Innovative Data for Urban Planning:

The Opportunities and Challenges of Public-Private Data Partnerships

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Utility services such as energy, water, sanitation, waste management, and transport are essential to life. The Digital Utilities programme enables access to affordable, reliable, safe, and sustainable urban utility services for low-income populations through digital solutions and innovative partnerships. In doing so, we also seek to support cities in low- and middle-income countries in their transition to a low-carbon, climate-resilient future.

The programme is supported by the UK Foreign, Commonwealth & Development Office (FCDO).

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Executive Summary

Rapid urbanisation will be one of the most pressing and complex challenges in low-and-middle income countries (LMICs) for the next several decades. With cities in Africa and Asia expected to add more than one billion people, urban populations will represent two-thirds of the world population by 2050. This presents LMICs with an interesting opportunity and challenge, where rapid urbanisation can both contribute to economic or poverty growth.

Primary and secondary cities in LMICs are seeing urban peripheries expanding quickly due to sprawling informal settlements inhabited by a growing low-income population. These informal settlements often face significant challenges as they are excluded from key urban utility services, including water, sanitation energy, waste management, and transport. The rapid pace and unequal character of urbanisation in LMICs has meant that not enough data has been generated to support urban planning solutions and the effective provision of urban utility services.

Data-sharing partnerships between the public and private sector can bridge this data gap and open an opportunity for governments to address urban development challenges with data-driven decisions. Innovative datasets are defined as data that is passively generated by digital services (as opposed to data collected manually and proactively, such as survey data). These data sources were not original intended to be used for social good use cases such as urban planning. They usually fall into four main categories: mobile network operator (MNO) data, remote sensing data, utility services data and other digital services data. Private companies in LMICs have an advantage with large data platforms that produce regular, granular and accurate data in country contexts where data has historically been scarce. These innovative data sources have the potential to be incorporated into policymaking processes and create both social and economic value for rapidly growing low-income urban populations.

Key use cases in the sanitation, energy, and transport sectors show that public and private stakeholders both stand to benefit from partnerships. There are many different types of private sector stakeholders in the data ecosystem, from big data holders and urban utility service providers to technical and financial partners. Their datasets often have widespread coverage and are low cost, extremely versatile and precise. They can be applied to a range of critical urban use cases, such as mapping traffic flow patterns, planning electric vehicle charging infrastructure, delineating metropolitan boundaries, optimising city-wide faecal sludge management or planning integrated energy solutions. The suitability of private sector data, and terms of engagement vary depending on the use case. Meanwhile, donors and public sector stakeholders want to use this data to improve urban planning and utility service provision and make them more inclusive. This, in turn, helps to open new market segments and create strategic value for private sector partners. In this report, we feature five in-depth case studies on data-sharing public-private partnerships (PPPs) from LMICs in Africa and Asia that are using innovative data sources to improve urban planning and the provision of utility services.

Synergies and incentives are usually not enough to initiate or sustain data-sharing partnerships, which inevitably encounter key challenges and enablers during their lifecycle. Data-sharing PPPs tend to follow a multi-stage journey that is described in more detail later in this report, but begins with the formation of a partnership followed by data management, impact and usage and evaluation and sustainability. Given the lack of funding available for data-sharing PPPs in LMICs, many partnerships emerge through facilitation and funding from a third-party stakeholder, such as the World Bank's involvement in the Nigeria Electrification Project (NEP) and the OpenTraffic partnership in the Philippines. It is also important to take into account challenges to the long-term sustainability of data-sharing PPPs, as many struggle to go beyond an initial pilot or demonstration phase. For example, in Madagascar, Gather's sanitation risk visualisation tool for municipal government may offer sector-wide value to both public and private stakeholders in Antananarivo's sanitation sector, but identifying long-term funding sources is a challenge. This report identifies challenges and enablers for data-sharing PPPs that relate to the partnership engagement model, data and technology, regulation and ethics frameworks and evaluation and sustainability.

Based on desk research, key informant interviews with more than 45 industry experts and in-depth examinations of successful case studies, we identified three recommendations for successful data-sharing PPPs in urban planning and utility service provision:

1. Develop and institutionalise a governance structure for data-sharing partnerships;

2. Recruit a public sector champion or third-party facilitator to push the partnership forward; and

3. Prioritise sustainability through technical and funding support from external partners.

While data-sharing PPPs are still relatively nascent in LMICs, and therefore there is limited evidence on the effectiveness and relevance of some underlying use cases, the opportunities associated with innovative data sources in supporting national and municipal authorities in making urban planning and urban service provision more inclusive and more evidence—based remain underexploited. The COVID-19 pandemic has fuelled government engagement with MNOs to use big data to monitor and predict the spread of the pandemic and evaluate the effectiveness of different mitigation measures. The pandemic is also expected to be a catalyst for data-sharing PPPs since many public sector and civil society stakeholders have witnessed the tremendous insights that can be derived from partnerships that leverage mobile big data.

Beyond mobile big data, private utility innovators are rapidly expanding their data platforms through effective collaborations with government and other private sector companies. This is exemplified by social enterprises such as Sanergy, a container-based sanitation service provider that provides urban sanitation services in Kenya and is combining geospatial data with survey data to plan its service roll-out. Meanwhile, Grab, a ride-hailing company in Southeast Asia, has partnered with several governments and donors to use their data for transport planning in the region.

While this report features insights from various data partnership examples, every PPP is unique and there is no single engagement model that can be applied across every country context or urban utility service sector. Still, governments have an opportunity to tap into new data sources that can help them make data-driven decisions and policies that deliver social value while addressing urbanisation and urban planning challenges.

The GSMA Digital Utilities programme supports urban resilience in LMICs by enabling access to essential utility services through digital solutions. Inclusive utility services, such as energy, water, sanitation, waste management and transport allow cities to better withstand challenges related to population growth, climate change, and inequality.

This report is aimed at data ecosystem practitioners in the private and public sector, urban development professionals, donors supporting data and statistical ecosystems, MNOs, private and state-owned utility service providers and municipal authorities. This report will enable you to:

- Learn about different types of innovative data sources and their relevance for different use cases;

- Go beyond the hype of data for development to understand how these use cases concretely help urban policymakers in LMICs respond to challenges associated with urban planning and the provision of urban utility services;

- Consider practical guidance on successful data-sharing partnerships based on desk research and interviews with ecosystem experts;

- Delve into detailed insights from case studies that tell the story of how various partnerships have evolved across different sectors and countries, and illustrate and exemplify the key enabling factors identified in the report; and

- Get tailored recommendations for how different stakeholders in the ecosystem can support impactful data-sharing PPPs for urban planning.

Introduction: Innovative Data in Urban Planning and Service Provision

DATA SCARCITY IN AN URBANISING WORLD

TWO-THIRDS OF THE WORLD'S POPULATION WILL LIVE IN CITIES BY 2050 WITH CITIES IN LMICS BEING THE KEY DRIVERS OF URBAN GROWTH GLOBALLY.[1]

Africa and Asia account for 90 percent of the world's urban population growth from now until 2050, by when their cities will be home to an additional one billion people.[2] While urbanisation can bring greater economic opportunity and boost standards of living, economic growth and structural transformation in cities in low- and middle-income countries (LMICs) has not kept pace with rapid urbanisation, creating new challenges for low-income urban populations. Unable to afford to live in dense central urban neighbourhoods, low-income urban populations increasingly live in sprawling informal settlements. This process of urbanisation without structural transformation, or in some cases urbanisation without growth, contributes to some of the key challenges facing low-income populations in cities: rising unemployment, high transportation costs, uncontained sewage, weak property rights, contaminated water, unreliable power supply, and growing waste.[3]

MANY CITY GOVERNMENTS IN LMICS DO NOT HAVE ENOUGH DATA TO MAKE POLICIES AND DECISIONS THAT IMPROVE THE PROVISION OF ESSENTIAL SERVICES TO LOW-INCOME POPULATIONS.

Governments and development institutions have long struggled to find quality, up-to-date data to support research and data-driven policy solutions. While governments have generated a certain amount of consistent data through household surveys, the high costs and time-consuming logistics require significant resources and some governments cannot afford to conduct them regularly. Meanwhile, rapid urbanisation, population growth, and climate change are swiftly changing on the ground realities in LMICs and are rendering previous surveys obsolete or outdated.[4] Also, data scarcity may be perpetuating inequalities as governments struggle to propose and plan for solutions that address the needs of poorer households in informal settlements.[5]

IN THIS ERA OF GREATER CONNECTIVITY, INNOVATIVE DATA SOURCES PROVIDE A NEW AND EXCITING OPPORTUNITY TO BRIDGE THE DATA GAP.

In this context, innovative datasets are defined as data points generated by a range of digital services that were not originally intended to be used for public policy purposes, such as urban planning. In this report, we focus on four different innovative data sources: MNO data, remote sensing data, private utility service provider data and other digital services data. Increased mobile penetration, declining handset costs and more relevant digital use cases in LMICs are key enabling dynamics, which make innovative data sources more ubiquitous, and hence more relevant. For instance, due to higher rates of mobile penetration in LMICs, MNO data represents one of the most relevant types of innovative data for urban planning and utility service provision. Data generated by utility service providers that use digital tools to engage their client base, such as Geographic Information System (GIS)-enabled mobile apps, mobile money, USSD, Internet of Things (IoT) or machine-to-machine (M2M) connectivity, are also a potentially rich asset in this respect. Due to these dynamics, MNOs and private utility service providers hold an advantage in LMICs with large data platforms that produce regular, granular and accurate data in contexts where data is typically scarce. Combined with administrative and other publicly available data sources, city administrators could have the ability to deliver the right services to the right citizens at the right time while also creating new opportunities for urban planning.

ALTHOUGH THERE IS A LOT OF POTENTIAL TO USE PRIVATE SECTOR DATA TO IMPROVE URBAN PLANNING, THERE ARE ALSO IMPORTANT CHALLENGES.

Creating sustainable PPPs that leverage innovative data requires overcoming important barriers, from privacy and regulatory challenges to a lack of digital literacy and data infrastructure. While the need for informed and data-driven policymaking in cities in LMICs has never been clearer, addressing these challenges will be critical. Both public and private stakeholders have a shared responsibility and interest in creating solutions that can respond to the challenges of rapid urbanisation and contribute to more productive and inclusive cities.

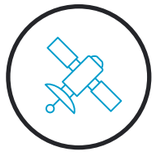
1. United Nations. (2018).
2. OECD. (2020). *Africa's Urbanisation Dynamics 2020*.
3. GSMA. (2020). *Digital Solutions for the Urban Poor*.
4. Dang, H.H., Jolliffe, D.M. and Carletto, C. (10 April 2019). *Alternative Methods to Produce Poverty Estimates: When Household Consumption Data are not Available (Part I)*. World Bank.
5. Beguy, D. (20 August 2016). "*Poor data hurts African countries' ability to make good policy decisions.*" Quartz Africa.

INNOVATIVE DATA: AN INTRODUCTION

In this report, "innovative data" is defined as data that is generated primarily by digital services (as opposed to data collected manually and proactively, such as survey data) and was not originally intended to be used solely for data-driven decision making for urban planning and utility service provision. These datasets do not contain insights on their own, rather, they must be analysed and complemented by other data sources to derive valuable insights for cities and urban policymakers.

There are four main categories of innovative data that can be used in the context of urban planning and utility service provision:

MNO DATA



REMOTE SENSING DATA

PRIVATE UTILITY SERVICE PROVIDER DATA

OTHER DIGITAL SERVICES DATA

MNO data

Unique mobile penetration in LMICs has been steadily increasing over the last two decades. In Africa and Southeast Asia, the unique mobile subscriber penetration rate is 49 per cent and 70 per cent, respectively, and is set to increase to 53 per cent and 73 per cent by 2025.[6] This means that MNOs in these regions hold vast quantities of passively generated data. The data used in this context primarily consists of:

- Event data: Logs recorded by an MNO when users connect to their network for calls, SMS, mobile internet, Unstructured Supplementary Service Data (USSD), mobile money transactions or other type of event data recorded by the MNO's system.
- Network data: Includes data on the telecom network itself, including the location of cells, antennae and underground networks, infrastructure status and other logs of activities taking place on the network.
- Customer data: This is usually collected by an MNO during the registration process and includes socio-economic and demographic information, information related to the sign-up and information related to the status and activity of the customer.

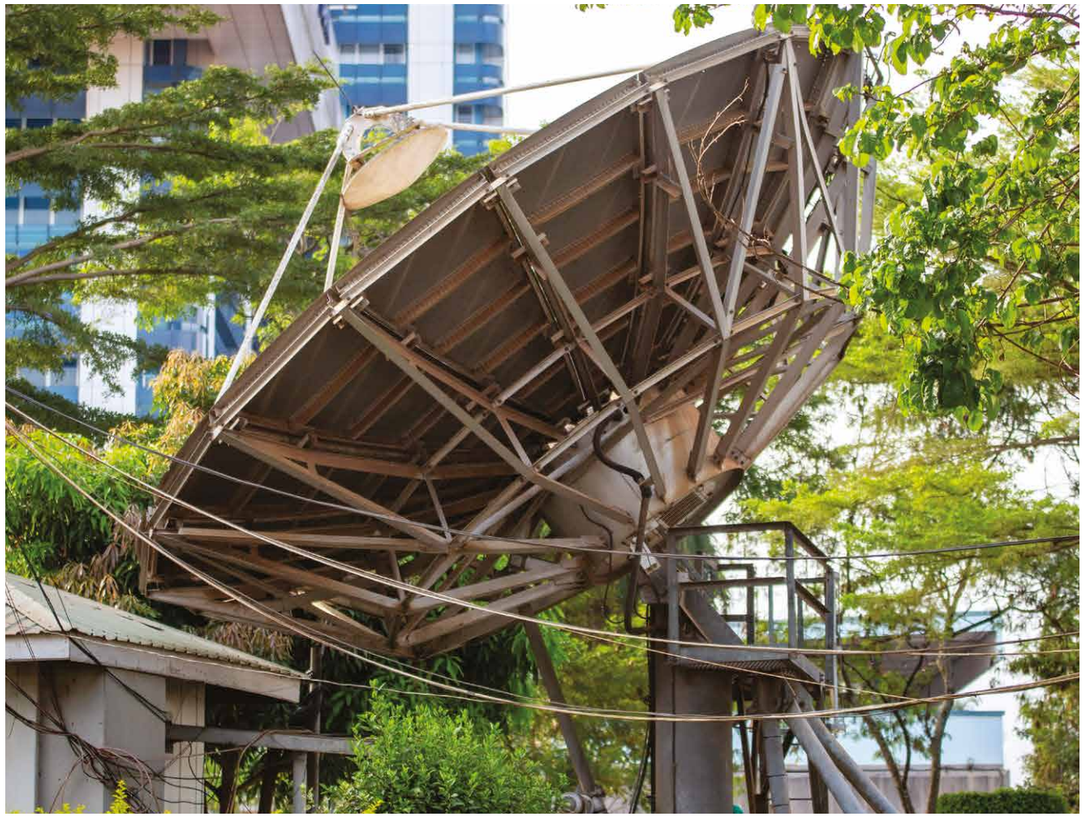
These datasets are usually accessed through direct partnerships with MNOs. In most cases, personally identifiable information does not leave the premises of the MNO in order to safeguard security and privacy. While telecom operators usually have an internal data team that prepares datasets for the data-sharing partnership, data processing activities in many LMICs usually require the support from third-party specialists. MNO data is processed to protect privacy through anonymisation and aggregation before it is shared. These steps to protect consumer privacy are an important industry-wide standard.[7]

Remote sensing data

The main types of remote sensing data that can be used for urban planning and utility service provision are satellite or drone images. Those images are usually defined by three types of resolution:

- Spatial resolution: The size of the smallest element that can be detected by the sensor of a satellite or drone and eventually visualised on the captured image. If a satellite has a spatial resolution of 50 cm, each pixel represents an area of 50 cm by 50 cm. For example, a car can be identified but not a sewer drain.
- Temporal resolution: The elapsed time between the acquisition of images. The temporal resolution needs to be adapted to the analytical use case. For example, while traffic monitoring probably requires regular snapshots, and therefore a high temporal resolution, land use changes may require only a couple of image acquisitions a year and would deliver a coarser resolution.
- Spectral resolution: The ability of a satellite or drone sensor to measure the reflectance or emittance of certain wavelength bands on the electromagnetic spectrum. The more and the narrower the bands, the more analytical opportunities are possible. Most sensors measure reflectance in red (high for clay roads), green (high for forests and grasslands) and blue (high for water bodies) bands, but other bands outside the visible wavelength are also used.

Satellite images can be accessed worldwide for free from publicly financed institutions, such as NASA and ESA, or purchased from companies that provide higher resolution images, such as Planet, Airbus and Digital Globe. Drone images, which capture images at a smaller geographical scale, can be purchased on demand from private local or regional companies. There are many private companies on the market processing and analysing remote sensing data.



6. GSMA Intelligence. (2019).
7. GSMA. (2019). *Mobile Privacy and Big Data Analytics*.

Utility service data

Utility service data comes from private utility service providers, particularly those active in the energy, water, sanitation, waste management and transport sectors. The data they generate can be subdivided into three categories. Like MNOs, private utility service providers collect and generate data through:

- Customer registration, for example, profile details collected from a customer registering for a pay-as-you-go (PAYG) solar system or other financed assets;
- Customer usage, for example, a record of payment and usage when a customer completes a ride with a transport service; and
- Monitoring and maintenance of utility infrastructure, for example, data generated by a sensor in a water tank to estimate the water level.

These different types of data can be shared with external stakeholders in a partnership or it can be analysed by service providers with the appropriate staff, data infrastructure and analysis capabilities to use and share their data. Private utility service providers with this capacity often use their data to make business decisions about service improvements, to identify their customers or to improve the efficiency of their operations to generate or save more revenue. However, this data can also be shared with government in partnerships with robust data governance and privacy.

