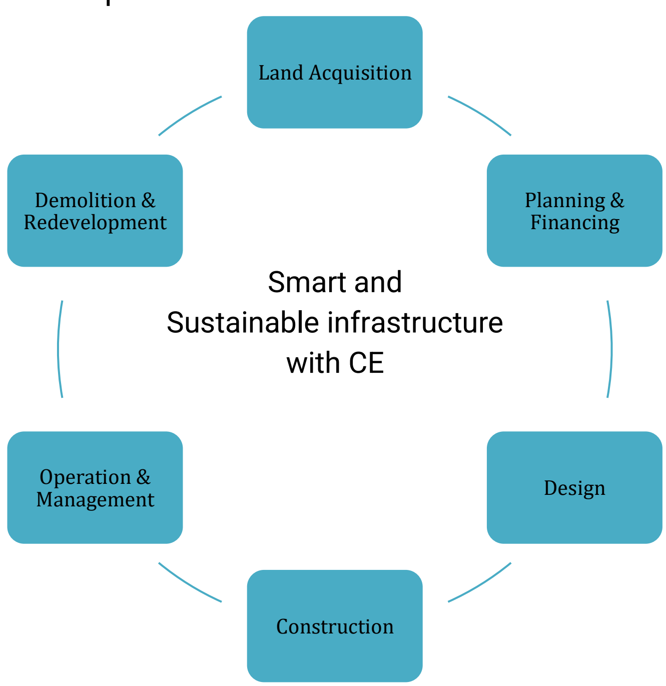

Figure 1: Lifecycle stages for smart and sustainable infrastructure with CE

Circular economy and modular construction

In shifting to a circular lifecycle, it is necessary to adopt construction methods that support the sustainable development goals (SDGs). Many studies have shown that modular buildings provide a better life cycle performance (Kamali and Hewage, 2016). Selecting a construction method should take into account the benefits and drawbacks based on the economies of scale and local circumstances. The technology that is considered suitable for smart and sustainable construction is modular construction technology (Iacovidou et al., 2021).

CE adoption means transforming linear pattern infrastructure models into a closed loop pattern. A CE allows the operator to manage uncertainties during the operational phase and the facilities by reusing or recycling. A clear long-term vision covers incorporating customer requirements, promoting CE business from small to large industries, implementing cohesive policy support for the CE concept, promoting an integrated modular approach and improving digital resources and automation capabilities (MacKenbach et al., 2020). The drivers, enablers and barriers for implementing modular construction are presented in Figure 2.

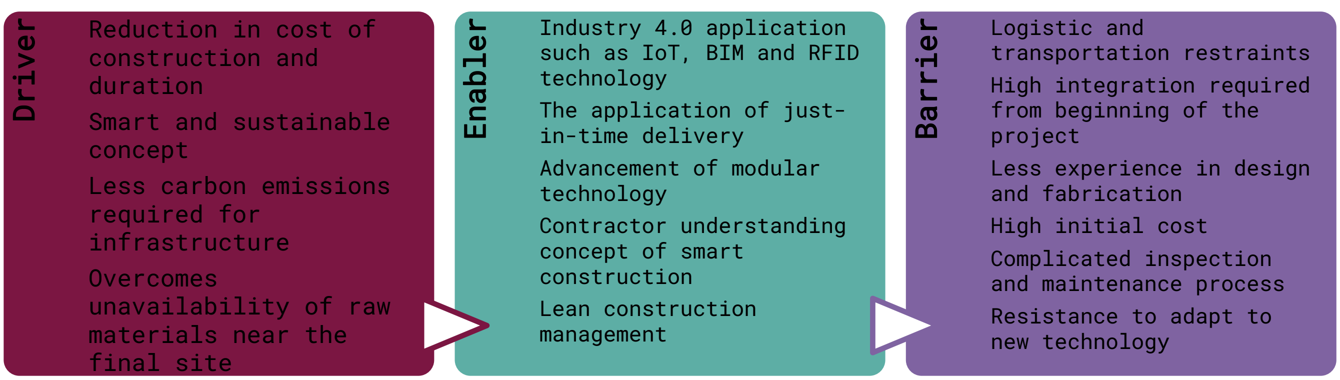

Figure 2: Drivers, enablers and barriers of modular construction

Sources: Kamali and Hewage, 2016; Liu et al.,2019; Nanyam et al.,2017

Using modular construction in urban "green" cities promotes digital, smart and sustainable infrastructure. Modular construction can accommodate intelligent energy management and minimises the requirements for heating, hot water, air conditioning and large ventilation systems.

