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Policy Brief

BIG DATA ANALYTICS FOR SAFE, DECARBONISED AND CLIMATE-RESILIENT INFRASTRUCTURE

Task Force 8

Inclusive, Resilient, and Greener Infrastructure Investment and Financing

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Abstract

This policy brief presents the possibilities of using big data analytics for safe, decarbonised and climate-resilient infrastructure. The policy brief focuses on current constraints and limitations to applying big data analytics to the infrastructure ecosystem and presents several examples and best practices for different infrastructure sectors and at different policy levels (national, municipal) to highlight recommendations and policy requirements needed for deep digital transformation and sustainable solutions in infrastructure planning and delivery.

Challenges

A technology-centric approach to establishing a data economy is not a panacea that will guide industry towards decarbonised and resilient infrastructure. Consequently, broader objectives of decarbonisation, resilience and human-centred infrastructure need to be considered.

Big data analytics require key infrastructure players to share data not only regarding single assets, but across the sectors. Promoting greater data sharing in the infrastructure sector could generate annual benefits such as a) more accurate resilience models, leading to reduced frequency, duration and impact of disruptive events, b) increased competition and development of advanced infrastructure services, savings for asset users and c) improved efficiency due to better capacity management, lower carbon emissions, higher productivity and performance, and lower costs and overall financial risks.

However, the main bottlenecks to the use of big data analytics and data sharing include:

- **Privacy and security** (e.g., data protection, vulnerability, system security). Across the infrastructure sector data is collected through geospatial tracking, payment, consumption and IoT devices. Any such data collection leads to potential concerns for individuals, firms and governments and sparks fears around privacy, perceived and real competition, cybersecurity, and ethical use of data (Lee, 2017).

- **Legal and national barriers** (e.g., adequate legal frameworks, asset user trust, IP rights, GDPR). A key gap in the use of big data analytics and sharing is represented by legal instruments used to restrict data sharing. Certain regulations, such as the General Data Protection Regulation (GDPR), which applies strict conditions for data sharing, might increase the cost of sharing data or dissuade users. Another barrier concerns a lack of adequate clarity around the lawfulness of data sharing and, specifically, whether and in what circumstances consumer consent is required (Deloitte, 2017). More broadly, the demand for digital sovereignty improves trustworthiness, but also increases the risk of protectionism.

- **Institutional and commercial barriers** (e.g., regulatory intervention, commercial sensitivities). Governments and infrastructure authorities often need to provide strong regulatory oversight to avoid potential consequences of incorrect data sharing. Traditional regulatory models are typically risk averse and may inhibit the implementation of modern data science in infrastructure (World Bank, 2020). Commercial barriers exist where data sharing and collaborative approaches are not implemented because the cost of sharing is perceived to be greater than the benefits, for instance when data shared by one firm is used by other firms without reciprocating with their own data.

- **Technological constraints** (e.g., data standards, resource limitations, interoperability, legacy IT). The adoption of data standards serves as the basis for enabling interoperability across the infrastructure industry, lack of interoperability standards or poorly enforced standards can complicate transactions and raise barriers to the information flow. Barriers to sharing also arise from technical barriers such as data not being digitalised, or stored only on legacy IT systems.

- **Cultural barriers** (e.g., fragmentation, siloed thinking, lack of understanding of benefits). Cultural barriers exist both within the private and public sectors, as different stakeholders might fail to recognise the benefits and positive outcomes of data and new technologies. Cultural barriers can also exacerbate trust issues and the belief that data should only be shared on a "need to know" basis, resulting in an excessively cautious view of privacy and security issues (Deloitte, 2017).

Ultimately wider adoption of digital technologies is hampered by the many actors and jurisdictions involved in infrastructure planning and delivery, lack of national standards and approaches, and lack of interoperability and economies of scale.