Other digital services data

This category includes all other innovative datasets that can be used for urban planning and utility service provision. Thanks to the rise of mobile internet penetration and coverage, as well as increasing financial inclusion in LMICs, these digital datasets include:

- Social media data held by private international companies, such as Facebook, Twitter and TikTok;
- Web browser data held by private international companies, such as Google, Apple and Microsoft; and
- Financial transaction data held by private international companies, such as Mastercard, Visa and American Express, as well as local or regional companies, including banks and financial service providers.

All this data can provide geolocated, granular and timely information on the behaviour patterns of users, for example, through the GPS of a mobile device that they use to access a service.

For any of these four types of innovative data sources to be useful for policymaking and provide actionable insights, it must go through multiple stages of processing and analysis (see Figure 1). Innovative datasets are usually initially processed in the data warehouse of the data holder before being analysed on a dedicated platform for urban planning or utility service provision. Once on this specialised, project-based platform, innovative data can be combined with other datasets, such as data collected by government.

Depending on the needs of end users, the data can then feed into different types of user interfaces, including mobile and web apps, static reports, simple data visualisations and direct messages sent through any type of communication media (e.g. SMS, emails, messages from mobile apps such as WhatsApp, Telegram and WeChat). Co-creating user interfaces to consider the needs and design preferences of end users is critical to gaining insights from innovative data that can then be translated into policy outcomes. This is particularly important in LMICs where digital literacy and the rules, processes and approaches underlying data-driven decision making vary significantly from one public institution to another. The successful design, development and implementation of user interfaces for urban policy and decision making requires an iterative and agile approach that involves several rounds of testing, evaluation and refinement with end users and partnership stakeholders.

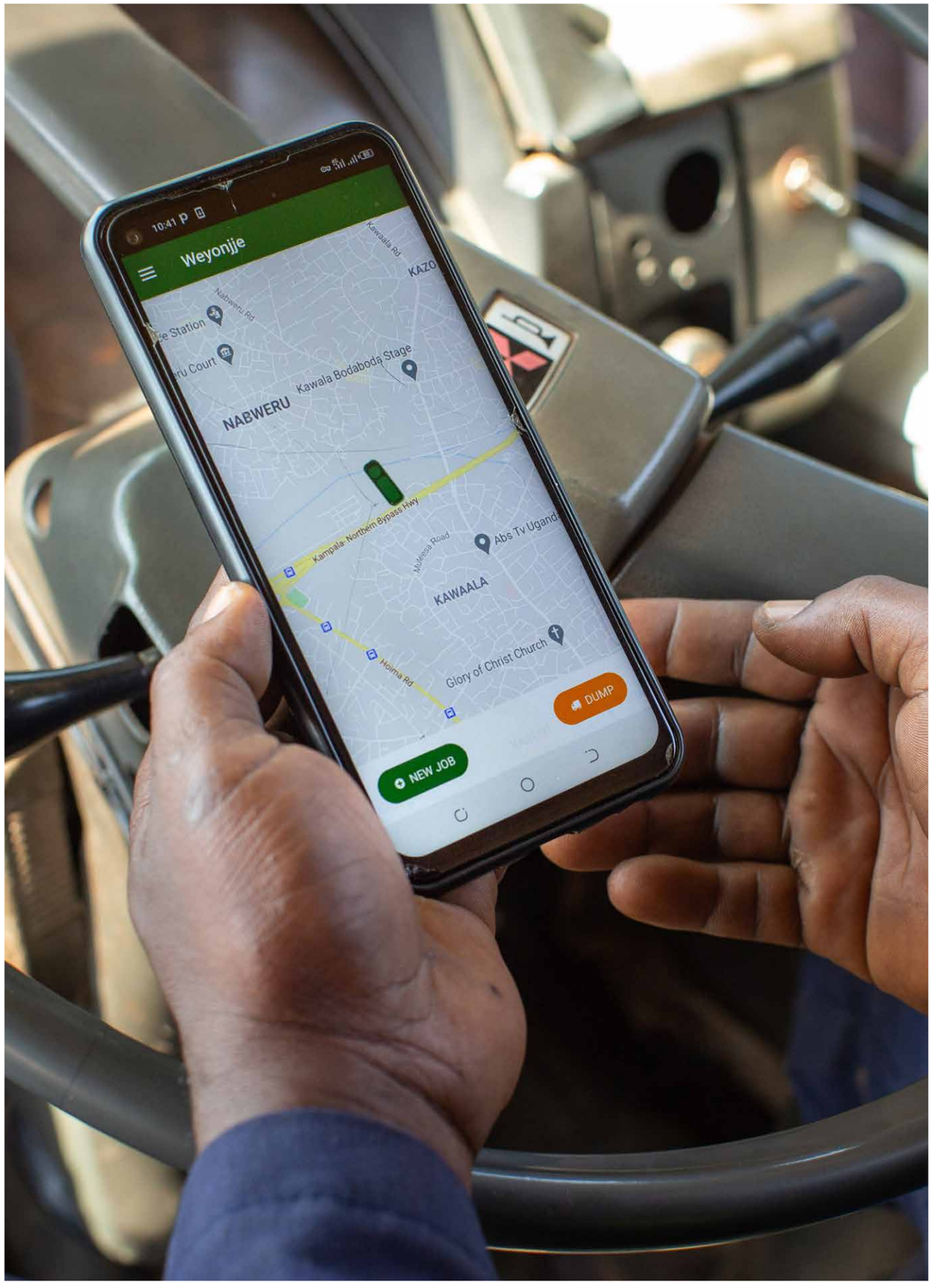


FIGURE 1

INNOVATIVE DATA PROCESSING FRAMEWORK

USE CASES FOR INNOVATIVE DATA IN URBAN PLANNING AND UTILITY SERVICE PROVISION

Innovative data sources present a unique opportunity to use accurate, real-time data in sectors and contexts where data is lacking. Before delving into how data-sharing PPPs can respond to the challenges of utility service provision, it is important to highlight how innovative data can support broader urban planning use cases, which can support more inclusive urban utility service provision. This is because many of the challenges cities face, from affordable housing and land value capture to resource mobilisation, access to finance and lack of quality employment, are highly interconnected and all have an impact on the quality of urban utility services. In many contexts, urban policymakers also lack vital foundational data on their city, including population size, growth rate, location, income levels and access to services.

According to the International Institute for Environment and Development (IIED), there is "an astonishing lack of data about informal settlements – their scale, boundaries, populations, buildings, enterprises and the quality and extent of infrastructure and services."[8] Agile and progressive city governments around the world have shown potential as laboratories for progressive reforms and innovative approaches that can be replicated on national or even global scale. However, to make robust planning and policy decisions, city governments need more sophisticated data.[9] Innovative data sources, such as geospatial and mobile big data, can complement foundational city data. As highlighted in case studies on the NYU Ethiopia Urban Expansion Project (see the Annex) and Telkomsel's collaboration with the Central Bureau of Statistics of Indonesia, innovative data sources can help policymakers understand the trajectories of urban expansion. This can also lead to better planning and, when institutional spheres of authority overlap, it can clarify the responsibilities of different sub-districts or spheres of government.

Beyond the use of innovative data for understanding fundamental city dynamics, urban utility service provision encompasses a range of sectors. This report focuses on three key sectors where public-private data partnerships are particularly salient and have already provided significant value:

ENERGY

SANITATION

TRANSPORT

The use cases presented in these three sectors highlight how private and public sector actors have collaborated to improve service provision for low-income urban populations in LMICs. They also offer sector-specific lessons on how data-sharing PPPs have been implemented.

8. Satterthwaite, D. (6 May 2021). "Broadening the understanding and measurement of urban poverty." *IIED Urban Matters Blog*.
9. Satterthwaite, D. (25 February 2020). "Invisibilising cities: the obsession with national statistics and international comparisons". *IIED Urban Matters Blog*.

SANITATION

Access to urban sanitation services is a vital issue facing many cities in LMICs. According to the UN-Water SDG 6 Synthesis Report,[10] sewer access is not keeping pace with urban population growth in 54 of the 120 countries analysed. Providing sewer access in informal settlements is particularly challenging, and in many cases unfeasible or uneconomical compared with other options. With urbanisation poised to accelerate in Asia and particularly in Africa, extending sanitation services to the urban poor is one of the most crucial public health and economic development challenges facing cities in LMICs.

Inadequate sanitation has severe consequences, costing an estimated $200 billion annually in health costs, lost productivity and lower incomes.[11] Without adequate sanitation facilities and services, low-income populations living in informal settlements often resort to open defecation which, coupled with inadequate faecal sludge management, is linked to water contamination and disease.

At the same time, poor quality data on informal settlements, where most people without access to sanitation services live, makes it difficult for policymakers to formulate appropriate solutions that consider the realities of life in informal settlements.[12] Cities with large informal settlements require innovative approaches to sanitation service provision. As the World Bank notes, these innovative solutions "can complement, or precede the arrival of, traditional sewers and conventional on-site solutions, and thus contribute to the realisation of the sanitation-related Sustainable Development Goals (SDGs)." The lack of data on non-sewered sanitation is compounded by an often fragmented sanitation value chain that does not collect data on a range of activities, preventing public, private and civil society stakeholders from effectively collaborating along the sanitation value chain.[13] Without coordinated and comprehensive data collection on the capture, storage, transport, treatment and reuse of faecal waste, it is difficult to identify and implement solutions that meet the needs of low-income urban populations.

Data-sharing use cases: Private entrepreneurs and utility service providers in LMICs are not only working to open access to better urban sanitation services, they are also developing their capacity to generate more data. Private container-based sanitation (CBS) service providers like Sanergy in Kenya, Clean Team in Ghana and Loowatt in Madagascar, are all leveraging new technologies to expand safe access to sanitation services.[14] These technologies include mobile tracking services, mobile payments and M2M connectivity to streamline operations and provide a high-quality experience for end users. Sanergy, Clean Team and Loowatt have created mobile apps for staff to coordinate logistics, including collecting faecal waste and scheduling toilet maintenance. In collaboration with MNOs, they have also allowed their subscribers to pay for waste management services through mobile money.[15,16]

These digital innovations allow CBS providers to collect large amounts of user, operational and payment data that can be used to improve and expand operations. CBS providers also share certain data with government partners to produce reports and support sanitation planning. While sanitation companies engage with governments regularly, for example, Sanergy's partnerships with Nairobi municipality and KIWASCO in Kisumu, PPPs that use shared data, are still in early stages.[17]

Some partnerships have focused on geospatial data to improve sanitation and faecal sludge management. With the support of the GSMA, the Kampala Capital City Authority (KCCA) in Uganda has developed a mobile app that provides a GIS tracking system for their pit emptier teams[18] and a platform for customers to connect to pit latrine emptying services, track service delivery and ensure safe disposal, for a cleaner, healthier

10. UN-Water. (2019). *SDG 6 Synthesis Report*.
11. Global Innovation Exchange. (2 March 2020). "Gather".
12. Gambrill, M. et al. (22 March 2017). "It's not all about toilets: Debunking 7 myths about urban sanitation on World Water Day." *World Bank Blogs*.
13. Sharma, A. (11 November 2019). "Can mobile help solve the sanitation challenge?" *GSMA Mobile for Development Blog*.
14. Morais, C. (18 November 2019). "Sanergy: Using mobile to unlock circular economy approaches to sanitation in Nairobi". *GSMA Mobile for Development Blog*; GSMA. (2017). Loowatt: Digitising the container-based sanitation value chain in Madagascar; Bauer, G. (19 November 2019). "Streamlining the complexity of urban sanitation with digital solutions". *GSMA Mobile for Development Blog*.
15. Sarin, R. and White, Z. (19 November 2020). "Container based sanitation alliance and Loowatt – digital tools for container-based sanitation providers". *GSMA Mobile for Development Blog*.
16. WSUP. (2019). *Triggers for growing a sanitation business aimed at low-income customers*.
17. EY. (2020). *Make way for the future of sanitation*.
18. Morais, C. and Kore, L. (21 January 2020). "Kampala Capital City Authority – Unlocking the power of mobile-enabled sanitation". *GSMA Mobile for Development Blog*.

city. The KCCA receives pit emptying requests from customers through its call centre and connects them with the nearest pit emptiers. The data pit emptiers collect for KCCA also includes the amount paid, volume emptied and the type and location of the household toilet system. The KCCA has worked closely with MTN Uganda to support and encourage pit emptiers to use mobile money to collect and perform payments. This can reduce the friction of doing business in cash, and the digital records of transactions and income have helped several pit emptiers receive business loans.

In Kenya, Sanergy has partnered with the Spatial Collective to use GIS mapping and drone imagery for the roll-out of its services in Viwandani, an informal settlement in Nairobi. This mapping exercise allowed Sanergy to plan, collect and store evidence from field surveys more effectively, and ultimately identify gaps in sanitation services and areas where additional toilet services were needed.[19] Figure 2 features a data visualisation of Viwandani that Spatial Collective and Sanergy produced from a geospatial analysis using plot profiles and survey data.

Although innovative new approaches are producing valuable data on sanitation, much of this data continues to be stored and managed in silos. Many private service providers are not collaborating or sharing data, either with each other or with the government, and governments are often unable or unwilling to seize the opportunity. To address this, Gather, a company based in Madagascar, launched the Antananarivo Sanitation Data Hub, which has brought together sanitation stakeholders, including government partners, to collect, share and act on sanitation data (see Case Study: Sanitation Data Hub, Madagascar). The Hub is building a visualisation tool that shows different levels of sanitation risk factors in Antananarivo. The tool is intended help the municipal government and utility service providers make data-driven decisions on infrastructure investment and service delivery, while also helping cities become more resilient by assessing various risks related to natural disasters and climate change.

Another sanitation visualisation and management tool, the Citywide Inclusive Sanitation Services Assessment and Planning (CWIS SAP) tool, is designed to support government stakeholders to evaluate and compare outcomes of different interventions or investments.[21] With the support of the Gates Foundation, the tool has been piloted in Zambia, Kenya, Bangladesh, Tanzania, Uganda and India, and is planned to be scaled across other cities and countries.[22] Both CWIS SAP and the Gather data tool present new opportunities for data-driven decision making by government stakeholders. While Gather complements government data with innovative data such as geospatial data, CWIS SAP tackles the fragmentation of public sector data by enabling public sector decision makers to take an outcome-based approach to safely managed sanitation and analyse how a proposed intervention would impact the equity, financial sustainability and safety of sanitation services in an urban area. In the longer term, the tool could serve as a platform that combines aggregated government data with innovative data sources to generate even better insights.

Visualising the extent of unequal access or lack of access to sanitation can also stimulate political pressure and mobilise civil society. This will be critical given that several LMICs continue to underinvest in sanitation. According to the World Bank, public intent data gathered through the National Water Supply and Sanitation Survey (commissioned by the Nigerian Government) revealed that 130 million Nigerians did not have access to adequate sanitation services. This led Nigerian President Muhammadu Buhari to declare a state of emergency in the sector and launch the National Action Plan for the Revitalization of Nigeria's Water, Sanitation and Hygiene (WASH) Sector.[23] While data visualisations are not a replacement for the complex task of policymaking, they can provide clear and understandable evidence to support political action. Similarly, national rankings generated by mandatory municipal reporting, or grievance redressal and accountability mechanisms, can identify underperformance in sanitation service provision and stimulate political pressure. For example, Asivikelane in South Africa surveys residents of informal settlements to compare service data and municipal budget data. The impact is even greater when performance is tied to meaningful incentives for municipal service authorities.[24]

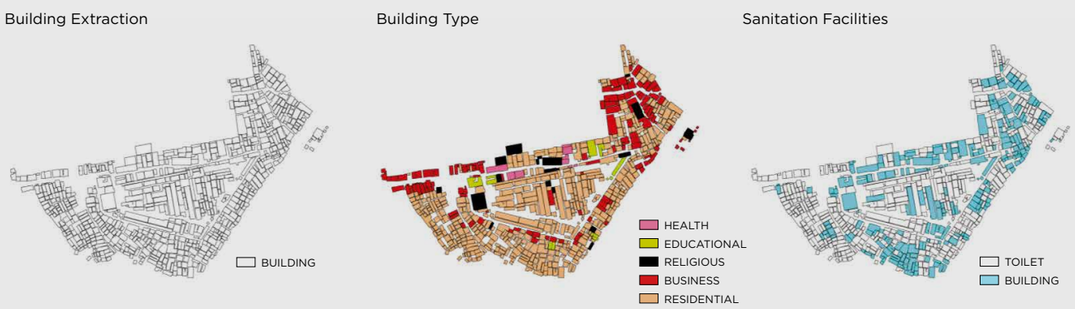
The use of urban sanitation data has many challenges. One is that, despite efforts by the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) to harmonise national sanitation data, there continues to be tremendous variability in the types of data sanitation service providers collect.[25] This is mainly due to a lack of donor alignment on outcomes and key performance indicators (KPIs), but it can also be the result of an organisation being required to report to multiple government departments that have different priorities.

Despite the challenges, there are also opportunities. For example, government subsidies for water and sanitation total $320 billion annually, equivalent to 0.5 per cent of global GDP according to the World Bank. For LMICs, this figure rises to 1.5 to two per cent, with most subsidies benefitting households in more affluent neighbourhoods with sewer connections and not reaching those who are not connected, perpetuating inequality. However, non-sewered models, which are supported by both big data and digital tools such as performance measurement and verification, open the door to delivering far more targeted subsidies at a lower administrative cost.[26] This is exemplified by the KCCA, which recently launched a subsidy fund pilot in one of Kampala's informal settlements to subsidise sewage emptying for 3,000 households.

19. Primus. (28 Febrary 2018). "Creating landlord and plot profiles of Viwandani Area". *Mapping: (No) Big Deal.*
20. Photo credit: Spatial Collective

FIGURE 2

Data visualisation of Viwandani informal settlement[20]



Assorted digital maps of Viwandani in Nairobi, Courtesy of Spatial Collective.

