InfraTech Value Drivers & InfraTech Policy Toolkit

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WORLD BANK GROUP

BACKGROUNDS

G20 Riyadh InfraTech Agenda

- Infrastructure Working Group under G20 endorsed the Riyadh InfraTech Agenda
- WB supported the development of InfraTech Agenda and issued two reference notes to support the Agenda: InfraTech value drivers and InfraTech Policy toolkit
- The focus was to highlight the **important role technology can play in helping countries make well-informed decisions and achieve more efficient financial outlays, by mobilizing private sector investment, by enhancing service delivery and by achieving environmental, social and economic benefits.**
- The Riyadh InfraTech Agenda provides **high-level policy guidance** for national authorities and the international community, including MDBs and IOs, to advance the adoption of new and existing technologies in infrastructure.
- The Agenda aims **to harness technology to deliver quality infrastructure investment; promote inclusive, accessible, sustainable, and affordable infrastructure in view of lifecycle costs; mobilize private-sector financing; and support the development of infrastructure as an asset class.**
- This guidance includes a set of **voluntary, non-binding elements.**

6 Elements of Riyadh InfraTech Agenda

1. Leverage InfraTech to enhance economic efficiencies and mobilize private sector investment to promote growth and sustainability
2. Promote technologies that foster inclusivity, sustainability, resilience, and good governance
3. Accelerate innovation and economic dynamism in InfraTech related industries to support economic recovery and growth
4. Foster a robust data ecosystem to improve resilience and better inform infrastructure planning, operation, maintenance, and investment decisions
5. Develop agile and flexible policy tools that promote potential growth, productivity and innovation while mitigating risks
6. Promote national and international cooperation in R&D and knowledge sharing

INTRODUCTION

Benefits of Using InfraTech

- **First, improving efficiency and reducing costs through enhanced analytical functions, better data management and flow of information.** Traditional approach looks at each input and output in isolation. InfraTech can connect multi-sourced data leading to cost savings across the lifecycle of the asset. This approach can support governments in better planning, decision making and implementing just in time solutions.

- **Second, Infratech can enhance economic, social, and environmental aspects by providing a cross sectoral view.** For example, there may be similar issues affecting local communities across various projects, which are most likely run by more than one government agency. By collecting the information using technology across the board, service providers can target specific areas of improvement to enhance social and environmental outcomes; instead of using project by project approach.

- **Third, the use of InfraTech can reshape demand and create new markets.** We are already seeing the new ways of living and doing business in COVID19 world. Adoption of InfraTech can support governments to be ready for the rapid changes under the new normal. Use of technology can create demand for new infrastructure services that previously did not exist (e.g. mobility as a service, charging of electric vehicles); and reduce demand for traditional infrastructure services that are superseded by another technology (e.g. 3D printing, 5G eliminating traditional forms of connectivity)

InfraTech is also essential in responding to the COVID-19 health and economic crisis through

- Enabling the data collection and advanced analytics needed for **evidence-based public health and economic policy decision-making;**
- **Maintaining economic and social activities (e.g., education)** during social distancing through connectivity and digital solutions;
- Helping ensure **continuity of essential energy, utilities, transport, and telecommunication services** by better targeting maintenance interventions, extending the life of existing assets and developing new modes of service delivery;
- Enabling effective monitoring of and support to **food and production supply chains**; and
- Upgrading **the safety and resilience of logistics and transport lines** to maintain an unobstructed flow of goods and to ensure that global supply chains and transport corridors remain efficient.;
- **Reshaping the healthcare system** with technology during social distancing in a shorter period and at a lower cost; (e.g., drones can transport blood)