Promoting reliance on renewable energy

The development of renewable energy marks a faster evolution of low-cost carbon systems. Each nation may have different potential renewable energy resources. Hydropower, bioenergy and waste-to-energy are considered important for supporting cities to achieve their renewable energy targets and to support energy transition. In comparison, wind, solar and geothermal energy are still emerging in many countries (IRENA, 2020). Predicting and mapping suitable renewable energy sources should consider the geospatial information and compatibility criteria, or potential factors by adopting a multi-criteria decision making (MCDM) based assessment and geographical information system (GIS) technology.

Freely accessible data for resource assessment, such as through SOLARGIS, the Global Wind Atlas and the Global Solar Atlas, combined with GIS software such as QGIS, gvSIG, SAFA and PostgreSQL/PostGIS allow the detailed analysis of renewable energy resources with a huge amount of geographical data (Díaz-Cuevas et al., 2021). Resource mapping is only the initiation stage, before moving to the provision of intelligent and cleaner powered transportation infrastructure and integrating a CE for waste management into a renewable energy target (RET) system such as biomass or a waste-to-energy power plant system.

Integrated Coastal Zone Management

The blue economy is considered a driving force in the green economy to manage sustainable coastal or marine area development as part of the urban system. Integrated coastal zone management (ICZM) and the blue economy allow countries to invest in policies and strategies for sustainable development and tourism, catalyse green investment, restore and protect coastal natural habitats, ramp up aquacultures and modernise fisheries (Panuccio, 2019).

ICZM projects should be supported with proper policies to regulate climate change, water purification, coastal erosion control, disturbance regulations, pollination, noise reduction and air purification (De Andres and Barragan, 2017). Coastal area and deep-sea environmental management should be considered as accumulative human and climate change impacts, as the global responsibilities demand the collaboration of all stakeholders. An ICZM aims to improve the ecosystem's health, strengthen the control of microplastics in the oceans, create a responsible community for marine environment protection, and the sustainable development of oceans and human beings (Wenhai et al., 2019).

Urban "green" transition

The pathway of transitioning to green should support sustainable urbanisation, encourage innovation and ensure sustainable consumption and production. It would be seen as a contribution to achieving the SDGs, especially SDG-9: Industry, innovation and infrastructure, SDG-12: Responsible consumption and production and SDG-13: Climate action.

The framework proposed for the urban green transition is exhibited in Table 3.

Tabel 3: Proposed framework for urban green transition

	Economic dimension	***Social dimension***	***Environmental dimension***
Physical infrastructure ➢ *Spatial Distribution* ➢ *Transportation Infrastructure* ➢ *Connectivity*	**Integrated function** ✓ Efficient and compact layout ✓ Disaster risk resilience ✓ Urban-rural integration	**Cultural consideration** ✓ Local customs ✓ National identity and dignity ✓ Improving Human Development Index	**Ecological improvement** ✓ Ecological diversity ✓ Efficient energy consumption
Capital & technology ➢ *Key resources* ➢ *Information technology*	**Green value chain** ✓ Circular economy ✓ RET transport infrastructure ✓ Green industries and public sectors	**Social adaptation** ✓ Technological ethics ✓ Community engagement with positive modern technology ✓ ICT literacy	**Ecological restoration** ✓ Net-zero carbon policy ✓ Suitable RET ✓ Adaptation of CE policy (reuse and recycling) ✓ Wastewater treatment
Stakeholders ➢ *Government* ➢ *Industry* ➢ *Residents* ➢ *Urban hinterland*	**Synergy strategy** ✓ Green climate fund ✓ Decentralisation blockchain ✓ Positive economic externalities	**Sustainability education** ✓ Strong governance ✓ Visionary leadership ✓ Corporate social responsibility ✓ Social inclusiveness	**Long-term sustainability** ✓ People's comfort and welfare ✓ Low ecological footprint ✓ Positive environmental externalities

Source: Adapted from (Fu et al., 2017)

Other urban engineering solutions can be leveraged to make infrastructure climate-resilient. This includes improved equipment/materials in construction and operations and environmentally optimised road designs using local and marginal materials to reduce the cost of the lifecycle, increase durability and improve the long-term performance of infrastructure. For instance, permeable paving material can accommodate the risk of floods. Additionally, it must be ensured that coastal construction happens away from the high-water mark by establishing a development setback line.