21. Athena Infonomics. (2021). Urban Sanitation Market Overview.
22. CWIS SAP was developed as a partnership with Athena Infonomics, the Eastern and Southern Africa Water and Sanitation Regulators Association (ESAWAS), Aguaconsult, the Gates Foundation, government regulators and sanitation authorities. For more information, see: www.cwisplanning.com.
23. World Bank. (2021). *World Development Report 2021: Data for Better Lives*.
24. ESAWAS. (2021). "Ensuring Accountability". *Citywide Inclusive Urban Sanitation Series*.
25. Busara Center for Behavioral Economics. Video: *Sanitation and Data: A Power Couple*.
26. GSMA. (2021). Smarter subsidies and digital innovation: Implications for utility services.

ENERGY

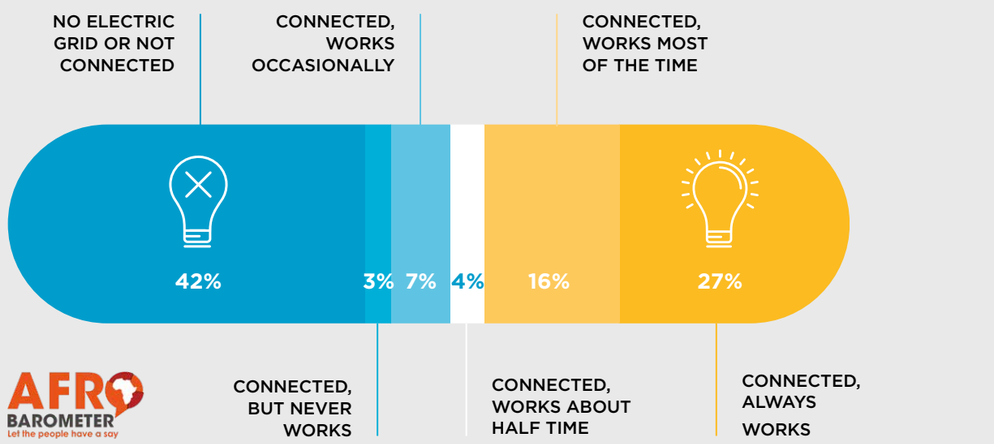
As of 2019, 759 million people lack access to energy with the COVID-19 pandemic further perpetuating energy poverty.[27] However, estimates suggest that the number of people without "reasonably" reliable energy is much higher – more than 3.5 billion according to a recent study.[28] Rapid urbanisation has typically led to higher demand for reliable energy services,[29] but in many cities in LMICS, rising demand has not necessarily been accompanied by corresponding increases in energy access, generation and transmission capacity. Although urban energy access in Sub-Saharan Africa (76 per cent) and LMICs in Asia (99 per cent) significantly exceeds rural energy access (29 per cent and 94 per cent, respectively),[30] energy access, reliability and affordability are still critical challenges for cities in LMICs. In a survey of 34 African countries in 2018, only 43 per cent of respondents reported having a reliable power supply, and 14 per cent of respondents reported that their connection to the national power grid worked half the time, occasionally or never.[31] There is also a significant "under-the-grid" population of low-income communities living near power lines that are still excluded from the grid.[32]

Although the energy sector is quite technologically sophisticated,[33] there is tremendous scope for cities, utilities and national policymakers to become more data driven. As policymakers devise integrated energy planning strategies, it is important for them to understand energy demand over time, customers' ability to pay and the potential for income-generating consumption use cases.[34]

27. World Bank ESMAP. (2019).
28. Ayaburi, J. et al. (2020). "Measuring 'Reasonably Reliable' access to electricity services." *The Electricity Journal.*
29. Sheng, P., He, Y. and Guo, X. (2017). "The impact of urbanization on energy consumption and efficiency". *SAGE Journals.*
30. International Energy Agency. (2021).
31. Afrobarometer. (2019). *Press Release: Progress toward 'reliable energy for all' stalls across Africa, Afrobarometer survey finds.*
32. GSMA. (2020). *Digital Solutions for the Urban Poor.*
33. TFE Energy. (2019). *Energy Access, Data and Digital Solutions.*
34. GSMA Future Networks. (2019). "Energy Efficiency: An Overview."
35. Afrobarometer. (2019). *Press Release: Progress toward 'reliable energy for all' stalls across Africa, Afrobarometer survey finds.*

FIGURE 3

Household connections to the electrical grid in 34 African countries, 2016–2018[35]



Source: Afrobarometer, 2019[36]

Governments and rural and peri-urban electrification agencies are becoming increasingly sophisticated at using digital tools to meet their development and public policy objectives through integrated energy planning. The aim of integrated energy planning is to select the lowest cost and most sustainable electrification strategy for a settlement. This can greatly reduce site and customer acquisition costs and accelerate and enable deployments from the energy access industry. The analysis generally involves a high-level comparison of the relative benefits of central grid expansion, construction of mini-grids and the provision of off-grid solar solutions, but it can also include more tailored and sophisticated modelling.[36]

While on-grid and off-grid energy provision has traditionally existed in silos, more and more researchers and funders are paying attention to the synergies between on-grid and off-grid energy provision. A working paper by the Duke Energy Access project argues that advances in digitised and decentralised technology and the rise of integrated energy planning "offer new delivery models for reliable and affordable access that African utilities could leverage to solve these dual challenges of financial sustainability and universal access."[37] Integrated energy planning therefore not only accelerates rural electrification, it can also allow utilities to hone in on their urban and industrial customer bases, lower the per connection cost of grid extension subsidies and invest in transmission and generation capacity.

In countries such as Nigeria, Togo, Senegal, Uganda and the Democratic Republic of Congo (DRC), momentum is gathering for public-private collaboration in energy planning. As a result, off-grid electrification efforts, such as decentralised mini-grids and stand-alone solar home systems (SHS) have ramped up.[38] Where chronic power shortages persist even in urban and peri-urban areas, including in the DRC and Nigeria, PAYG products have gained some traction among urban households that are seeking access to a sustainable energy source and have a greater ability to pay for it.[39] Overall, the introduction of these kinds of technology-driven business models have offered new ways to generate data in the energy sector. However, to avoid fragmentation, data-driven approaches to energy access planning and investment have become more critical.

By 2020, cities will account for nearly three-quarters of world energy use, and over 80 per cent of greenhouse gas (GHG) emissions, making it vital for them to address complex challenges of poverty reduction and resilience to natural disasters.[40] In urban contexts, big data is a key enabler for cities to improve the efficiency of energy distribution and operations and to transition to a lower carbon energy mix to provide inclusive and reliable services for all.

While the introduction of smart meters alone cannot produce the large cuts in urban household energy use needed to mitigate climate change, they can make households and utilities more aware of price and consumption patterns, help to diversify and localise power generation and enable households to become both consumers and producers of energy (for example, from rooftop PV cell arrays).[41] More importantly, the imperatives of boosting revenue collection, reducing non-revenue expenses and improving customer service has led many utilities in Africa to invest in advanced metering infrastructure. Yet, many LMICS have a long way to go. In Nigeria, only 38 per cent of the country's 10 million active electricity consumers have meters that measure actual consumption and quality, while 62 per cent are billed based on estimates.[42] With more utilities in LMICs deploying more sophisticated metering infrastructure, along with sensors and built-in trackers, governments and urban service providers can better analyse customer behaviour, forecast demand and optimise energy generation, all of which will be critical in the transition to smarter and more decentralised energy grids.

Another promising use case relates to electrical vehicle (EV) charging infrastructure. Road traffic is one of the primary causes of air pollution in cities such as Lagos and Mumbai.[43] Cities in LMICs stand to benefit significantly from cost-effective innovative solutions, such as e-bikes. For example, Rwanda has set a target to phase out all gas motorcycles to stimulate the

36. TFE Energy. (2019). *Energy Access, Data and Digital Solutions.*
37. Duke Global Working Paper Series. (2020). *Unlocking Utilities of the Future in Sub-Saharan Africa.*
38. Bauer, G. (29 May 2019). "Mini-grids, macro impact?" *GSMA Mobile for Development Blog*; GSMA ClimateTech. (2021). "Renewable Energy for Mobile Towers".
39. Bauer, G. (17 July 2019). "Why off-grid energy providers are increasingly paying attention to urban areas – insights from the DRC and beyond". *GSMA Mobile for Development Blog.*
40. World Resources Institute (WRI). (2021). "Buildings Initiative".
41. Jia Wang, S. and Moriarty, P. (2018). "Big Data for Urban Energy Reductions". *Big Data for Urban Sustainability.*
42. Nwele-Eze, C. (11 May 2021). "What will Cost- and Service-Reflective Tariffs Mean for the Nigerian Electricity Sector?" *Energy for Growth Hub.*
43. World Bank. (2020).

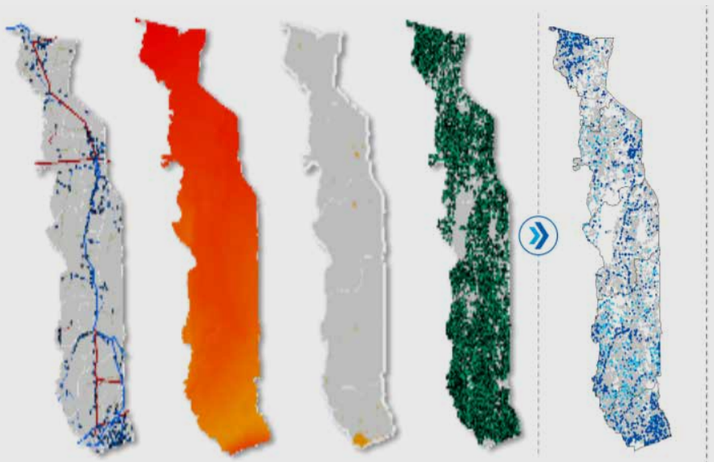
growth of the e-mobility sector.[44] A major barrier to the growth of e-mobility solutions in LMICs, and globally, is insufficient charging infrastructure. For instance, India, which is home to six of the 10 most polluting cities in the world according to the World Economic Forum, only has 970 installed public EV charging stations.[45] Given the global nature of the challenge, several studies and use cases have found that a genetic algorithm using origin destination (OD) data can be used to determine the optimal location of EV charging infrastructure in a city.[46] Convenient, cost-effective away-from-home charging is especially vital in LMICs where many lack reliable and affordable access to energy at home.

Data-sharing use cases: Geospatial analytics can play an important role in integrated energy planning. This is exemplified by Fraym and the Nigerian Off-Grid Market Accelerator's collaboration with the Rural Electrification Agency (REA).[47] Fraym combined several datasets, including distance from grids, willingness and ability to pay and other socioeconomic indicators, and then applied geospatial analysis and machine learning to identify sites in 10 states for the government to deploy off-grid electrification products. Several other rural and peri-urban electrification agencies, such as the Togolese Rural Electrification and Renewable Energies Agency (AT2ER) and the Agence Nationale de l'électrification et des Services Energétiques en Milieux Rural et Périurbain (ANSER) in the DRC, have used geospatial analysis to support digital off-grid solar subsidy schemes (CIZO in Togo and MWINDA in DRC), as well as broader energy policies (see Figure 4).[48]

44. Bright, J. (28 August 2019). "Rwanda to phase out gas motorcycle taxis for e-motos". Tech Crunch.
45. Saur Energy International. (2021). 970 Government Funded Public EV Charging Station Installed in India so far.
46. Efthymiou, D. et al. (2017). "Electric vehicles charging infrastructure location: a genetic algorithm approach". *European Transport Research Review, 9 (27).*
47. Ibid.
48. Bauer, G. and White, Z. (2021). "Smart subsidies and digital innovation: Lessons from Togo's off-grid solar subsidy scheme". *GSMA Mobile for Development Blog.*
49. Government of Togo. (May 2018). Presentation: *Togo Electrification Strategy.*

FIGURE 4

Geospatial analysis for national electrification in Togo[49]



Source: Government of Togo. (2018). Presentation: Togo Electrification Strategy.

Many private PAYG SHS companies, including Lumos in Nigeria, have entered the energy market in LMICs facilitated by the simultaneous growth of mobile money and mobile connectivity. The PAYG SHS model has expanded clean energy access by enabling customers to pay for energy in installments while leveraging technology to remotely control or monitor SHS through M2M connectivity.[50] These PAYG models depend on data platforms that track energy consumption, payment history, demand patterns and likelihood of default. Additional analytics can be used to understand seasonal and geographical impacts on energy consumption and build customer credit profiles based on payment patterns.[51] These types of data points have a great deal of potential to support other activities, such as selling larger productive assets like solar water pumps,[52] and to provide decision-making support for the broader energy sector and government partners.

Lumos is one of 19 private companies that has participated in the Nigeria Electrification Project (NEP), a results-based financing scheme designed and funded by the World Bank and implemented by the REA in Nigeria (see Case Study: Nigeria Electrification Project NEP).[53] To qualify for the subsidy, Lumos shares information related to SHS deployments (such as location, serial number and associated phone number) to a central data platform developed by Odyssey, which is then verified by a third party. The results-based financing facility enables the REA to rapidly scale up rural energy access based on insights from a prior integrated energy planning exercise, while also allowing Lumos to lower the portfolio risk associated with serving low-income customers. Meanwhile, the REA can build a large database with inputs from multiple private companies and their commercial product deployments. Data from SHS companies and mini-grid companies, as well as additional population-related data, have been combined for the government to price assets, set tariffs, engage in regulatory planning and develop national policy for the expansion of electrification.[54]

Other PAYG companies currently do not share data with government either because they think it could be less competitively advantageous or due to a lack of government interest. Governments could benefit greatly from understanding PAYG companies' portfolio locations, repayment patterns and expansion strategies. For example, in the DRC, BBOXX made customer survey data public to illustrate the economic impact of the COVID-19 pandemic on their customer base and understand their needs and priorities.[55] Under the Utilities 2.0 pilot in Uganda, the utility, Umeme, is working to explore data synergies with mini-grid developers and appliance distributors.[56] Such new partnership models are likely to become more relevant as countries transition to smarter decentralised grids, and the importance of data-sharing in the sector becomes more evident.

Mobile data is also relevant for integrated energy planning. Research by MIT and Orange Group shows that mobile phone activity is strongly correlated with energy consumption, and mapping these patterns can inform infrastructure planning strategies.[57] Given the rise of PAYG solar and the synergies between energy access and digital connectivity, understanding the state of mobile connectivity and mobile usage activity vis-à-vis the state of energy access across a country is essential for both companies and policymakers. Covering 15 African countries, the GSMA Mobile Coverage Maps capture the availability of mobile connectivity in every city or village, estimate how many people can be reached using mobile technologies and provide key information to support the business case for expanding mobile coverage.[58] The GSMA is currently exploring how to make this data more widely available with several key stakeholders in the energy access ecosystem.

MNOs can also enter partnerships with energy utilities to improve urban energy provision through smart metering and monitoring. In Sri Lanka, Dialog Axiata

50. GSMA. (2019). *Mobile for Development Utilities Annual Report: Intelligent Utilities for All.*
51. Dalberg stakeholder interviews.
52. ESI Africa. (2020). *Partnership cultivated to deliver solar-powered farming in Togo.*
53. REA. (n.d.). "The Nigeria Electrification Project (NEP)".
54. Dalberg stakeholder interviews.
55. De Muylder, L. (23 April 2020). "Covid : Quel impact pour les ménages urbains de l'est de la RDC?" *La Libre Afrique.*
56. Energy and Economic Growth. (2021). "Energy Insight: Business model innovations for utility and mini-grid integration: Insights from the Utilities 2.0 initiative in Uganda".
57. Emerging Technology from the arXiv. (29 July 2019). "How much electricity does a country use? Just ask cell-phone users". *MIT Technology Review.*
58. GSMA Network Coverage Maps: https://www.gsma.com/coverage/.

partnered with Lanka Electricity Company (LECO) and University of Moratuwa to install smart meters and smart grid solutions.[59] These new technologies collect data on LECO's power distribution in real time while allowing customers to pre-pay for energy access rather than through monthly bills. The solution enables smart meters and network monitoring devices to be seamlessly integrated on a single platform, providing the utility with greater flexibility, scalability, operational efficiency and convenience. It has also helped LECO digitise its operations by using APIs within the smart grid solution and enabling it to use web-based apps.

For EV charging infrastructure, algorithms and models for site selection require large datasets on locations and potential vehicle travel trajectories (see the Transport section for more detail). Researchers have also used order trajectory data from ride-hailing company Didi to create a forecasting model for urban EV charging demand in Nanjing, China. In India, traffic flow modelling is often complemented by stakeholder participation to ensure the modelling is refined with local knowledge, stakeholder inputs and site-specific factors. Given that the transition to EVs is a global challenge, tools applied in high-income countries, such as the University of California Davis EV Planning Toolkit, shows where people can buy EVs and the location and magnitude of anticipated charging demand. The Georgetown Climate Centre EV Infrastructure Location Identification Tool (ILIT) could be used to support assistance for future charging infrastructure, and could be leveraged and tailored to LMIC contexts.

TRANSPORT

Often, the urbanisation of cities is absorbed primarily by informal settlements and city peripheries where the majority of low-income urban populations live. The lack of affordable and reliable transport services and inadequate transport infrastructure connecting these settlements and peripheral areas to a city's urban core have important social and economic consequences. While residents of informal settlements often work in the urban core, research shows that residents of informal settlements in many cities in LMICs have less access to public, private and informal transport services. In Nairobi, for example, an average of 79 per cent of city residents live within half a kilometre of a matatu (Kenyan mini-bus taxi) stop. This figure drops to 50 per cent for low-income residents.[60] Integrating informal settlements in urban transport systems is critical to productivity and equality of opportunity.