Challenges and Risks of InfraTech

- **The potential benefits** of InfraTech options will need to be **weighed against the upfront capital investment or recurring costs, long-term returns, and societal benefits in a balanced way.**
  - While some InfraTech opportunities may come with relatively low upfront costs, other investments come with upfront costs that may be prohibitive for some countries or regions. However, **costs and benefits of InfraTech options are rapidly evolving given changes in technology maturity curves and the context in which the technology is applied.** Pandemics such as COVID-19 demonstrate that investments in connectivity and data-related technologies are even more essential
- **Transformation will not be uniform**. It will be driven by **a complex interplay** between **different sector requirements, specific location adoption readiness, the technology maturity and market dynamics.**
- **There will not be one-solution fit for all.** There will be **risks** involved. Governments could face **implementation risks on timing of technology versus infrastructure itself**, **procurement guidelines** may not be enough to include latest requirements
- **Economically, there will be a transition**. Process automation, sensors and AI are just a few of the technologies that will have human capital impacts **and potential job losses** associated with their implementation.
- **Socially,** this could **widen the digital divide** and **intensify issues such as data ownership, monetization, sharing, trust, security, privacy and its use for the public good.**

What is InfraTech

Infrastructure technology or InfraTech, can be described **as the integration of material, machine, and digital technologies across the infrastructure life cycle.**

At its broadest definition, InfraTech can be considered **any technology that impacts the development, delivery, and ongoing operation of infrastructure**

This may include technologies used to **define the strategic requirements of infrastructure** or **enable data-driven decision-making**, **innovations in finance and funding that support the commercial management of an asset**, or **technologies integral to the relationship a customer has with infrastructure services**

Use Case	Description	Sector	Technology Type	Case Studies and Locations	Relevant to COVID-19 Response?
Intelligent process optimization for water treatment	AI driven data analytics to treat water to a better standard and reduce operational costs by up to 10%	Water	Analytics AI augmentation Digital twins	• Createch360 usage in Brembate wastewater treatment plant, Italy • Emagin HARVI usage in the City of Calgary in Canada	✓
Automated pre-fabrication of stainless steel pipelines	Automation of labor-intensive pre-fabrication processes to reduce time, costs, waste and enhance worker safety	Water	Construction automation	• K-TIG usage in The Acueducto Gran San Juan project, Argentina	✓
Automated robot cranes for Ports	Automation of crane operations in ports to reduce the operational costs and increase capacity while also providing a safer working environment	Transport	Sensors Cameras/CCTV IoT	• Automated Container Terminal in Shanghai, China • Automatic Stacking Cranes in Port of Brisbane, Australia • Neo-Panamax ship-to-shore cranes at the Victorian International Container Terminal in Melbourne, Australia	✓
Sensors and Robotics for Bridge Maintenance	Sensors, robotics and special dehumidifying system to reduce bridge maintenance costs and increase the asset life of bridges ** This use case is a contribution from the D20 Long Term Investors Club*	Transport	Sensors Analytics IoT Construction automation	• Genoa bridge over Polcevera river, Italy	
Electronic Tolling	Electronic tolling technologies to optimize transport efficiency and increase toll revenues ** This use case is a contribution from the D20 Long Term Investors Club*	Transport	Cameras/CCTV Analytics IoT	• DarsGo electronic tolling system, Republic of Slovenia	✓
Dynamic Road Pricing	Dynamic pricing to optimize traffic flows, enhance revenues and reduce congestion ** This use case is a contribution from the D20 Long Term Investors Club*	Transport	Cameras/CCTV Analytics IoT	• Dallas-Fort Worth region highways, North America • Stockholm Dynamic Congestion Zone, Sweden	
Satellite Based Navigation to Optimize Traffic Flows	The use of GPS and other technologies to track and guide public transport to enhance its safety and efficiency ** This use case is a contribution from the D20 Long Term Investors Club*	Transport	Communications Analytics	• RNIS real-time control system in the Moscow Region, Russia	
Predictive maintenance of physical assets	Sensors and data analytics to monitor assets and predict maintenance requirements, thereby reducing operational costs and extending the life of assets	All	Analytics	• Data61 pipe failure prediction in Sydney, Australia • Voda AI software for pipe monitoring in Florida, USA • Movus machine condition monitoring in Brisbane, Australia	✓
Knowledge access platforms for construction and maintenance	Digital knowledge platforms and devices to create a single 'source of truth' for construction data, thereby increasing efficiency, reducing costs, minimizing waste and providing safer working environments	All	Analytics Wearables Distributed ledgers	• Hindsite knowledge management platforms in Sydney and Melbourne, Australia • RedEyeDMS platform in Southern Nevada, USA	
Augmented and Virtual Reality for Training and Inspection	Utilizing the latest visualization technologies to enhance worker training and provide greater access to information on	All	Analytics IoT	• AR for safety inductions at the Sydney Metro, Australia	✓