Protective hard infrastructure such as seawalls and breakwaters can be useful in mitigating disaster risks. While hard infrastructure may be the most feasible or cost-effective approach in certain contexts such as highly dense cities, building and maintaining hard infrastructure across all exposed coasts is not financially viable and may be technically impossible. Hard infrastructure also negatively affects biodiversity and coastal ecosystems, further increasing coastal vulnerability. This is where nature-based solutions come in.

> ***Nature-based solutions (NBS) as defined by the International Union for Conservation of Nature (IUCN) as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits" (IUCN, 2016),*** represent an integrated approach to deliver environmental value across the urban-rural continuum (UN Habitat, 2020). This can take the form of restoring coastal ecosystems (wetland restoration), floodplain restoration and managing rewilding. However, integrating hard coastal infrastructure with nature-based solutions can achieve the requisite balance between urban development and coastal biodiversity. Coastal ecosystems can dampen waves, attenuate water flows and flooding, reduce stormwater runoff and build up coasts by contributing to the processes that generate, trap and distribute sediment across shorelines — protecting, restoring and maintaining natural systems like mangroves and water bodies act as a cost-effective natural cushion against the adverse impacts of natural disasters by dampening waves and reducing storm surge and flood depth. Seagrasses can attenuate waves and stabilise sediments. Coral reefs dampen waves and supply and trap sediment. Dunes can act as natural dikes that reduce exposure to flooding, and coastal forests act as windbreaks. Restoration and conservation of coastal psamophilous forests associated with dune and wetland systems in the coastal zone can also reduce the impact of natural calamities (UNESCO-IOC, 2021). Management of exotic species (acacia, eucalyptus, pines) can reduce the risk of falls and fires and facilitate dune regeneration. Renaturation of ravines and coastal wetlands can go a long way in designing sustainable urban drainage systems.

The "science" of creating living shorelines as a nature-based solution is relatively new and is generally limited to low energy shorelines and offers little protection against major storms. Alternatives for high near-shore energies are "hybrid" designs that represent a compromise between nature-based infrastructure and engineering solutions that allow processes at the land-water interface to be sustained while providing a viable habitat for aquatic systems.

All new investments into transportation, logistics, renewable energy grids and data and communications infrastructure need to be designed to address adaptation and transition challenges.

Financing

Scaling up investments in sustainable and resilient infrastructure cannot be achieved solely through public sector funding. Given the limitations of public sector financing of infrastructure, large scale implementation of nature-based solutions (and green/gray infrastructure) and hybrid solutions require de-risking investments to attract private investment. To do so, mechanisms such as "first-loss guarantee" and "off-take agreements" can be used (IUCN, 2022). In a first-loss agreement, a third party (usually international financial institutions) guarantees that the lender (such as a commercial bank) gets compensated if the borrower (local government, for example) does not deliver on the project. Under off-take agreements, future benefits from the project are sold beforehand to serve as funding for the project. This can de-risk the NBS projects and enhance profitability, especially for projects that require large investments.

Blended finance offers incentives to private players and can be used to de-risk NBS projects by funding feasibility studies. New and unique blended finance solutions such as the 2018 Seychelles Blue Bond, which used a concessional loan from the Global Environment Facility (GEF) to cover coupon repayments, and a repayment guarantee from the World Bank for part of the principles can be devised. Other than that, alternative and innovative procurement models can also help distribute risks among those involved in an infrastructure project. Programmes such as the UN Biodiversity Finance Initiative (BIOFIN) can help in de-risking large scale investments. Through the BIOFIN framework, integrated green-grey infrastructure projects could attract funding to improve the evidence base while measuring national-scale biodiversity and providing resilient climate infrastructure.

The current contribution of Multilateral Development Banks (MDBs) and Official Development Assistance (ODA) on coastal and riverine infrastructure projects does not reflect the importance of sustainable coastal infrastructure. MDBs can play an important role in attracting private investors. They can either act as a catalyst in ensuring that the risks for investors remain bearable or as a trailblazer creating new markets and demonstrating the potential for new investments. For large-scale, long-lived infrastructure projects, various delivery models could be envisaged covering the catalyst role, including long term concessions or public-private partnership (PPP) models. These are more likely to generate income over the long term, and therefore be not just environmentally but also financially sustainable, and generate government revenues through taxes. MDBs can be honest brokers between governments and the private sector, enabling investment structuring that considers the country's needs and the investors. Alongside project preparation and structuring support, catalytic capital from public sources and philanthropy can be used in blended finance to increase private sector investment in sustainable infrastructure (IUCN, 2020).

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