Inadequate and unaffordable public transit options, poorly constructed and unmaintained roads and the high cost of private vehicle ownership, are all barriers to using city transportation networks and, therefore, to equitable access to economic opportunities.[61] Often, dangerous and unregulated informal transportation options, including mini-buses (e.g. matatus and jeepneys), motorbike taxis (e.g. boda-bodas) and auto rickshaws become the only options for motorised transport. However, there is often no data on mobility and usage patterns of informal transportation networks, and without this evidence it is difficult to improve access for urban low-income populations. It is also often overlooked that walking remains the main mode of transport in many Sub-Saharan African cities, especially for low-income residents in informal settlements. Poor planning and pedestrian infrastructure make walking a serious challenge, and this is often perpetuated by policymakers who are not responsive to the realities of daily life in these settlements.[62]

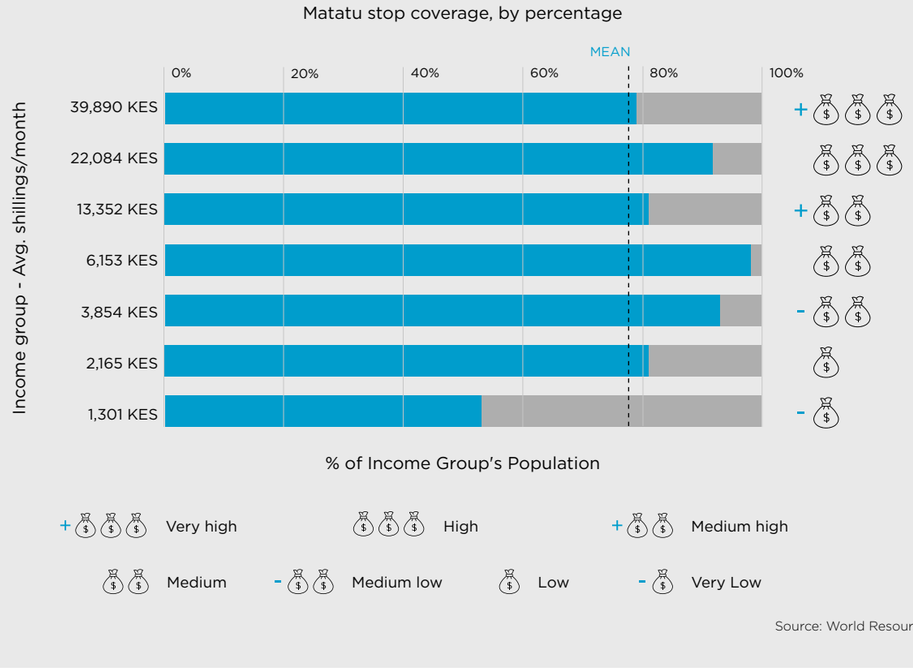
Rapid urbanisation also puts pressure on a city's existing transport infrastructure, resulting in increased traffic congestion, pollution and accidents. The WHO estimates that 1.35 million people die every year from traffic injuries.[64] 90 per cent of these fatalities occur in LMICs even though they have just 47 per cent of registered vehicles globally.[65] Traffic congestion has a direct impact on economic productivity, with the Asian Development Bank (ADB) estimating that road congestion costs Asian economies an estimated two to five per cent of GDP every year due to lost time and higher transport costs.[66]

Historically, the transportation sector has generated more data than other utility service sectors, allowing government stakeholders to plan ways to address traffic-related issues. City transportation agencies and ministries of transportation around the world have drawn on a range of big data use cases to inform decisions on transport planning. Yet, there are significant differences in the sophistication of data use in LMICs. While transport authorities in Southeast Asia and South Asia use big data monitoring tools for both planning and day-to-day management, several transport sector stakeholders in cities throughout West and Central Africa, such as Lagos and Kinshasa, have pointed to the need for more data-driven planning to improve transport systems.

Planning with inadequate or outdated data means that decisions may not align with the current and future needs of cities and their residents. Examples include making greater investments in transport policies that support increased motorisation and the use of private vehicles and further exclude low-income populations; public infrastructure such as bus stops that prioritise routes to rich neighbourhoods; or bans on informal transport modes without adequate alternatives.[67] There

FIGURE 5

Percentage of Nairobi's population covered by a matatu stop, by income, 2019[63]



Source: World Resources Institute.

59. GSMA, Dialog and LECO. (2019). *Internet of Things Case Study: Sri Lanka Takes First Step Towards Smart Grid; Dialog.* (13 February 2019). *Dialog and LECO to Launch Sri Lanka's First IoT Based Smart-Grid Solution to Support Prepaid Electricity Metering.*
60. WRI. (2019). *Integrated Transport Opportunities in Africa: A Review of Nairobi and Kampala.*
61. Faiz, A. (December 2011). "Transportation and the Urban Poor". *ITE Journal-Institute of Transporation Engineers, 81.*
62. The Conversation. (23 March 2021). "People living in African urban settings do a lot of walking: but their cities aren't walkable".
63. WRI. (2019). *Integrated Transport Opportunities in Africa: A Review of Nairobi and Kampala.*
64. WHO. (7 February 2020). *Fact Sheet: Road Traffic Injuries.*
65. Thondoo, M. et al. (December 2020). "Small cities, big needs: Urban transport planning in cities of developing countries". *Journal of Transport & Health, 19.*
66. Asian Development Bank. (2021). Urban Transport.
67. Thondoo, M. et al. (December 2020). "Small cities, big needs: Urban transport planning in cities of developing countries". *Journal of Transport & Health, 19.*

is therefore a need for cost-effective innovations that support data-driven decisions for transport planning that meet the needs of evolving cities.

Data-sharing use case: Of all the sectors addressed in this report, the transport sector is the most advanced in terms of innovative data sources and use cases. With many new private service providers entering the transport space, including ride-hailing technology companies such as Grab, GoJek and SafeBoda, the availability of transport-related data has exploded. These ride-hailing companies collect billions of real-time GPS data points from thousands of drivers in LMICs, creating the ability to visually map traffic patterns.

In the Philippines and Malaysia, Grab has partnered with municipal and national governments and the World Bank Open Transport Partnership. Their open data visualisation tool, OpenTraffic, uses anonymised driver GPS data to understand traffic congestion and make data-driven decisions on transport planning and infrastructure investment.[68] Grab also recently created the AI Lab in partnership with the National University of Singapore (NUS) to use machine learning to make transport networks more efficient across Southeast Asia and to build smarter cities.[69] These partnerships have provided governments with better and more cost-effective visibility into transport dynamics and patterns where only expensive and time-consuming government surveys had existed before.

These types of innovations are also providing more visibility into public sector transport networks. GoMetro, a company that provides mobile transit data to improve urban commuting, has created a GPS tracking app that collects data from public transit networks.[70] Partnering with the municipal government in Kigali and the Ministry of Infrastructure, GoMetro provided data that informed the redesign of their 450-bus network and optimisation of routes. The company has also collected data for government partners in the DRC, Tanzania, Lesotho, South Africa, Botswana and Malawi.

Building on its successful engagements with governments, GoMetro has partnered with Ascendal, a transit operations and advisory company, to create the UK Aid-backed African Urban Mobility Observatory in 10 African cities, which will create a big data web platform of transit-related solutions.[71] It includes analytical tools to track mobility patterns, support transport planning, manage logistics and task administration and allow commuters to plan their journeys. The Observatory aims to push the transport sector to better understand urban transportation dynamics and land use while also catalysing multisectoral partnerships for sustainable mobility projects.

In Thailand, the Toyota Mobility Foundation, Toyota Motors Thailand, Chulalongkorn University, Grab, Bangkok Metropolitan Administration and the Bangkok Metropolitan Police Bureau partnered from 2015 to 2017 under the Rama4 Model project.[72] The partnership leveraged multiple data sources, including Grab data, CCTV traffic sensor data and public bus GPS data to address traffic congestion and provide more efficient public transport options. The project relocated several bus stops, implemented new measures such as reversible lanes during peak traffic hours, identified the best routes for public bus networks and created a shuttle bus service for local schools. The TMF is also partnering with the Da Nang People's Committee (DPC), the municipal government of Da Nang, Vietnam, to implement a similar data-driven project to enhance their bus network system while also addressing traffic congestion, pollution and safety challenges.

Transportation data is also supporting informal and semi-formal transportation networks where data and driving route maps have historically been less readily available. In Kenya, where over 70 per cent of the population rely on semi-formal public mini-buses, the Digital Matatus project used a mobile phone GPS data collection app to map out the matatu system.[73] The project also involved discussions and feedback with a think tank, policy analysts, transportation offices and transport operators.[74] Digital Matutus and other collaborative mapping exercises, such as Mapa Dos Chapas in Maputo, Mozambique, not only generate useful insights for municipalities, but can also empower residents of informal settlements as agents of change. They provide them with the information they need to demand relevant policy interventions, and create the opportunity to engage key stakeholders in a more grounded, coordinated, open, inclusive and integrated transportation process.[75]

While some urban policy makers consider semi-formal transport as a fundamental barrier to more sustainable modes of transport, while for others it does not align with their vision of what a world class city transport system should look like, there are important interventions ranging from optimising networks, improving labor conditions and the commuter experience, or creating an enabling environment for product innovations such as EVs, that can make semi-formal transport more efficient, sustainable, and pro-poor. The Digital Transport for Africa project, which is coordinated by the World Resources Institute (WRI) and financed by Agence Française de Développement (AFD), builds on these efforts to create a collaborative digital commons for innovative transport data on African cities.[76]

68. Grab. (27 September 2018). "Understanding Big Data to Unlock the Future of Smarter Transportation".
69. Open Gov Asia. (20 July 2018). "National University of Singapore and Grab partner to set up AI lab".
70. Future Cities Africa. Video: "Redefining Urban Mobility in Africa".
71. Coetzee, J. (1 August 2020). "GoMetro and Ascendal Mobility Observatory launches in Africa with DFID and UKAid backing". *GoMetro*.
72. Stone, T. (20 November 2019). "Toyota Mobility Foundation supporting project to ease traffic congestion in Bangkok". *Traffic Technology International*.
Stone, T. (21 April 2017). "Toyota Mobility Foundation completes traffic congestion mitigation project in Thailand". *Traffic Technology International*.
73. Bailey, S. and Duggan, B. (28 January 2020). "Nairobi's matatu minibuses are getting a high-tech makeover". *CNN Business*.
74. Williams, S. et al. (December 2015). "The digital matatu project: Using cell phones to create an open source data for Nairobi's semi-formal bus system." *Journal of Transport Geography, 49*. pp. 39–51.
75. Klopp, J. and Cavoli, C. (12 April 2019). "Mapping minibuses in Maputo and Nairobi: engaging paratransit in transportation planning in African cities." *Transport Reviews, 39 (5)*. pp. 657–676.
76. Digital Transport4Africa. (2021).
77. Blumenstock, J., Maldeniya, D. and Lokanathan, S. (16 November 2017). "Understanding the Impact of Urban Infrastructure: New Insights from Population-Scale Data". *Association for Computing Machinery (ACM)*.
78. Putra, A. et al. (2019). "Measuring Commuting Statistics in Indonesia Using Mobile Positioning Data". BPS-Statistics Indonesia. Presentation at the Asia-Pacific Economic Statistics Week, Bangkok 17–21 June 2019.
79. Orange Business Services. (9 November 2017). Presentation: "Flux Vision". AFD.
80. GSMA. (2018). *Telefónica Case Study: Predicting air pollution levels 24 to 48 hours in advance in São Paulo, Brazil.*
81. GSMA AI for Impact Initiative (2021), "Utilising mobile big data and AI to benefit society: Insights from the Covid-19 response".

Mobile big data in the transport sector

The use of mobile big data has become increasingly popular in the transport space as a source of data capable of analysing mobility patterns. Some examples are featured below.

- In Colombo, Sri Lanka, LIRNEAsia, UC Berkeley and University of Michigan leveraged mobile call detail records (CDR) data to study the mobility patterns of nine million people.[77] This data was then used to analyse the impacts of a new highway in the capital, which showed a dramatic change in preferred travel routes, changes in overall travel speeds and reductions in average traffic times.

- In Indonesia, the Bureau of Statistics (BPS) used Telkomsel data to understand commuting patterns within Metropolitan Bandung and nationally throughout Indonesia, opening opportunities to make future planning decisions with the Ministry of Transport.[78]

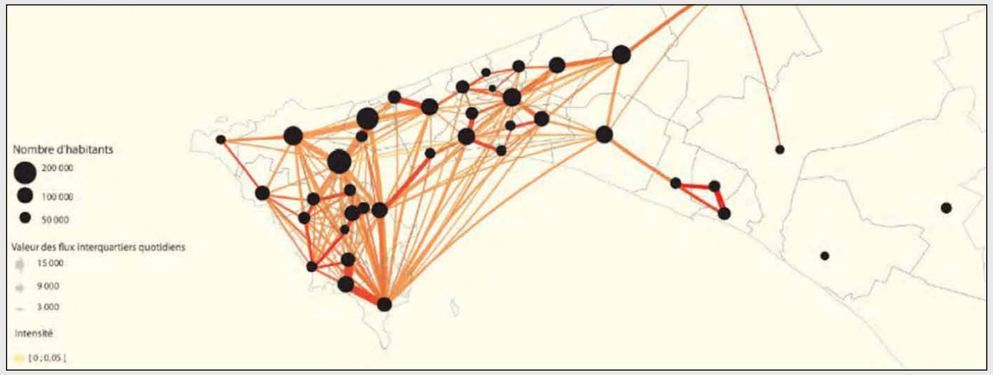
- Orange Flux Vision has identified the transportation sector as one of its key service offerings and has partnered with many private companies and governments to understand population mobility dynamics. In Senegal, Flux Vision partnered with Conseil Exécutif des Transports Urbains de Dakar (CETUD), SYSTRA, Sonatel, Groupehuit and the AFD to use mobile big data for transport planning.[79] Mobile geolocation data from CDR was used to understand movement on peri-urban fringe areas, track mobility changes during events such as floods or holidays such as Ramadan and forecast the impacts of setting up the Baux Maraîchers bus station.

- Telefónica Brazil (Vivo) is working with the municipalities of São Paulo to harness mobile network data to combat the adverse health impacts of air pollution. Developed by Telefónica's AI unit, LUCA, these algorithms use machine learning and anonymised data from the mobile network, combined with data from weather, traffic and pollution sensors, to monitor and predict pollution levels over the entire city. The solution can predict pollution levels 24 to 48 hours in advance, enabling local authorities in São Paulo to take preventive steps if nitrogen dioxide emissions reach levels that endanger human health.[80]

- In Rwanda, the GSMA as part of it's AI for Impact initiative, partnered with the Ministry of ICT and Innovation, the Rwanda Utilities Regulatory Authority, the Rwanda Transport Development Agency and MTN Rwanda to generate insights from mobile big data, combined with transport and infrastructure data, to help optimise national bus routes.[81]

FIGURE 6

Orange Flux vision analysis of mobility patterns in Grand Dakar, 2017[82]



Source: Orange Business Services, 2017

Innovative data sources continue to evolve and push the limits of data-driven transport planning and programmes. With the rise of digitised payment systems in cities, such as Kigali where AC Group provides cashless 'Tap & Go' cards for ticketing that can be topped up via mobile money, mobile payments data could soon become a more relevant data source. Social media is another emerging and important innovative data source. A group of researchers has used nearly 850,000 tweets related to traffic in Nairobi, Kenya, to map these points on OpenStreetMap (OSM) and use machine learning to identify traffic accident locations.[83] This type of data analytics opens up more innovative use cases, such as targeted road safety improvements and urban transport system planning.

A rapidly evolving big data ecosystem brings both opportunities and risks, and new use cases have renewed conversations on data privacy, the anonymisation of data and protection of personal information. Despite the risks, the examples featured here are concrete demonstrations of the utility of innovative data use cases in LMICs, and suggest even greater potential for data-driven transport planning in the future.

Beyond urban utility service delivery, data-sharing PPPs have been used for infrastructure planning, climate change mitigation, disaster management, health and education initiatives and financial inclusion.[84] For instance, in earthquake-prone Turkey, TurkCell has developed a platform called Galata in partnership with the government to use mobile big data to respond to natural disasters, including earthquakes and flooding.[85] With the largest market share in the country, TurkCell has a large user base and processes billions of data points daily. Through Galata, the government can use TurkCell's real-time data and digital platform to send rapid emergency notifications, deploy emergency response teams in affected areas, plan evacuation routes and locate people quickly in the aftermath of natural disasters.

82. Keran, Fluxvision. (2017).
83. Milusheva, S. (3 February 2021). "Applying machine learning and geolocation techniques to social media data (Twitter) to develop a resource for urban planning". *PLOS ONE.*
84. GSMA. (2020). *Mobile Big Data Solutions for a Better Future.*
85. GSMA. (2019). *Utilising real-time mobile analytics to inform emergency disaster response in Turkey.*

The critical role of mobile big data in the COVID-19 pandemic

The COVID-19 pandemic has been a catalyst for partnerships between governments and MNOs around the world. When the pandemic began, it quickly became clear that insights from mobile big data would be critical for contact tracing, tracking disease patterns, population movement and understanding the economic impact of lockdowns on low-income populations.[86] The following are a few examples from the GSMA AI for Impact programme:

- In 2020, a group of stakeholders formed a partnership in the DRC to use aggregated and anonymised mobile datasets to help the government visualise and track mobility patterns during the pandemic. This partnership included the GSMA, Orange Flux Vision, Kinshasa Digital, ANICiiS, Texaf Digital Campus, Africell, Vodacom and Flowminder. MNOs provided their datasets, Kinshasa Digital developed a series of nationwide dashboard visualisation tools and Flowminder delivered data analytics reports, all of which supported the government's COVID-19 response. The GSMA shared lessons learned through the AI for Impact initiative, provided technical support for data science and ensured that the partnership adhered to COVID-19 data privacy guidelines. The government was able to use this data-driven solution to track both the spread of the virus and policy responses. In both examples, stakeholders from across the public and private sectors contributed with their unique strengths to the partnership and collectively used their data for the greater social good.
- In Burkina Faso, a partnership has been established through the GSMA AI for Impact initiative between Orange Flux Vision, the Ministry of Health, Cooper Smith and the World Bank. The objectives of the partnership are to use mobility data to provide the Ministry of Health with insights to optimise resource allocation and support the COVID-19 response and epidemiological surveillance.
- In Benin, the GSMA led a collaboration between the Ministry of Health, Ministry of Communication and the Post, AFRIA and their local technical partner, Otris. Through the partnership, a prototype of a nationwide dashboard was developed to identify districts at high risk of COVID-19 and prioritise the response.