INFRATECH VALUE DRIVERS

Reference Note| InfraTech Value Drivers

Objective: This Reference Note supports the InfraTech Agenda endorsed by the G20 Infrastructure Working Group by **outlining the potential economic, social and environmental value to countries by adopting InfraTech solutions**. It also provides **a framework for evaluating the benefits of these solutions against their costs and risks.**

Key Messages:

1. InfraTech can help countries mount **an effective public health and economic response to COVID-19**
   - Broadening access to digital connectivity
   - Leveraging AI and big data
   - Promoting maintenance of critical infrastructure
   - Enhancing safety of transport and supply chains
2. InfraTech offers **the opportunity to realize significant economic, social and environmental value across the lifecycle.**
3. Countries can **prioritize adoption of InfraTech solutions depending upon cost, technology readiness, existing applications, and country readiness.**
4. Infratech also brings **significant new implementation, economic, social and environmental risks that need to be managed.**

Understanding InfraTech

The accelerated adoption and successful application of InfraTech is a key factor supporting all nations to address such major issues as climate change, the UN's Sustainable Development Goals (SDGs) and the growing pressures to deliver on the economic and social commitments through the innovative use of new and existing infrastructure.

Cost reduction	• InfraTech offers the opportunity to deliver **financial cost reductions, improved asset efficiency** and will be critical in bridging the projected **global infrastructure funding gap.**
Data to intelligence	• The ability to turn **complex and often unrelated data into infrastructure intelligence** will drive much of the early value from InfraTech and develop the platform for its ongoing success.
Blurring boundaries	• InfraTech is starting to blur the traditional infrastructure **boundaries of lifecycle, location and sector** to support new asset ecosystems to access increased pools of value.
Advancing the QII Principles	• InfraTech is critical advancing the **Quality Infrastructure Investment Principles.**
Balancing risks, rewards, and costs	• **Key challenge for governments is finding the right balance to managing transformation risk and incentivizing industry to change.**

Key Technologies that Drive Value for Infrastructure

Outlined below is the aggregation of technologies into **categories based on their key value proposition for infrastructure**. These categories allows us to **articulate more effectively the multiple InfraTech value propositions across the asset lifecycle which impact infrastructure delivery.**

Connectivity & Communica-tions	Analytics & Computation	Cloud & Data Storage	Devices & Automation	Platforms & Interfaces	Materials, Energy & Construction
Wired or wireless technologies that connect people or devices and enable data transfer.	Advanced analysis that uses machine learning to process large amounts of unstructured data.	Tech solutions that enables efficient mass movement and storage of large data sources.	Physical interfaces and components that perform specific tasks or enhance automation.	Complex systems combining multiple technologies or have whole of system design thinking.	Applied science and engineering directly related to efficiency or quality for OPS and construction.
▪ **Broadband (e.g. 5G Mobile)*** ▪ LEO Satellite ▪ Wireless ▪ Industrial IOT ▪ **Sensors / IOT*** ▪ GIS / GPS	▪ Big Data ▪ Data & Analytics ▪ AI Augmentation ▪ Auto Cognitive ▪ Edge Computing	▪ **Cloud*** ▪ HD Video ▪ BIM	▪ Robotics ▪ UAVs (e.g. Drones) ▪ Sensors / IoT ▪ Batteries ▪ Wearables ▪ Biometrics	▪ **Cybersecurity*** ▪ Autonomous Cars ▪ Fintech and DLT (e.g. Blockchain) ▪ AR/VR ▪ Digital Twin	▪ 3D Printing ▪ 4D Printing ▪ Nano-materials ▪ Modular Construction ▪ Concentrated Solar Power