Proposals for G20

Adopting big data practices in (public) infrastructure and reducing barriers to data sharing in the infrastructure industry require action at all levels of government, including a collaborative and engaged approach from public institutions, infrastructure actors, civil society including academia, and third-party data users. The G20 case studies taken into consideration for this brief demonstrate that leading practices include:

A. Creating federated infrastructure data platforms and frameworks that follow a secure and data-sovereign governance structure, platform principles, design and protocols.

Open and federated digital platforms that combine the physical with the technological layer of infrastructure represent an opportunity to significantly improve value chain integration of development and delivery for the infrastructure sector. Platform-driven integration cannot only advance the symmetry of knowledge among stakeholders, but it can also spur innovation through ecosystem participation, and accelerate the achievement of the broader objectives of decarbonisation, resilience, and human-centred infrastructure (Bühler, Jelinek, Nübel et al., 2021). Several examples of sharing of these initiatives already exist both at the national and multinational levels.

G20 initiatives, such as the InfraTech Stock Take of Use Cases, and the latest supra-governmental initiatives, the Gaia-X federated digital platform, offer important references. The Stock Take of Use Cases developed by the Global Infrastructure Hub (GIH) supports the InfraTech Agenda by identifying InfraTech use cases in four quality infrastructure sectors (water, waste, energy and transport) and identifying four key opportunities: addressing the barriers to technology adoption; engaging with the private sector; supporting the advancement of quality infrastructure investment; and supporting the government's response to COVID-19 (GIH, 2020). Gaia-X is a European project that connects existing cloud services and generates innovative new modes of connectivity to create a federated digital infrastructure for Europe, enabling data sharing while allowing participants to retain data sovereignty. The goal of the platform is to continually identify, develop and implement scalable and marketable new use cases through a bottom-up approach, which provides transferable knowledge in the infrastructure ecosystem (Bühler et al., 2021).

B. Supporting industry-led and government-facilitated data-sharing communities that identify appropriate use cases and support collaboration between stakeholders.

Supporting data-sharing programmes and platforms that are centred on the development of use cases represents a key policy measure for implementing safe, decarbonised and climate-resilient infrastructure. Cross-sector and public-private partnerships are crucial to ensuring scientific progress, knowledge transfers, boosting innovation and introducing new business models. The project "IDE@S: Innovative Data Environment @ Styria", funded by the government of the Federal State of Styria in Austria, is fostering cooperation between Styrian stakeholders both in the private and in the public sectors in data science and collaborative data tools with the goal of creating a distributed data platform that includes use cases, potential business models and desired development of technical infrastructure (Jean-Quartier, 2022). In Germany, the Federal Ministry for Digital and Transport (BMDV) has created a data-oriented R&D-funding programme: the mFUND initiative. The aim of the project is to support the development of data-based business models for smart mobility (Mobility 4.0). A main focus of the programme is the provision of mobility and geo and water data (e.g., transport and traffic data, hydrological data, climate and weather data). For this purpose, different stakeholders have access to a central, open data access point for mobility-related data (mCLOUD) (OECD 2019).

C. Utilising data for intelligent decarbonisation and climate-resilient urban planning.

Advanced urban analytics powered by urban big data can play an important role in shaping the future urban environment. Big data analytics and information technology-enabled smart solutions could facilitate resilience-building activities through, among other things, improving the capacity to coordinate the activities of different stakeholders and actors involved in resource management, utilising big data analytics for real-time and proactive urban planning, and ensuring effective and efficient use of increasingly scarce resources (Chien et al., 2022).

The city of Turin, Italy, provides an example of data-driven approaches for facilitating disaster resilience. By using GIS-based techniques the initiative creates hydraulic vulnerability maps by identifying cloudburst vulnerable areas. Through using different datasets and modelling techniques, this approach shows the potential impacts of extreme rain events on the urban water network and discusses the necessary adaptation strategies for enhancing flood resilience (Brunetta et al., 2022).