Turning ad hoc collaboration into more permanent partnerships can help prepare for and prevent future crises. Initiatives during the COVID-19 pandemic have mostly been reactive and lost valuable time at project inception. Through sustainable PPPs, mobile big data and AI expertise can support the response to future health emergencies, natural disasters and other unforeseen socio-economic crises. This requires the public sector to take full advantage of the opportunity by developing a culture of data and digital transformation, allocating public investment to big data and AI solutions and engaging the mobile industry as a partner to create these solutions together.[87]

86. Nigeria partnered with mobile network operators to identify vulnerable informal workers in urban areas through airtime purchase patterns. See: Davidovic, S., Prady, D. and Tourpe, H. (22 June 2020). "You've Got Money: Mobile Payments Help People During the Pandemic". IMFBlog.
87. GSMA. (2021). *Utilising mobile big data and AI to benefit society: Insights from the Covid-19 response*

DATA-DRIVEN PPPS: IDENTIFYING SYNERGIES

Across the sanitation, energy and transport sectors, data-sharing partnerships between the public and private sector have the potential to create value for both parties. Each stakeholder brings specific "haves" to the partnership that fulfil the needs of their partner. Together, these determine the synergies, or opportunities for collaboration, between these two stakeholders. This report focuses on four types of stakeholders that could create shared data partnerships with governments to improve urban planning and utility service provision (see Figure 7).

These four types of actors have varying data assets and capacities which, along with their respective motivations, define their level of engagement in data-driven partnerships. While big data holders and private utility service providers typically have innovative data that can benefit the partnership, they also (to varying degrees) have internal data capacity to bring to the partnership if necessary. For example, Orange's data analytics arm, Flux Vision, has very strong mobile data capabilities while Telkomsel in Indonesia has begun to strengthen their data analytics capabilities as a result of data engagements with the Indonesian Government Bureau of Statistics (BPS). However, digital capacity and data analytics skills vary significantly across countries and companies, and between MNOs' larger group level countries of operations. Some MNOs seem to be developing stronger analytics and AI technologies due to increased strategic prioritisation of such services and to meet growing demand of such services in the countries where they operate.

At the very least, big data holders and private urban utility service providers need the capacity to store and share their data with third parties, but they also sometimes clean, pre-process and even analyse their own data. Meanwhile, government stakeholders generally have datasets they want to combine with innovative data, as well as some data capacity depending on their institution's overall level of digitisation. Finally, some partnerships require additional data capacity that technical and/or financial partners can provide.

It is important to note that although the data-related assets and capacities of a data-driven PPP may differ by market and sector, there are overarching themes and common synergies. These opportunities for collaboration reveal the broader benefits and motivations of private and public stakeholders to enter a data-sharing partnership. This is expressed in the "haves and needs" framework in Figure 8.

88. World Bank. (2021). *World Bank Development Report 2021: Data for Better Lives.*

FIGURE 7

Types of stakeholders partnering with public institutions in data-driven PPPs for urban planning

Big data holders

These are companies gathering high-volume, high-speed and/or diverse data, such as MNOs and enterprises using their network, global companies offering services through mobile apps, remote sensing companies or enterprises that own web browsers. Other big data holders include large technology companies like Facebook, Google, Apple and Amazon, which collect billions of data points through their various platforms and product offerings. According to the World Bank Development Report 2021, which focused on data for development, six US companies (Google, Facebook, Netflix, Microsoft, Apple and Amazon) generate 40 per cent of global internet data flows, and Google, YouTube (which is owned by Google) and Facebook are among the top 10 most visited websites in 62 of 77 LMICs.[88] While lessons from this report will also be relevant to PPPs with large technology companies such as Facebook, this report will concentrate on MNO data, as increased mobile penetration in LMICs has made it especially relevant.

Private service providers

These are private companies or non-profits that provide urban utility service provisions to fill an unmet gap. Private urban utility service providers have leveraged new technologies to deliver cost-effective services. In the process, they have begun to generate or collect large amounts of customer and consumption data on their own digital platforms, as well as on their network.

Technical partners

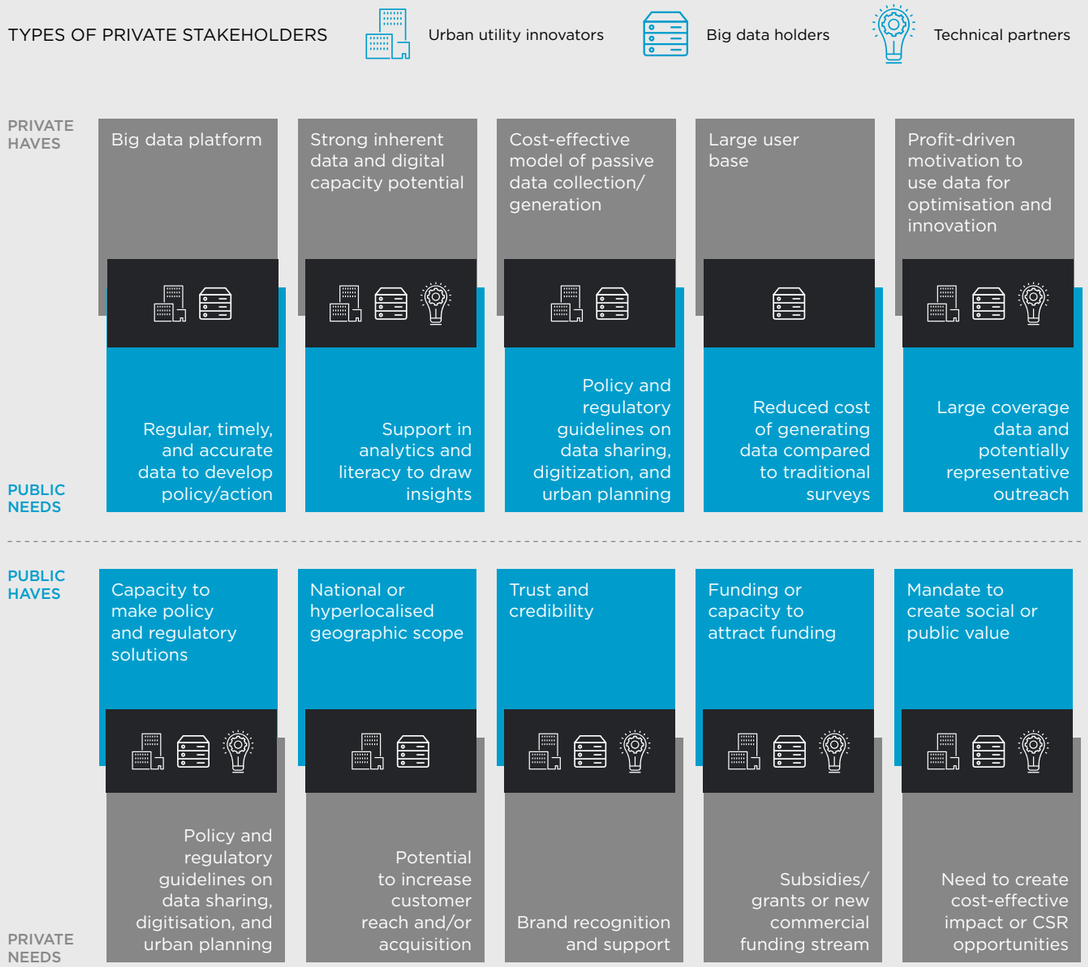
These are private companies that specialise in the provision of data science services, including hands-on data management (from data collection to dissemination and consumption of insights), data strategy advisory and data or broader digital capacity building.

Financial partners

These include institutions like development finance institutions (DFIs), banks, governments, NGOs and foundations that provide financial support to establish and sustain data-driven PPPs. Financial partners consider support for data-sharing PPPs as a vital part of achieving their development objectives. In some cases, the financial partner also provides technical support, such as capacity building or counselling for partners.

FIGURE 8

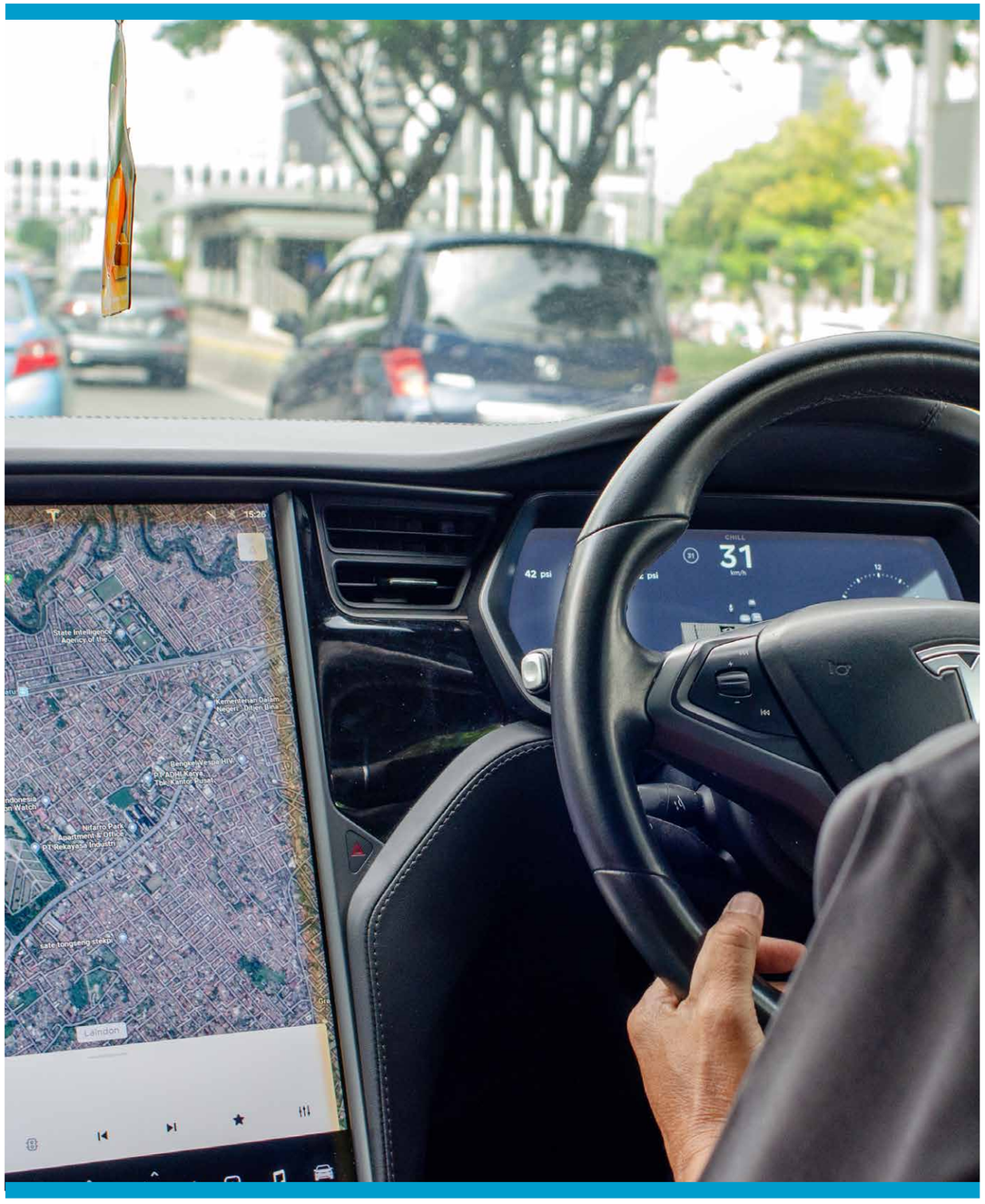
A haves and needs framework for data-sharing PPPs



When accessing innovative data from private sector stakeholders, governments can leverage large and representative datasets to generate cost-effective insights that can be translated into policy solutions. Private sector actors, in turn, can navigate regulatory frameworks while scaling their businesses, benefit from increased trust or customer acquisition and, at times, generate new commercial funding streams. This type of public-private engagement has increased over time due to these synergies and the expanding potential use cases for innovative data sources.

However, the case studies in this report have revealed that these benefits and incentives are not enough to initiate, successfully conduct or sustain data-sharing PPPs. A series of enabling factors also has to be considered, and these are documented in the next section.

Emerging Insights



THE PPP JOURNEY MAP FRAMEWORK

While there are differences between markets, sectors and stakeholder types, all partnerships go through a similar basic process. The "journey map" framework in Figure 9 details the lifecycle of data-sharing partnerships between public and private stakeholders and the steps they need to follow to ensure strong coordination. These four key stages are: 1) Partnership formation, 2) Data management, 3) Impact and usage and 4) Sustainability.

It is important to note that the PPP journey map is not a linear, but a dynamic process. The PPP can begin informally at the data management or sustainability stage rather than by taking steps to formalise a concrete partnership framework. These stages can also occur simultaneously and move back and forth. The PPP journey is extremely diverse and reflects the adaptable nature of PPPs in different contexts.

However, the PPP journey map framework shows best practices and how the different stages of the framework relate to each other. For example, while a partnership can begin more informally at the data management phase, many important downstream challenges may arise if a data framework was not determined in the partnership formation stage. Furthermore, assessing the impact of data insights or policy solutions may be difficult if the data was improperly managed (data management) or if a concrete use case was not developed (partnership formation).

FIGURE 9

Journey map for data-driven PPPs

PARTNERSHIP FORMATION

This stage of the PPP journey is clearly the most important, as all stakeholders must come to several levels of agreement to prevent major challenges from arising throughout the partnership. While there may be differences in terms of which party initiates the conversation, both private and public stakeholders must consider the following issues:

- Scoping and use case: Partnerships identify the key stakeholders required for the engagement, determine the skills and capabilities of all stakeholders, assess the potential utility of the use case and how it links to a public policy/service provision challenge and align on the use case for the data-driven innovation created by the partnership.
- Governance framework: Partners delineate the roles and responsibilities of each stakeholder, reach agreement on the terms and processes of all stages and establish risk mitigation measures.
- Financial agreements: All stakeholders agree on the funding or commercial models for data sharing and engagement.
- Data framework: Partners design all the steps involved in data management, from collection to dissemination, and from quality assurance to data privacy and security.

DATA MANAGEMENT

The second stage of the PPP journey builds on the use case that has been determined and how the data will be managed. Responsibilities for different parts of the data management process can be assigned depending on the digital capabilities of the partners. If neither of the primary partnership stakeholders are capable or willing to carry out certain data activities, a technical partner can fill this gap and join the partnership. The data management level includes:

- Collection, storage and processing: The relevant stakeholder not only collects and processes the data, but also builds the necessary system and infrastructure for all stakeholders to engage with the data (if they have access to it). The data systems and infrastructure prioritise data quality, accessibility and interoperability to ensure the data can be used by a variety of stakeholders and tools.
- Exploring and analysing: The relevant partners explore the processed data, merge the data with other data sources at an aggregated level and analyse it to generate actionable insights. A third-party technical partner can also be involved at this stage if external capabilities are required, including in data analytics, geospatial analysis or modelling.
- Security and privacy: Stakeholders ensure all security and privacy protocols for managing the data are followed and monitored throughout the entire process.
- Quality assurance: The partners conduct quality assurance checks that have been built into the data framework.

IMPACT AND USAGE

At this stage of the partnership, insights have already been generated from the data and can be consolidated for dissemination. Stakeholders can also translate these insights into action or policy development as part of the data use case. This step is important to ensure that the partnership has an impact on the sector-specific challenges and the key populations affected by these challenges. This level includes:

- Impact assessment: Based on their insights, the partners can understand and assess the impact of the data sharing use case on key beneficiaries.
- Synthesis and dissemination: The insights are synthesised and disseminated to share lessons with other relevant stakeholders or the public.
- Data-driven actions: Stakeholders translate insights into data-driven action through additional programmes or development projects.
- Data-driven policy: Public stakeholders design and implement policy solutions informed by data insights to address systemic issues or enable additional insights in the future.

EVALUATION AND SUSTAINABILITY

This stage of the PPP evaluates the entire process, identifies areas for improvement and puts systems in place to ensure it is sustainable. While not all partnerships value sustainability, continued engagement of public and private stakeholders ensures that the solutions and actions can evolve and continue to address the challenges of the sector. This level includes the following:

- Evaluation: This step provides space to evaluate the partnership, engagement framework, barriers to translating insights into action and data management. These lessons will guide future iterations of the partnership.
- Partnership sustainability: Stakeholders determine whether and how the partnership will continue and discuss how to refine future engagement frameworks and terms of agreement.
- Data sustainability: Partners agree on continued data sharing and how the data will be managed jointly in the future.
- Financial sustainability: With data becoming a greater asset for private sector stakeholders, there may be additional conversations on updating the financial agreements for the partnership.

FIGURE 10

Enabling factors for data-driven PPPs

ENGAGEMENT MODEL

- Key stakeholders;
- Stakeholder and process alignment;
- Financial agreements;
- Business and impact case; and
- Sustainability.

DATA AND TECHNOLOGY

- Digital connectivity and infrastructure;
- Digital literacy and capacity;
- Use case development;
- Data framework; and
- Tools and infrastructure.

REGULATION AND ETHICS

- Data privacy;
- Sharing limitations and intended purpose; and
- Representation, inclusion and cultural sensitivity.