■ Foundational technology

Three Types of Value Created by InfraTech

1	**Improving efficiency and reducing costs** through enhanced analytical functions, data management, communications and automation are producing material cost savings across the lifecycle of the asset. New data driven decision making with faster decision cycles and alternative service solutions will be multiply the value in both greenfield project delivery and brownfield asset prolongation.
2	**Enhancing economic, social, and environmental value** by connecting service offerings across sectors will unlock new pools of customer value and generate new or alternative revenue streams**.** These will create not just economic value through market exchanges, but also create positive externalities in terms of improving social and environmental impact compared with traditional infrastructure services.
3	**Reshaping demand and creating new markets** has the potential to change the underlying mechanics of an infrastructure demand model through two models: i) creating demand for new infrastructure services that previously did not exist (e.g. mobility as a service, charging of electric vehicles); and ii) reduce demand for traditional infrastructure services that are superseded by another technology (e.g. 3D printing, 5G eliminating traditional forms of connectivity)

However, InfraTech adoption may also result in significant up-front or recurring economic, social, or environmental costs that may reduce the net value ultimately achieved

Technology Maturity, Roll-out Complexity and Country Readiness

A key challenge in capturing the value of InfraTech is managing the inherent **diversity and complexity, technology maturity, sector-based applications and adoption readiness** are all key factors and constraints that inform the pace of InfraTech adoption. When and how value will be realized will depend on three key areas.

1	**Technology maturity:** the level of technology maturity, from both a technical and commercial perspective, will impact the rate of adoption, the risk of implementation, and the cost structure of the technology
2	**Roll-out complexity:** the scale and implementation risks associated with the specific technology roll out will may increase costs and risks of different technologies
3	**Country adoption readiness:** the following criteria are key to a country's ability to realize value: ▪ **Knowledge** which covers a country's ability through its talent base, education, and relevant organizations, to analyze and develop new technologies ▪ **Technology** as a contextual framework (regulatory, technological, etc.) for the development of technologies ▪ **Future readiness** as it pertains to the level of IT integration into the economy and the country's business agility

Key risks to Achieving Potential Value

Implementation Risks	• **The transformation will not be uniform**. It will be driven by a complex interplay between different sector requirements, a specific location adoption readiness, the technology maturity and market dynamics. • **Delivery differences between infrastructure and technology cycle times** for both innovation and adoption of disruptive infrastructure technology are materially different to the cycle times for infrastructure development itself. • InfraTech **procurement capabilities require agile and flexible management approach** required to continually develop viable technology solutions. • **Public-sector skills gap** must recognize and plan for the fact that the role of government in infrastructure is materially changing.
Economic risks:	• Process automation, sensors and AI are just a few of the technologies that will have **human capital impacts and potential job losses** associated with their implementation. • **Traditional business models may be disrupted** in favor of integrated ecosystems and new delivery models are being applied to increasingly diverse supply chains.

Key risks to Achieving Potential Value (cont'd)

Social risks:	• **Widening digital divide** if adoption exacerbates existing divides, including regional. • **Data's role in the changing nature of the social contract** will enable the data holder to have unprecedented knowledge on the movement and activity of its citizens. • **Solving the data challenges** around ownership, monetization, sharing, trust, security, privacy and its use for the public good.
Environmental risks	• **Increased energy costs** will have a material impact on a countries energy consumption. • New technology hardware is drawing on **scarce natural resources** where environmental and social standards along the supply chain may be lacking. • Some technology led solutions could lead to **higher rates of pollution** or worsening air quality. For example, ride sharing services have in some cities led to an increase in cars on the road.

Key Sector Trends

Digital	• The two major InfraTech trends in Digital are the increasing utility of **fiber**, a campus driven roll out of the new **5G mobile technology** which could unlock USD $4.3 trillion in value globally across a range of industries over the next 7 – 10 years.
Energy	• Technological advancements in the energy generation, storage, transmission and distribution are making power generation less expensive, more efficient and more environmentally sustainable.
Transport	• Future mobility with connected **autonomous vehicles**, **electric vehicles** and **mobility as a service**, is expected to generate USD$22 trillion in additional value across multiple sectors between now and 2030.
Water	• Technology advancements in the drinking water sector include **sensors** to ensure water is clean, **drone**s to inspect infrastructure, and **smart metering** to anticipate demands.
Cross-sectoral / Smart Cities	• Increasingly **cities and municipalities are a testing ground** for InfraTech integration. To achieve this change a focus on getting **the foundational elements of hyper connectivity, security and data governance, and storage in place** to support any form of major roll out.