Climate and environmental databases are critical for achieving the United Nations Sustainable Development Goals (SDGs) and for efficiently planning and implementing appropriate adaptation measures. Available federated and distributed databases can serve as necessary starting points for municipalities to identify needs, prioritise resources, and allocate investments, considering often tight budget constraints. High-quality geospatial, climate and environmental data are now broadly available and remote-sensing data, e.g., Copernicus services, will be critical. There are forward-looking approaches to using these datasets to derive forecasts for optimising urban planning processes for local governments (Bühler, M.M.; Sebald, C.; Rechid, D. et al., 2021).

The Chinese government has committed to using big data in its cities for intelligent decarbonisation (IDC). One example is Alibaba's "City Brain" project in Hangzhou. City Brain is a cloud-based system, aggregating data from a range of data sources, such as the transportation bureau, public transportation systems, a mapping application, and hundreds of thousands of cameras. The project focuses on comprehensively analysing pedestrians, vehicles and incidents from various dimensions based on a fusion of multi-view learning with multi-source heterogeneous data. City Brain has been used to coordinate traffic and road signals in real-time, shorten commuting times and to reduce congestion significantly.

Since 2018, City Brain has also been operating in the Malaysian city of Kuala Lumpur to manage traffic signals at 281 intersections (Naughton, 2020). Another example has been the work on IDC carried out by the Cambridge Centre for Advanced Research and Education in Singapore (CARES) and the Swiss Academy of Science. The study highlights that AI in combination with cyber-physical systems (CPSs) can significantly contribute to the reduction, elimination, or removal of carbon dioxide emissions. An IDCadjusted marginal abatement cost curve shows a significantly higher potential for emissions reduction and lower costs of avoiding 1 ton of CO_2 compared with a conventional decarbonisation approach (Inderwildi and Kraft, 2022).

D. Project-owner/government-led initiatives will be necessary to overcome regulatory, cultural, and commercial barriers to collaboration and data sharing and improving capacity building.

Improving governance systems and coordination mechanisms across different levels of governments is of paramount importance. Institutional and legal certainty along with the implementation of regulatory frameworks concerning cybersecurity, privacy and data sovereignty are considered major success factors for building trust and the necessary conditions to overcome data-sharing barriers. This is especially so considering the cross-border nature of many infrastructure projects. Establishing a trust framework developed by public, private or third-party stakeholders that includes a set of standardised legal and contractual agreements can ensure individual privacy rights, protect against abuses of power or authority, and safeguard ethical use of data along with well-defined rights and responsibilities for data-sharing parties (Sum4all, 2021).

Aside from the need to formulate the right regulations and policy, improving capacity building and sharing good practices are a common priority in improving the design and implementation of digital-enhanced infrastructure. Deploying and integrating data and technologies requires a range of new skills and capabilities. Education and training programmes should focus on digital skills and competencies needed to harness the development potential of existing and emerging digital technologies. In the United Kingdom, the Digital Skills Partnership, for instance, brings together private and public sector actors to boost skills in the digital economy and to enhance data analytics. Austria's initiative for the provision of a big data infrastructure and technology foundation supports the development and provision of statistical and analytical methods and tools with the help of data scientists for different target groups (OECD, 2019).

RELEVANCE TO G20

The G20 and its Infrastructure Working Group have a longstanding agenda in support of infrastructure investment and finance. Building on past G20 and T20 work on digital applications to infrastructure, this brief contributes to several G20 themes "Energy Transition", "Environment and Climate Sustainability", "Digital Economy", and builds upon the "G20 Principles for Quality Infrastructure Investment" enhancing the "G20 InfraTech Agenda". It provides a holistic big data economy framework that could become the testbed acknowledging an environmental- and socio-centred value network approach and supports SDGs 9, 11, 13 and 17. It addresses the following policy areas: utilising technological advances for infrastructure development; strengthening infrastructure governance, openness, transparency and inclusion of local communities; new initiatives and mechanisms to support digital infrastructure; and integrating environmental criteria into infrastructure investment.

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