INDIRECT MOTIVATIONS

- Digital strategy;
- Previous engagements and relationships;
- Organisational strategic priorities; and
- Trust, transparency and reputation.

ENABLING FACTORS FOR DATA-DRIVEN PPPS

Throughout the course of the PPP journey, there are many enabling factors that can either be a barrier to the partnership or help to facilitate it. Based on research and stakeholder interviews, we have identified four key categories of enabling factors.

Engagement model

While the engagement model of the PPP is largely determined at the partnership formation level, it is relevant throughout the partnership. Without a proper model for different stakeholders to engage and a plan for partnership sustainability in place, the partnership may encounter many challenges later. The engagement model has five critical challenges and enablers that affect its success: key stakeholders, stakeholder and process alignment, financial agreements, sustainability and the business and impact case.

Key stakeholders

This enabling factor emphasises selecting the right stakeholders for the partnership, including the organisations included in the partnership, the number of individuals who will regularly engage with each other and the level of influence these individuals have within their respective organisations. Selecting the right partner organisations ensures that all the necessary skills, capacities and technical knowledge are in place for successful governance and stakeholder interactions. This may mean bringing in additional third-party organisations to fill skills gaps, such as a data analytics company, or to contribute technical knowledge, such as the World Bank's Development Impact and Evaluation Unit, the GSMA or the Digital Impact Alliance. However, having too many stakeholders might slow decision-making processes and create a bureaucratic working environment.

In terms of stakeholder influence, the representative or key point person from each organisation must have adequate influence within their organisations to push the partnership and its key mandates forward. This therefore requires a mid- to senior-level staff member. This person needs to be a "champion" of the partnership who recognises the potential value of the partnership and is motivated to push its objectives forward, both within the partnership and their organisation (see Case study: NYU Ethiopia Urban Expansion Initiative, Ethiopia).

In urban utility service partnerships, private utility service providers typically engage with local municipal governments and their respective utilities departments (see the example of Gather in Case study: Antananarivo Sanitation Data Hub, Madagascar). Our research revealed that innovative data-sharing PPPs often involve partnerships with local government stakeholders as they often have regulatory and implementation authority over local services. However, this can vary by sector, as regulatory authority and service provision for basic services such as water and sanitation differ across countries. For instance, in Dhaka, Bangladesh and Kampala, Uganda, city governments are responsible for faecal sludge management while in Lusaka, Zambia, it is the water utility, the Lusaka Water Supply and Sanitation Company.

Many private sector and other types of government partners have stated that government counterparts may have less data analytics skills or less time and resources. Certain government agencies that do have greater digital capacity and analytics skills, such as the statistics or technology departments, may serve as key partnership facilitators and champions. In our view, a model of piloting data-driven solutions in selected cities accompanied by rigorous evaluation, could potentially create a pipeline of nationally scalable solutions, while reducing risks and maximising potential returns for national governments. This is exemplified by the Citywide Inclusive Sanitation Services Assessment and Planning (CWIS SAP) tool, which through pilots across multiple cities in Africa could induce countries as a whole to take a more data-driven, innovative, and inclusive approach to non-sewered sanitation in African cities.

Stakeholder and process alignment

Key enabling factors in stakeholder alignment and processes include clear delineation of roles and responsibilities, decision-making and accountability mechanisms and a clear, mutual understanding of all partnership terms and stages. Stakeholder alignment ensures that each stakeholder has a clear understanding of their own responsibilities, such as data management or policymaking, and that there are processes in place to hold different stakeholders accountable. Decision-making processes, platforms for communicating and meeting

regularly and channels to provide feedback, all provide pathways for cohesive engagement and alignment. While some partnerships will have clear delineation of stages in the partnership with quantified milestones and KPIs, the nature of particular use cases or the context in which use cases are implemented (for instance, health emergencies) may mean that certain partnerships cannot be conceptualised in terms of stages and will need to follow a more dynamic framework. Instead, as represented in the journey mapping framework (Figure 9), many of the partnership stages will involve a feedback loop and reiteration as the partnership evolves.

Financial agreements

The financial aspect of the engagement model is critical and likely to vary significantly from partnership to partnership. Key enabling components may include a signed contractual agreement that stipulates how different partnership activities will be funded, and what the contributions or relevant deliverables are for each stakeholder group. From a private entrepreneur or MNO perspective, there might be a commercial model in place through which government institutions or their donors can acquire relevant anonymised datasets. A budget must be established for data acquisition. Some might argue that private sector stakeholders, such as MNOs, should simply make data available for free through philanthropic initiatives, but such an approach does not account for the internal trade-offs that must be made and that ultimately might lessen the transformational potential of mobile big data. As demonstrated by the GSMA AI for Impact programme, purely philanthropic models require a cash trade-off from other business areas given the inherent cost of extracting and, in some cases, analysing mobile indicators. As the volume and scope of mobile big data solutions increases and pressure on margins for traditional mobile operator services intensifies, other business models for data sharing become more relevant.[89] In the context of mobile big data, the GSMA AI for Impact programme has identified five different business models (see Figure 11).

Business and impact case

Clear business and impact cases for public and private partners are a key enabler for data-sharing PPPs, while the absence of them can lead to ineffective and unsustainable partnerships. Since partners may have very different motivations for entering a partnership, stakeholders or third-party organisation must facilitate a conversation on the business and impact case of the partnership and reach agreement on definitions of success. For private stakeholders, this often means that the partnership will provide a financial, commercial or strategic benefit to the company. For example, data-sharing PPPs can provide a new revenue stream, increase existing revenue streams, yield new insights on existing or new customers, improve the regulatory and policy environment through greater awareness of the potential of digital innovation or support the growth of the digital and data ecosystem, which creates new opportunities for digital payments, e-commerce and data use cases. For public sector stakeholders, a clear impact case that demonstrates the ability of the data-sharing PPP to create social good or public value is essential. While the motivations of different partners may not appear to align at first, data-sharing PPPs provide an opportunity to create a win-win partnership through the development of an aligned business and impact case for all stakeholders.

There are some notable differences between partnerships funded by governments than those funded by an external donor. In most of the case studies featured in this report, there are fewer partnership examples in which governments paid for data-sharing engagements. In part, this is due to the relative novelty of these kinds of partnerships, but it is also because government institutions in LMICs face fiscal constraints that make it difficult to justify using scarce public funds to acquire data analytics tools with uncertain impact and relevance in exploratory use cases.[90]

Many LMICs also struggle to properly fund national statistical offices that collect crucial foundational data, which are vital for data analyses that draws on more innovative sources of data. PARIS 21, a global network of statisticians, policymakers, analysts and development practitioners, seeks to close this gap by facilitating capacity development and donor support for data and statistics. According to a recent report quantifying donor support for data and statistics, support is concentrated in just a few recipient countries with the top 25 recipients receiving nearly half of the total support dedicated to 165 countries. This suggests that addressing critical gaps in development data will require a greater share of both domestic and external funding.[91] In low-income countries in particular, external donor funding is usually an important catalyst for data-sharing partnerships, as there is an understanding that a more sustainable financing model will be created with greater government spending or other sustainable funding models. In all four sectors examined in this report, donors and large philanthropic foundations play a key role.

For non-donor funded partnerships, the transport sector provides the most examples. This may be driven by the high degree of private sector digitisation that generates a significant amount of data that can be analysed and, therefore, more evidence about the potential impact and utility of use cases for innovative data in the sector, as well as greater data capacity and digital literacy among the key actors and stakeholders in the sector.

A predominantly donor-led context might reduce incentives to establish a more government-led financing model and, by extension, government buy-in and accountability for the partnership objectives. However, data-sharing PPPs are still relatively new, and most governments are still coming to understand the potential of innovative data sources. While governments might be initially hesitant to fund projects without more financial resources and evidence of the development returns associated with these partnerships, donor-funded pilots can both raise awareness of the potential of data sharing and increase government capacity to engage with the private sector in the future. In some countries, governments mandate the provision of, and access to, private company data in certain circumstances, or make certain support measures or licences for the private sector subject to a certain level of data access. For example, certain governments require Grab, a ride-hailing fintech and e-commerce 'super app' in Southeast Asia to provide their data in order to operate in the country (see Case study: OpenTraffic, Philippines).

Although this can be an interesting approach to ensuring greater data access in LMICs, its usefulness must be evaluated on a case-by-case basis. Successful data partnerships must also be evaluated based on whether they enable concrete outcomes beyond mere data acquisition.[92]

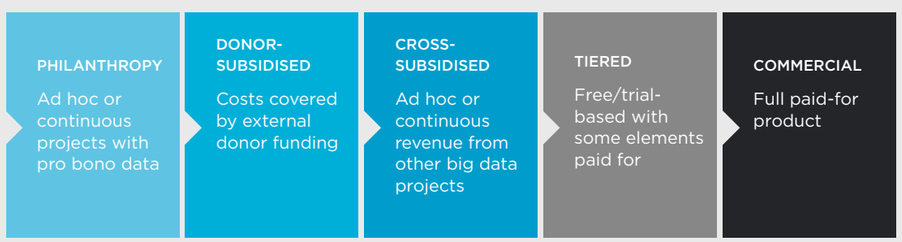
Sustainability

Sustainability plans for the partnership, financials and data sharing are key enablers of the engagement model. These should be designed to guide a definition of success so that the impact and value of the engagement can be continually evaluated and improved. While there is considerable interest in providing financial support in the early stages of data-sharing PPPs to pilot and test the viability of various use cases, less funding is available for the on-going maintenance and sustainability of these partnerships.

89. GSMA. (2018). *Scaling Big Data for Social Good: The Need for Sustainable Business Models*.

FIGURE 11

A typology of mobile big data partnership business models



Source: GSMA, 2018

90. Dalberg stakeholder interviews.
91. PARIS21. (2020). *The Partner Report on Support to Statistics: PRESS 2020*.
92. Dalberg stakeholder interviews

Concrete evidence from evaluations is often missing, but could be used to make the case for more funding.

Managing partners' dependence on data and building trust are also vital to the sustainability of data-sharing PPPs. Some public stakeholders may not want to become dependent on a private dataset or one that is captured by a particular data analytics provider given the potential risks involved. For example, a private company may terminate operations, use data standards with limited interoperability or begin to charge much higher prices for access to their data.

Consequently, a conversation that establishes trust and clearly outlines a plan for long-term sustainable engagement is important at either the onset of the partnership or immediately following a pilot. However, given that many use cases and their underlying impact and effectiveness are still unproven, it may be difficult to envisage long-term engagement models at an early stage. This makes it even more important to have long-term and patient financial support and agile engagement models that leave room to fail, learn and iterate.

The type of output and time frame for the data analytics produced by the data-sharing PPP are also important to consider. Some outputs cover a long time horizon and, therefore, do not require plans for recurring updates. This is the case for some large donor-funded programmes, such as the Ethiopia Urban Expansion Initiative, which is intended to support the planning of the arterial road grid in Ethiopia's secondary cities over a 20–year time horizon. While there is not a planned reiteration or second phase to this initiative in the same cities of implementation, the Urban Expansion Initiative has since expanded to other cities and country contexts (see Case study: NYU Ethiopia Urban Expansion Initiative, Ethiopia).

Data and technology

Data management is at the heart of any data-sharing PPP, which makes data and technological factors significant enablers or barriers to the partnership. Some of these factors are systemic while others are unique to the partnership. They include the data and technological ecosystem, use case development, the data framework, digital literacy and capacity and tools and infrastructure.

Digital connectivity and infrastructure

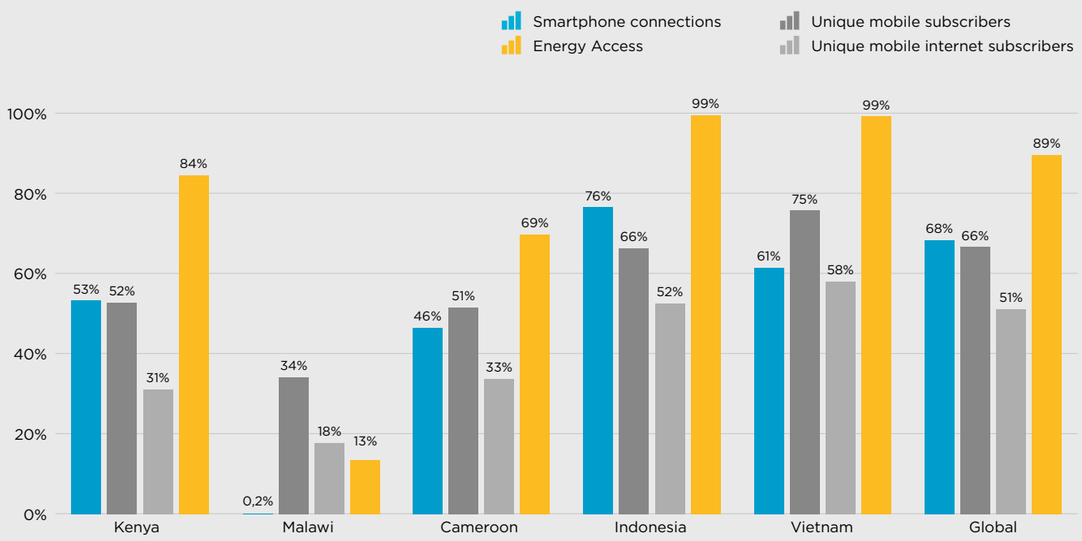
LMICs are at varying levels of digitisation. Widespread digital infrastructure, the maturity of a country's digital ecosystem and reliable energy are all key enabling factors affecting the feasibility of the use case and data-sharing PPP (see Figure 12). Without adequate digital connectivity, mobile and computing technology, databases and electricity, data may not be representative or able to be stored safely and analysed domestically.

The World Bank's 2021 World Development Report stresses that most LMICs do not have the domestic infrastructure required for locally generated data to be exchanged (via internet exchange points, IXPs), stored (at co-location data centres) and processed (on cloud platforms) (see Figure 13).[93] Less than one per cent of the world's data centre capacity is in Africa, according to Xalam Analytics. While Africa's data centre industry is expected to grow to 600 megawatts in 2020 with Vodacom/Safaricom, MTN, Rack Center Nigeria, Africa Data Centres and Teraco holding more than 95 per cent of data centre capacity in the region, chronic power challenges continue to limit the region's digital competitiveness. Data centres are vital to internet infrastructure as they centralise data storage, computing power and networking equipment, and require reliable and affordable access to energy.[94] As the Energy for Growth Hub suggests, "Ministries of information and communication technology need to turn to their Ministry of Energy colleagues and emphasise, 'No power, no digital transformation'."[95]

93. World Bank. (2021). *World Bank Development Report 2021: Data for Better Lives*.
94. Mutiso, R. and Hill, K. (5 January 2021). "Powering Africa's Data Infrastructure: No Power, No Digital Transformation". *Energy for Growth Hub*.
95. Mutiso, R. and Hill, K. (11 August 2020). "Why Hasn't Africa Gone Digital?" *Scientific American*.

FIGURE 12

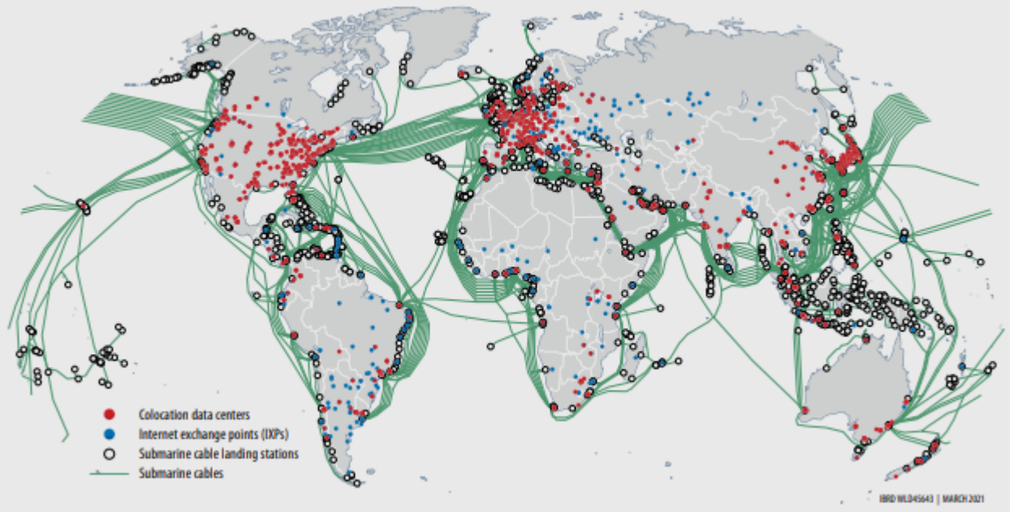
The energy and digital connectivity landscape varies widely across LMICs



Source: GSMA Intelligence and International Energy Association

FIGURE 13

Data infrastructure is not yet widespread in all parts of the world



Source: World Bank, Word Development Report 2021, Data for Better Lives.

The digital strategies of private and public sector stakeholders influence the maturity of data and technology ecosystems (see the Indirect motivators section). According to the 2020 GSMA State of Mobile Internet Connectivity Report, of the four billion people who do not yet use mobile internet, the vast majority – 3.4 billion – live in an area already covered by mobile broadband. This gap is now six times greater than the mobile coverage gap. While handset and data prices have fallen on average across LMICs, there is still tremendous scope for governments to make internet-enabled handsets and data services more affordable, support the expansion of local digital ecosystems with relevant content and services and expand access to networks and enablers (e.g. electricity, training and sales facilities, formal IDs).[96]

The pace of digital transformation across LMICs suggests that possibilities for data-sharing PPPs will increase significantly. GSMA Intelligence predicts that smartphone penetration in Sub-Saharan Africa will increase from 44 per cent in 2019 to 65 per cent in 2025,[97] and the mobile internet penetration rate in Asia Pacific will increase from 48 per cent in 2019 to 61 per cent in 2025.[98]

Digital literacy and capacity

Digital literacy and capacity can vary significantly by country and local municipality and, in data-sharing PPPs, by stakeholder. There may also be differences between public sector institutions, and certain skills gaps may make it difficult to establish partnerships and require third-party companies to provide technical knowledge or services. For example, Singapore's Government Technology Agency (GovTech) is leading initiatives to develop the government's capabilities and use of data science and AI. Through a partnership with the ride-hailing company Grab, the Government of Singapore has been able to lead and conduct its own data analytics. In the Philippines, however, a partnership with Grab required the support of a third-party data analytics provider (see Case Study: Open Traffic, Philippines). In Madagascar, the local municipality (Commune Urbaine d'Antananarivo) and the government waste utility (SAMVA) were able to rely on their own team of data scientists and geospatial analysts (see Case Study: Antananarivo Sanitation Data Hub, Madagascar).