INFRATECH POLICY TOOLKIT

Reference Note| InfraTech Policy Toolkit

Objective: This Reference Note supports the InfraTech Agenda by **outlining priority areas and tools for policymakers to implement the InfraTech Agenda.**

Policy Priorities:

1. **Play an active role in leading and enabling an inclusive InfraTech agenda,** including leading a technology led response to COVID-19
    - Improve enabling environment for digital connectivity
    - Employ data driven solutions and build the data ecosystem
    - Procure solutions that safeguard critical infrastructure services
    - Foster new business models that mitigate economic and social impacts
2. **Take a forward-looking approach to technologies and risks**
3. **Put data at the center across all infrastructure sectors**

Policy Levers:

1. **Legislation and regulation;**
2. **Procurement and contract management;**
3. **Funding and financing;**
4. **Effective institutions; and**
5. **A future-enabled workforce**

Cross-cutting Priorities

The policy toolkit establish basic set of principles which guide development of a set of cross-cutting government priorities at the outset to guide policymaking.

1	**Play an active role in leading and enabling the InfraTech agenda** in assessing the benefits and costs of various technologies and acting as both leaders and enablers for technologies with significant value potential.
2	**Take a forward-looking approach to technologies and risks** by designing regulation, legislation and procurement guidelines should be flexible and focused on outcomes and categorical rather than specific technologies.
3	**Put data at the center across all infrastructure sectors.** Data needs to be open and integrated to develop innovation and collaboration.
4	**Support sector convergence and systems particularly as cities** are set to be the focus of InfraTech development in the coming years. If established effectively, city systems will leverage InfraTech technologies, allowing far greater integration across different stakeholders and sectors.

Policy Tools and Required Change

Legislation and Regulation	• InfraTech adoption will require legislation and regulation that creates an enabling environment to **foster innovation and market growth** while **addressing information asymmetries, cyber security and data privacy concerns.**
Procurement and Contract Management	• To be better suited for InfraTech, governments must look to incorporate **flexibility and focus on outcomes, with a balance between local capacity and global expertise**.
Funding and Financing	• To mitigate this **perceived (or actual) higher risk of InfraTech projects**, an appropriate governance structure and clear decision making mechanisms are vital.
Building Institutions	• Institutions need to be equipped to change or adapt the regulatory environment to enable adoption of InfraTech.
Foster a Future Enabled Workforce	• Governments can address this issue through support for **training initiatives**, increased collaboration with educational institutions and industry and through global knowledge exchange.

A | Legislation and Regulation

Current policy, legislative and regulatory systems can provide roadblocks that hinder the adoption of InfraTech. These roadblocks include:

- Regulations are not keeping up with the **rapid pace of technological change**.
- Regulations are typically **risk-averse** and may inhibit the adoption of InfraTech.
- Technology is increasing the **risk of Information asymmetry with the private sector.**
- Regulatory approaches are typically **siloed** and not cross-sectoral.
- Local, national and international approaches are not aligned and lack international standards.

TOOLS (EXAMPLES)

- **Develop a national InfraTech plan to set goals**
- **Adopt data privacy and protection measures**
- **Create an enabling environment to foster innovation and market growth**
- **Address and reduce information asymmetry**
- **Establish cloud storage legislation and regulation**
- **Adopt cybersecurity measures**

Example | New tools and new regulatory structures are being developed among early public sector adopters. For example, following a series of high profile data breaches, legislators in Japan overhauled its Privacy Protection Law in 2015, and again in 2017. This led to the introduction of laws requiring organizations to obtain individual consent before using or sharing personal data with third parties and to notify the public of any data sharing.

B | Procurement & Contract Management

Existing procurement systems and contracts are designed for **long-lived assets with minimal changes assumed** in construction, operations or maintenance systems, or technologies.

At the same time, **emerging technologies are evolving and changing at a faster rate when compared to existing technologies, leading to dramatically shifting cost structures, risk profiles and delivery models over the life of the project.** These changes make it more challenging for governments to scope and assess proposals during the procurement process.