It is therefore important to take a granular, case-by-case approach to assessing digital capacity in LMICs. The Harvard Kennedy School has developed the Digital Maturity Indicator, a tool to help organisations measure, benchmark and accelerate their digital maturity. It has six dimensions, including political environment, institutional capacity, delivery capability, skills and hiring, user-centric design and cross-government platforms.[99] Together with Public Digital, a digital transformation agency, the tool was used to survey digital maturity within Madagascar's government and create a three-year roadmap for digital transformation that makes the most effective use of available funding and builds capacity over time.[100]

The digital capabilities of governments can strengthen over time, either through public sector transformation strategies as mentioned above, or through increased digital and mobile penetration and piloting data-driven use cases that can stimulate "learning by doing" and raise awareness of digital capabilities. For example, some governments that engaged with MNOs and their big data platforms during the COVID-19 pandemic developed their digital literacy and are now exploring additional data use cases.

The retention of experienced data scientists and researchers in LMICs is another challenge, particularly in the public sector, given global demand and higher potential salaries in innovation hubs such as North America or Europe. However, what some lament as "brain drain" can also lead to "brain circulation" with many scientists from countries such as China, India and Nigeria who initially sought experience in world-class organisations abroad to make substantial contributions at home.[101] The International Finance Corporation (IFC) and Google estimate that there are nearly 700,000 professional software developers in Africa, with more than 50 per cent concentrated in five key markets: Egypt, Kenya, Morocco, Nigeria and South Africa.

The rise of informal education channels, greater gender diversity and proactive government support are all making software development more accessible to a wider audience. However, more advanced digital skills, such as AI, scientific computing and human-computer interaction, are still not widespread and may require reliance on foreign partners.[102] While capacity building may help to build a more advanced digital skills base, staff retention will continue to be a challenge in LMICs. Participation in well-funded and innovative data-sharing PPPs may provide opportunities for longer term staff retention, however, as many data scientists and developers working on these projects are showing a willingness to forgo higher potential salaries elsewhere to work on projects that contribute to national development objectives.

Finally, some governments also have agencies dedicated to facilitating and coordinating digital initiatives, such as A2I in Bangladesh, the National Information Technology Agency in Ghana and the National Information Technology Authority in Uganda. Those agencies can play a digital capacity building role for other public institutions.

Use case development

A critical part of establishing a data-driven PPP is a clear use case that identifies the intended purpose, relevant end users, feasibility and potential policy implications. An unclear use case may complicate stakeholder alignment and commitment and may translate into less concrete results and final analytics that are not necessarily relevant for policy action. Interdisciplinary teams that have the digital capacity to understand the potential use cases of available datasets while also understanding the policy and sector context and key public policy objectives, are particularly important to the development of use cases. In their MD4D Handbook, the Digital Impact Alliance and Data-Pop Alliance stress that every mobile big data project needs to identify the right set of technical capacities needed for the project. These typically include:

- Project manager: to liaise with all internal and external stakeholders;
- Data scientist: highly skilled in methods and tools needed to extract insights from datasets;
- Data engineer: builds the infrastructure needed to process, transfer and store data;
- Data visualisation specialist: able to create interactive and/or visual outputs of the project data;
- Data privacy expert: has a deep understanding of privacy, laws and regulations regarding the use of data; and
- Humanitarian and development practitioners: have a thorough understanding of the project and can leverage their knowledge to provide resources for those in need.[103]

In the case of innovative data-sharing PPPs for urban planning, a government liaison that attends all relevant meetings and highlights local and governmental priorities is an equally important member of a team.

Ideally, the development of use cases begins once the partnership is established, and the process may be supported by a third-party actor if the government or private company lacks the necessary digital capacity or understanding of the data's potential. The partnership engagement framework should ensure there is room for constant iteration and incorporation of feedback from end users.

Data framework

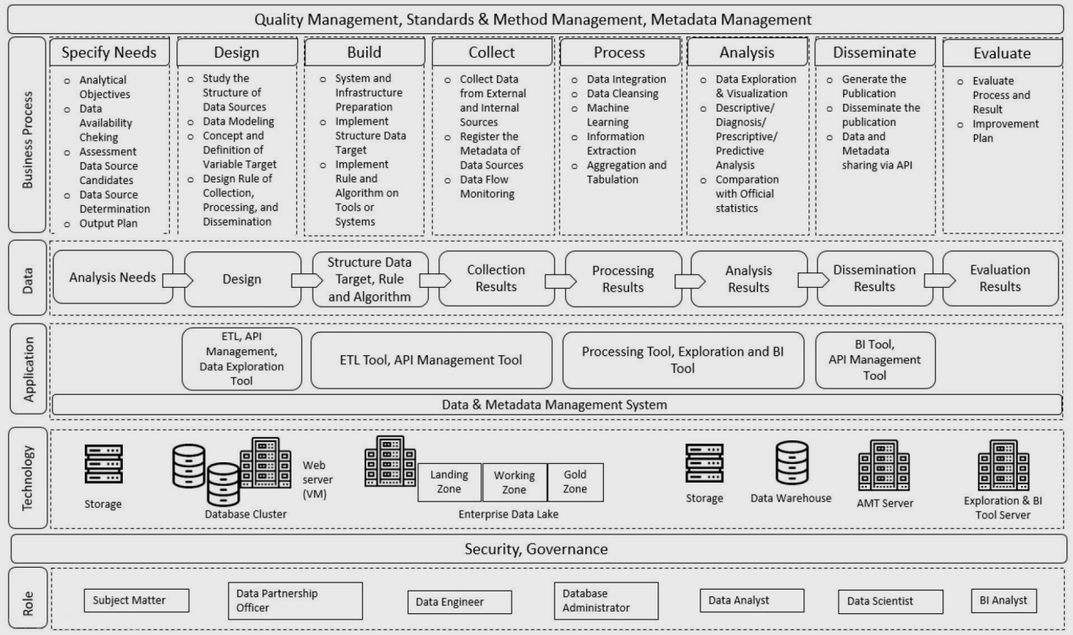
A collaborative and comprehensive design of a data framework is a key enabler of a successful data-sharing PPP. Every step of the data management process, beginning with data collection, must be carefully planned. This includes developing accurate algorithms, metadata documentation, quality assurance protocols and security measures. Without a comprehensive data framework and alignment of all stakeholders, the data partnership may not be properly executed or it may produce inaccurate insights.

Data security is an important enabler within the data framework, and involves protection against potential data breaches and protection of intellectual property. Data security regulations are critical to ensuring that the PPP implements the necessary protocols and technologies to ensure all data that is shared is secured. Potential data breaches can have a negative impact on confidentiality and trust, and the data may be used for unintended purposes. In addition, protection of intellectual property creates an environment in which private stakeholders are more willing to share their data and technologies as they will not be losing their competitive advantage.

96. GSMA. (2021). *Accelerating mobile internet adoption: Policy considerations to bridge the digital divide in low- and middle-income countries*.
97. GSMA. (2020). *Mobile Economy: Sub-Saharan Africa*.
98. GSMA. (2020). *The Mobile Economy: Asia Pacific*.
99. Stephenson, L. (2019). "How we're adapting the Harvard Kennedy School's 'Model for Digital Maturity' for use in Australian government". Code for Australia.
100. Public Digital. (2020). "A roadmap for digital transformation in Madagascar".
101. Saxenian. A. (June 2005). "From Brain Drain to Brain Circulation: Transnational Communities and Regional Upgrading in India and China". *Studies in Comparative International Development, 40*. pp. 35–61.
102. Google and IFC. (2020). *e-Conomy Africa 2020*.
103. Digital Impact Alliance. (2021). *MD4D Handbook*.

FIGURE 14

Example of data framework applied by BPS in a collaboration with Telkomsel[104]



Source: BPS

Tools and infrastructure

Having the necessary tools and infrastructure to implement the data framework is another critical enabler. The management of data requires complex infrastructure, including:

- On-site data centres or cloud computing where the main vendors are Amazon Web Services, Google Cloud Platform and Microsoft Azure (see "Sharing limitations and intended purpose" in the Regulation and ethics section);
- Data storage tools (such as relational and non-relational databases and event systems like Hive and Kafka);
- Data processing and analysis tools (e.g. Python and R, as well as Hadoop, Spark and TensorFlow for large amounts of data); and
- Data dissemination tools for large amounts of data (e.g. dashboards with proprietary solutions like Microsoft Power Bi and Tableau, or with open source solutions based on standard web development technologies like JavaScript, CSS and HTML).

These tools and underlying infrastructure must be both technically sufficient to complete the data framework yet sufficiently user friendly for those with less access to technology and lower digital literacy and capacity. In partnership with Grab in the Philippines, the World Bank and Conveyal created OpenTraffic, a user-friendly traffic visualisation tool that the Cebu City Transportation Office could use to understand traffic congestion patterns and commuting times. As the local municipal government did not have the capabilities to run their own data analytics, OpenTraffic offered an extremely thorough yet simple tool for government stakeholders to make decisions on transport planning, investments and policies (see Case study: OpenTraffic, Philippines).

Tools and infrastructure developed to manage data should prioritise FAIR principles: Findability, Accessibility, Interoperability and Reuse of digital assets. Since data tools and services are constantly emerging and changing, many companies and institutions risk perpetuating data and technology silos and working with data that cannot be used readily by other actors. Therefore, FAIR principles – applied through open data standards and open source technologies – should be prioritised to ensure data and data-driven solutions can be applied by all stakeholders using various tools.[105] This was a key focus of Gather's work in Antananarivo, Madagascar, where they researched the accessibility of available sanitation data and lack of data standardisation. After assessing the difficulty of downloading and manipulating various datasets, they noted that certain data was formatted for specific analytics software that were not accessible to some government stakeholders. Other datasets were not accurate or incomplete. Therefore, Gather developed standardised guidelines for sanitation data that would help the sector make datasets more usable for different stakeholders. They also created a framework for minimum specifications to ensure the completeness of data and interoperability (see Case study: Antananarivo Sanitation Data Hub, Madagascar). It should be noted that in cases where data is deemed particularly sensitive from a commercial, privacy or political perspective, insistence on FAIR principles might not be the right approach and could make private sector stakeholders, such as MNOs, less likely to share their data insights.

Open source algorithms and code provide additional avenues for data collaboration and interoperability. They provide a certain degree of transparency into how data is processed, particularly big data, and an opportunity for datasets to be used by many different stakeholders. In the context of COVID-19, several data scientists and software developers have improved user interfaces and data visualisation tools using openly available government estimates and insights. In France, this is exemplified by ViteMaDose, a website that in two clicks scans disparate French health sites for scarce vaccination slots.[106]

These types of data standards and open data can be enforced by governments or according to the preference of a large donor. For example, the World Bank, International Monetary Fund (IMF) and Inter-American Development Bank (IDB) have launched the Development Data Partnership, a platform that facilitates more open data sharing between private companies and international organisations to use data for research and development-related projects. Other initiatives, such as NYU's GovLab, use "data collaboratives" to transcend PPP models that are limited to just a few organisations, creating a platform that can be used by many, including research institutions, to exchange data to solve public problems.[107] For example, in Europe, several MNOs have made anonymised datasets available, enabling researchers to track calling and commuting patterns and gain better insight into social problems, from unemployment to mental health.[108] In the United States, LinkedIn is providing free data on demand for IT jobs in different markets which, when combined with open data from the Department of Labour, helps communities target their training efforts.[109]

Regulation and ethics

Since data sharing and management is a key component of a PPP, there are many potential regulatory and ethical enabling factors. These include data privacy, sharing limitations, intended impact and social inclusivity.

Data privacy

Because of confidentiality issues and potential privacy risks, the use of any data is governed, shaped and constrained by national regulation. Many international institutions and governments have begun to enact their own data privacy principles and guidelines, including the

104. Noviyanti, I. et al. (2020). "Towards big data as official statistics: Case study of the use of mobile positioning data to delineate metropolitan areas in Indonesia." *Statistical Journal of the IAOS, 36.* pp. 943–954.

105. GO FAIR. (n.d.). "FAIR Principles".
106. The Economist. (1 May 2021). How France's data scientists are upstaging its administration.
107. GOVLAB.
108. Lam, B. (1 June 2015). "What Could Economists Do With All That Cell-Phone Data?" *The Atlantic*.
109. Noveck, B.S. (24 September 2015). "Data Collaboratives: Sharing Public Data in Private Hands for Social Good". *Forbes*.

European Union's General Data Protection Regulation (GDPR), which is becoming somewhat of a standard for other countries and regions. For instance, the 2019 Kenya Personal Data Protection Act is modelled on GDPR and enshrines important rights related to issues such as specific consent and anonymisation. Safeguards include anonymisation and aggregation steps to remove personally identifiable data and to protect against potential surveillance or targeting of individuals or groups. Enforcement of these rules and laws, and penalties against companies that breach these laws, is on the rise. For instance, in Uganda, the National Information Technology Authority, Uganda (NITA-U), mandated the ride-hailing company Safe-Boda to make some fundamental changes to how they handle customers' personal data in order to comply with the Data Protection and Privacy Act, 2019.[110]

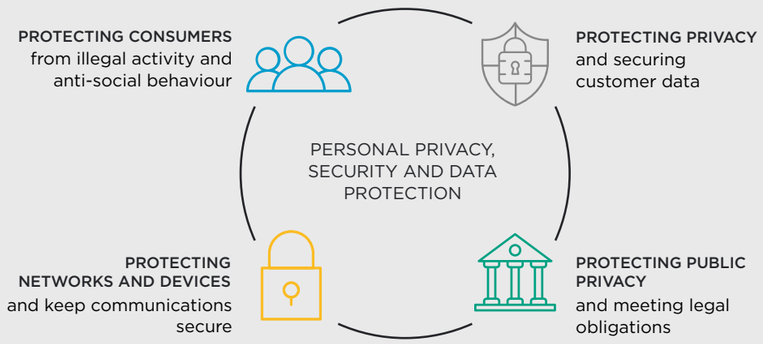
Governments in different country contexts have varying levels of data privacy guidelines and regulations. While some country governments may have very strict policies on data sharing, others may be more open to sharing data for innovation purposes. In Southeast Asia, the World Bank and Grab have worked in different country contexts with different privacy standards. Given that Singapore has the strictest data privacy laws in Southeast Asia, Grab follows these standards in every country where they operate, regardless of national laws. The example of the World Bank's global DRIVER platform demonstrates that certain programmes can still adhere to GDPR standards while navigating local regulatory environments, and build a platform that is more tailored to the country context and its regulations. For the DRIVER platform in Vietnam, data points are extremely high level, counting total traffic accidents in a given area. In the Philippines, the platform offers an even higher level of detail on traffic accident datasets, including time stamps and driver gender (see Case study: OpenTraffic, Philippines).

A strong understanding of these data privacy and protection laws and frameworks will not only ensure that data is being used ethically in a data-driven PPP, but also that all stakeholders have the capacity to build regulatory-compliant data frameworks. The GSMA and the mobile industry are committed to the advancement of responsible data practices. The GSMA has developed the Mobile Privacy Principles, which describe the ways in which the privacy of mobile consumers should be respected and protected when they use mobile apps and services that access, use or collect their personal data. Through the AI for Impact initiative, the GSMA has also published a report that examines how these principles are applied in the context of mobile big data.[111,112]

110. Privacy International. (2021). *A win for Unwanted Witness: Uganda's data protection authority finds ride sharing app unlawfully disclosed personal data to third parties.*
111. GSMA. (2016). *Mobile Privacy Principles: Promoting consumer privacy in the mobile ecosystem.*
112. GSMA. (2018). *Mobile Privacy and Big Data Analytics: Big Data for Social Good Considerations.*
113. GSMA. (2017). *Safety, privacy and security across the mobile ecosystem: Key issues and policy implications.*

FIGURE 15

The GSMA data privacy and security framework[113]



Sharing limitations and intended purpose

Regulatory frameworks include limitations on how data can be shared, particularly across borders. For example, a private company may want to share a large dataset with an analytics firm in another country to generate insights. However, given the rise of cross-border data-sharing regulation in LMICs, this exchange may not be possible. Countries like China, India, Vietnam, Russia and Rwanda are all implementing laws related to data localisation and digital sovereignty.[114] In some instances, this may facilitate the use of local analytics companies or investment in the capacity of local data analytics. Conversely, this may prevent data from being used to generate insights into data-driven actions and policies. In Vietnam, for example, the government implemented a data cybersecurity law in 2019 that requires online service providers to store data related to Vietnamese citizens in data centres within Vietnam. For companies with hubs outside Vietnam, such as Grab's headquarters in Singapore, additional investment is required to store this data and invest in analytics capabilities in Vietnam. See the GSMA industry position on cross-border data flows in the GSMA Mobile Policy Handbook.[115]

Regulation to ensure that shared data is only used for its intended impact and then destroyed is often a critical enabler of shared data management. This ensures that data is not continuously stored by other stakeholders for different purposes without a previously agreed use case. In some instances, an anonymised dataset that is used for a particular use case (e.g. transport flow visualisations via CDR data) could also be relevant for other use cases (e.g. planning EV charging infrastructure or understanding the commuting patterns of low-income workers). In cases where the potential for multiple use cases for a dataset is identified early on, and multiple public sector stakeholders can derive value from them, innovative approaches that allow multiple intended purposes while also protecting data privacy (e.g. GovLab's data collaboratives) might be the most suitable.