The nature of existing procurement systems lack incentives for innovation in either enhanced service delivery or lower costs.

TOOLS (EXAMPLES)

- **Collaborative procurement and contracting approaches**
- **Consider procurement models that balance the need to foster local capacity with global expertise**
- **Use technology to better develop and track outcome based metrics**
- **Incorporate consistent data management guidelines across infrastructure sectors**

Example | Governments should consider alternative options if neither public-private partnerships nor alliancing, where participants work to collaborate closely on cost savings and enhanced performance, fit a project. For example, the Municipal Innovation Exchange (MIX) project is led by the cities of Guelph, London and Barrie in Canada. Each of the three city governments is running an innovation procurement challenge, as well as looking at the potential for multi-city challenges. MIX will share best practice and lessons learnt with other municipal governments..

C. Funding and Financing

Financiers and funders assess the risk profile of a project prior to investing. Projects with a technology component, particularly where it is new technology, typically have a different risk profile than what is seen on a traditional infrastructure project. InfraTech projects can involve greater uncertainty, unproven outcomes, typically require a higher upfront investment and can change the operations and maintenance costs in a more unpredictable way than traditional project.

While the inclusion of technology does not make a project immediately unbankable, it may change the required returns, or protections requested by investors, and make the pool of financing and funding sources smaller - not all entities are comfortable with an uncertain, or different risk profile. To mitigate this perceived (or actual) higher risk of InfraTech projects, an appropriate governance structure and clear decision making mechanisms are vital.

TOOLS (EXAMPLES)

- **Sector subsidies**
- **Project level subsidies**
- **Adopt best practice PPP and governance structures to help ensure appropriate risk transfer among stakeholders**
- **Innovative financing solutions: technology companies providing financing**

Example | Microfinancing is an option for financing small-scale InfraTech projects, similar to the UN Capital Development Fund's CleanStart program using this method to support low-income households and micro-entrepreneurs in Africa and Asia in getting access to clean energy.

D. Effective Institutions

Current government institutions are not always appropriate in the InfraTech context. Government institutions often lack the appropriate structure to provide effective support to, and oversight of, InfraTech issues.

Institutions need to be equipped to change or adapt the regulatory environment to enable adoption of InfraTech. In particular, city governments need to consider the whole ecosystem, silos typically limit abilities to use and exploit data across institutions.

Effective institutions have an important role to play in fostering the adoption of InfraTech.

TOOLS (EXAMPLES)

- **Upgrade existing agency structures**
- **Financial incentives / infrastructure banks**
- **Create InfraTech-focused institutions**

Example | Institutional structures must be redesigned to embrace the increasing pace of innovation and to operate more effectively in a rapidly changing InfraTech climate. For example, Singapore's Energy Market Authority launched a framework for the testing of innovative products and services in electricity and gas. The framework supports companies before market introduction of innovative solutions through a "regulatory sandbox".

E. A Future-enabled Workforce

Governments can conduct surveys within the infrastructure sector to assess technology skills gaps.

The results of such surveys should help modify education and training based on what the industry needs, as well as increasing collaboration between educational institutions in achieving this.

Regulations are not keeping up with the rapid pace of technological change.

TOOLS (EXAMPLES)

- **Assess InfraTech skills gap and the impact on jobs**
- **Support training initiatives: offer grants and incentives for industry; enable online learning platforms; establish InfraTech training programs for civil servants**
- **Increase collaboration between educational institutions, industry and government**
- **Global knowledge exchange**

Example | Online education initiatives run by massive open online course providers and traditional universities include ‘microdegree’ and ‘nanodegree’ programs that provide low cost targeted training. For example, the Massachusetts Institute of Technology’s MITx MicroMasters program offers online courses in areas including supply chain management, finance, data, economics and development policy, which can be used to apply for accelerated master’s degree programs at MIT or other universities.

DISCUSSION

Infratech Value Drivers: https://openknowledge.worldbank.org/handle/10986/34320

Infratech Policy Toolkit: https://openknowledge.worldbank.org/handle/10986/34326