Representation, inclusion and cultural sensitivity

The penetration of digital solutions in larger urban areas provides great potential for generating innovative data. However, innovative datasets can often ignore the complexity and diversity of urban life, which is marked by rapid transformation and social exclusion. Migrants and unregistered youth in particular can become digitally, socially and financially excluded in cities where they do not have formal title or registration as a resident, lack official identification documents or cannot provide a valid proof of address.[116] Inherent biases in the use of innovative data may exclude certain vulnerable populations in insights. For example, there is growing evidence that certain big data use cases, such as credit market algorithms, might perpetuate existing inequalities for groups that have been historically and disproportionately denied access to loans and mortgages or charged higher interest rates than other customers.[117] It is critical to appreciate how racism and inequality can be perpetuated at various stages. The framing and focus of certain use cases may often be determined or influenced by funders or by the interests and backgrounds of those planning and conducting the analyses. Similarly, analytical decisions, such as how variables are defined, can also perpetuate racism and inequalities.[118]

There is a potential statistical bias with mobile data from MNOs that have partial market share or from populations unable to access mobile handsets. For example, an MNO with a dominant market position may be the favoured option as a partner or dataset. To reduce this bias, using data from several, if not all, MNOs at the same time should always be considered. The most vulnerable groups that are completely digitally excluded, lacking phones and any kind of digital (or even non-digital) identity, can unintentionally be overlooked when digital data sources are used to inform planning, despite being a key consideration in many urban planning scenarios. In all cases, being mindful

114. GSMA. (2018). *The impact of data localisation requirements on the growth of mobile money-enabled remittances.* Huddleston, J. and Varas, J. (16 June 2020). "Impact of Data Localization Requirements on Commerce and Innovation". *American Action Forum Insight.*
115. GSMA. (2021). "Cross-Border Data Flows". *Mobile Policy Handbook.*
116. GSMA. (2019). *Identity and the Urban Poor.*
117. Savchuk, K. (28 October 2019). "Big Data and Racial Bias: Can That Ghost Be Removed from the Machine?" *Insights by Stanford Business.*
118. Knight, H. et al. (2021). "Challenging racism in the use of health data". *The Lancet, 3(3).*

of these biases in the data and taking the necessary steps to ensure social inclusion and representation is important. Such steps could include verifying a small segment of the data insights using survey data, complementing quantitative with qualitative insights and ensuring there is a feedback loop between data scientists, the sector- and local-experts. Not only will insights be more comprehensive, but actions and policy can be tailored more accurately.

It is also important to be mindful of cultural norms, motivations and social dynamics. Understanding these norms and fluency in the local language (in the context of a foreign private partner) can be key enablers of effective partnerships. Meanwhile, a lack of cultural understanding can derail a partnership, relationships and willingness to engage in the future. In five northern Kenyan counties, multiple stakeholders, including the Millennium Water Alliance, USAID, IBM and county governments, established a partnership called the Kenya RAPID project to address water scarcity.[119] IBM built a visualisation tool, E-Maji, that used sensors attached to hundreds of boreholes to collect data on usage and breakages. The tool automatically generated a maintenance request to a pre-identified service team to ensure minimal disruption to water access for local communities. The five counties represented in the partnership have different cultures, levels of education, religious beliefs and levels of digital literacy, all of which were critical to understand to implement the project successfully.

Indirect motivations

There are many indirect motivations that influence the formation of, and engagement in, a data-sharing PPP. These motivations are intertwined with many of the objectives of stakeholders. We have identified five key indirect motivators: digital strategy; previous engagements and relationships; market share; trust, transparency and reputation; and cultural sensitivities.

Digital strategy

Private and public stakeholders may have different digital strategies driving their participation in data-sharing partnerships. For governments, the inclusion of innovative data sources for the public good may be part of a larger effort to digitise government services or part of a broader national data strategy. For private stakeholders, digital strategy may include customer acquisition or profit. The internal digital strategies of these organisations may indirectly influence their priorities and willingness to engage in the partnership.

For example, the Rwandan Government is strongly aligned with a nationwide priority for digital transformation initiatives through the President's Vision 2020 initiative. As part of Vision 2020, the Ministry of ICT has also produced the ICT Hub Strategic Plan (2019–2024) to fuel the digital transformation of Rwanda. Although not all government stakeholders have strong digital capacity, many government department leaders will still value and be open to innovation-related projects. This was highly beneficial for the GSMA AI for Impact initiative's collaboration with the Rwandan Government on transport (see the Transport section for more details), as the digital strategy encouraged public sector champions who knew precisely which public sector challenges the use case should address. Understanding governments' digital strategies and their focus areas can help potential private sector partners understand how their data analytics capabilities could be of strategic value for different government departments or certain ministries. While many cities in LMICs face similar challenges and use cases might be relevant in multiple contexts, it is critical for potential partners to understand and engage with national digitisation and development priorities.

Previous engagements and relationships

Previous experience with PPPs or, more significantly, innovative data-sharing PPPs, can facilitate future engagement. Along with contributing valuable lessons learned, stakeholders will have much more experience managing data. Through the Nigeria Electrification Project, lessons and selection criteria were drawn from a previous Solar Nigeria project (see Case study: Nigeria Electrification Project (NEP), Nigeria). In the BPS-Telkomsel Bandung Project, the government built on lessons from past mobile big data projects on tourism statistics (see Case study: BPS-Telkomsel, Indonesia). Conversely, if a stakeholder had a negative experience in a previous partnership, this may make them unwilling or cautious to work with new partners. Even without previous partnership experience, established relationships with the government or companies with data platforms may facilitate the creation of data-driven PPPs. While some companies and governments go through bidding processes, some may identify partners more informally through a personal or professional connection. The design of the partnership should consider the points raised about representation in the previous section, as relying solely on previous or familiar partners might limit the scope of an analysis and make it less inclusive.

Organisational strategic priorities

Beyond a digital strategy, public or private sector stakeholders may have internal organisational priorities that could also influence the data-sharing partnership. For example, private companies may have impact-driven strategic objectives (such as the United Nations Sustainable Development Goals, which the mobile industry committed to achieve in 2016) and want to engage in opportunities to have a positive social impact. With the rise of shared value thinking, which posits that the competitiveness of a company and the health of the communities around it are mutually dependent, as well as growing pressures on companies not only to serve their shareholders but also their stakeholders, creating social value is likely to become more central to corporate strategy.[120] This shift will also lead to more to data-sharing PPPs, as private companies are motivated to showcase how they are supporting government and solving critical public challenges. Given the mobile industry's early commitment to support the SDG agenda, and the vast contributions of mobile to the SDG agenda, MNOs are well positioned for this shift and should continue to lead the way.[121]

For government, these priorities can appear at different levels, including the departmental and individual level. On the departmental level, it is critical for potential private sector partners to consider both the explicit and implicit strategic priorities of government institutions, and tailor their engagement and approach to respond to these priorities. This requires a deep understanding of political economy dynamics, for instance, highlighting how insights from a particular use case could help an institution respond to new regulatory mandates or more clearly define rules and responsibilities in an urban policymaking context that often has overlapping spheres of authority.

From the perspective of a private utility service provider, engaging in data-sharing PPPs could be motivated in part by a desire to highlight their strategic value to government. Urban utility services are heavily regulated, and the role of private sector providers in urban utility service provision is subject to both political choices and the evolution of a city's urban development requirements. While there is no guarantee that data-sharing PPPs lead to more favourable regulation, in certain sectors such as ride-hailing that are extremely sensitive to municipal regulation (as highlighted by the recent motorcycle ride-hailing ban in Lagos),[122] companies may engage in data sharing to encourage government to take a data-driven regulatory approach that differentiates between different ride-hailing modes based on their safety and value to a city.

Trust, transparency and reputation

A data-sharing PPP requires trust and transparency from all stakeholders. As there are many potential regulatory and security risks involved in data management, trusting that all stakeholders will adhere to all engagement and data management protocols is essential. Trustworthiness and transparency of government is particularly crucial for PPPs. Many projects might not materialise if the private sector fears that data will be used for authoritarian or other harmful purposes, particularly if there are precedents. Some governments may also be disincentivised and unwilling to use data or share insights transparently if the data sheds light on the reality of poor conditions, holds the public sector accountable for making progress on different indicators or result in reputational damage. This is even more relevant with urban planning, which directly affects the public space.

Like trust, reputation is a key enabling factor for data-sharing PPPs as there are reputational risks associated with working with an organisation that has a negative public perception, as well as the risk of the partnership failing. Conversely, an organisation may be motivated to improve brand recognition or reputation by partnering with a company or government. For example, organisations such as young start-ups seeking to penetrate the market, large MNOs striving to keep their market share or government bodies representing their citizens.

119. Millennium Water Alliance. (2016). *The New 5-Year MWA Partnership in Kenya: Kenya RAPID (Kenya Resilient Arid Lands Partnership for Integrated Development)*.

120. Porter, M. and Kramer, M. (January–February 2011). "Creating Shared Value". *Harvard Business Review*.

121. GSMA. (2021). *2020 Mobile Industry SDG Impact Report*.

122. Adeoye, A. and Idris, A. (4 January 2021). "Nigeria's war on wheels". *Rest of World*.

Case Studies

CASE STUDY: BPS-TELKOMSEL, INDONESIA

Context

Home to more than 255 million people, Indonesia has the highest rate of urbanisation in Asia.[123] As of 2019, 56 per cent of the population live in urban areas and cities, and in the next decade it is estimated that Indonesia's low-income urban population will surpass its rural population. This rapid rate of urbanisation has major implications for economic growth and urban planning strategies.

Currently, urban development in Indonesia is highly concentrated in Java where four of Indonesia's 10 metropolitan areas are located. These metropolitan areas are the centres of economic growth nationally and contribute to more than a third of GDP. Each is characterised by an urban core city surrounded by peripheral districts. These outer areas have significant socio-economic integration with the urban core and high degrees of movement between them. As urbanisation has increased, urban sprawl has expanded the peripheral districts, many of which are now informal settlement areas due to a lack of infrastructure investment and the challenges associated with a growing low-income urban population.[124]

Without understanding the dynamics within metropolitan areas and a clear, updated delineation of metropolitan area boundaries, local governments cannot develop urban planning solutions to address the challenges of urbanisation. The result is higher poverty and lower economic growth and regional sustainability to meet the needs of a fast-growing population. The delineation of city boundaries also provides a clear mandate for geographical jurisdiction and responsibility, not only for infrastructure investment that better integrates the urban core and the peripheral districts, but also for potential new services to alleviate issues in informal settlements.

Partnership formation

In 2020, the Central Bureau of Statistics (BPS) Indonesia partnered with Telkomsel, one of the largest MNOs in Indonesia, to delineate the metropolitan boundaries of Cekungan Bandung by assessing commuting patterns between the core city Bandung and the surrounding peripheral districts.[125] Cekungan Bandung, or Greater Bandung, is the country's second largest metropolis and is home to more than 11 million people. Their analysis of commuting data revealed the percentage of the commuter population travelling between Bandung and the surrounding peripheral districts. This provided a clearer picture of the socio-economic integration between these areas to clearly delineate the boundaries of Cekungan Bandung. These boundaries can inform larger government statistical and budgetary planning for this metropolitan zone, support the Government of Indonesia in future urban planning efforts and inform the local government of its geographical jurisdictions and responsibilities to provide investment and services. Based on this clearer mandate, the government would also be able to allocate its resources more efficiently through targeted infrastructure investments. An additional use case of the analysis was to determine whether mobile big data could replace traditional commuting surveys conducted by the statistics department. Traditional surveys often require large budgets, training and logistics to deploy, and given Indonesia's large geographical footprint, there have been insufficient resources to conduct regular and comprehensive surveys that covered the entire country.

BPS and Telkomsel had an existing PPP for data sharing as they had worked together on previous projects related to tourism statistics in 2016.[126] As a result, this project was a continuation of many data-driven initiatives that BPS was leading in Indonesia to integrate innovative data sources with official statistics for better national planning. Therefore, the governance, financial and data frameworks had already been created, and the data framework built on lessons from their past engagements and adapted algorithms to pre-process signalling data better and prevent excess noise. BPS

123. Urban Gateway. (n.d.). *Indonesia has the Fastest Urbanization Growth in Asia*.
124. Hosea, H. et al. (2019). "Landscape metric in the analysis of urban form in Cekungan Bandung urban region". *SPIE*.
125. Noviyanti, I. et al. (2020). "Towards big data as official statistics: Case study of the use of mobile positioning data to delineate metropolitan areas in Indonesia." *Statistical Journal of the IAOS, 36*. pp. 943–954.
126. Lestari, T.K. et al. (2019). "The use of Big Data as the Leading Indicator of Tourism Demand". BPS-Statistics Indonesia. Presentation at the Asia-Pacific Economic Statistics Week, Bangkok 17–21 June 2019.

largely led the engagement, including the use case development, methodological design and generation of data insights,[127] while Telkomsel collected the data, processed it in line with data privacy standards and stored it in a "sandbox" that BPS could access. In terms of financial agreements, BPS did not pay for the data when the agreement first started, but the purchase of the data was renegotiated every year withBPS paying Telkomsel for additional "ticket items" related to data.

Data management

As part of the data framework, Telkomsel was responsible for the collection, storage and initial processing of the data. To analyse commuting patterns, BPS used mobile positioning data (MPD), a large set of spatial and temporal data that could provide a detailed location of an MNO subscriber through their mobile device. These data points are passively recorded by Telkomsel every time the phone user conducted a transaction, including calls, SMS, signal searching or mobile data use. As a result, MPD provides a consistent and accurate depiction of a mobile subscriber's movement patterns throughout the day, including their residence, work and commuting routes.

To address discrepancies in commuting frequency, BPS defined a commuter as someone who routinely conducts a round trip outside their point of residence at least once a week in two different weeks during a one-month observation period. This definition allowed BPS to designate which data points of commuters could be used as part of the analysis. Next, the BPS needed to define a threshold for the minimum commuter population percentage needed from a sub-district to sufficiently integrate with Bandung and be included in the larger metropolitan area. Based on previous commuter surveys and labour force data, BPS determined a commuter population percentage threshold of five per cent. BPS conducted all these analyses in-house with their data scientist and engineering team, and was able to delineate 40 sub-districts as part of the Cekungan Bandung Metropolitan Area.

To ensure data privacy and security, Telkomsel processed the initial data and dropped the data into a 'sandbox' that was housed in Telkomsel's servers but accessible to BPS data scientists and engineers for anonymisation processing. After this step, the anonymised data was dropped into a "data lake" on BPS's servers where the BPS team could analyse and visualise the data. BPS hired 907 volunteers to validate a subset of Telkomsel data through an app called MEILI, an open source mobile app that functions as a travel diary survey and collects active geopositioning location data from mobile phones. Although this GPS location point data was more accurate than aggregated MPD datasets from Telkomsel, the sample set was very small. By comparing this data to aggregated MPD, BPS was able to determine the accuracy of the data based on the similarity of the data points.

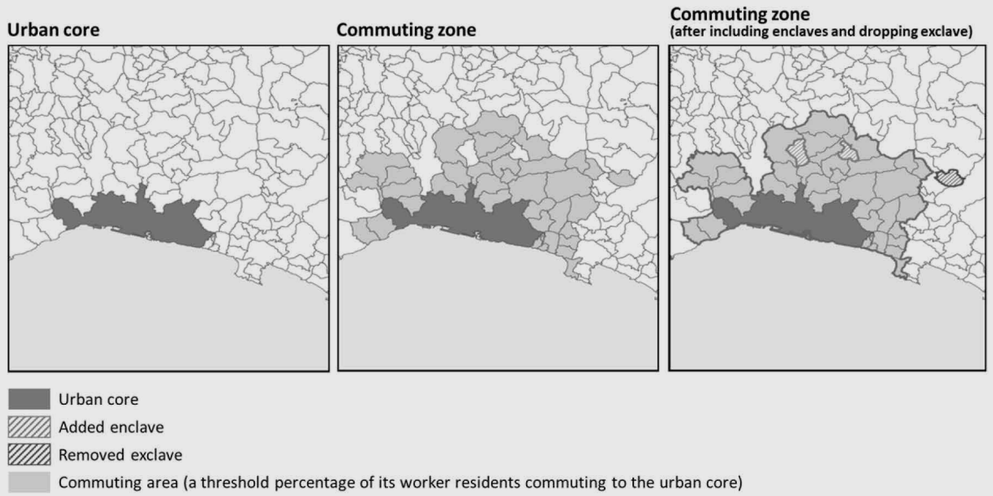
Impact and usage

The data partnership helped to successfully delineate clearer boundaries for Cekungan Bandung. While the Indonesian Government had originally delineated 52 sub-districts as part of Cekungan Bandung, the data analysis only included 40 sub-districts.[128] The redrawn boundaries of the Cekungan Bandung metropolitan area will also support the government with future national spatial and budget planning. While the results are still new, there is potential for municipal governments to more clearly understand their jurisdictions and responsibilities for service provision. If certain sub-districts show higher levels of poverty or lower access to services, including water and sanitation, the municipal government now has a clear mandate to expand support for these sub-districts. The government can also invest in targeted infrastructure to connect these sub-districts within the core city of Bandung and engage with the Ministry of Transport to support future planning for transport infrastructure.

Another use case that BPS wanted to examine was whether MPD could be incorporated in official national statistics, either to complement or replace traditional surveys. BPS had previously shown that MPD could be used for tourism statistics, but did not know whether MPD could be used as an alternative data source for commuting surveys. The exercise showed that MPD was indeed a high-quality, regularly generated and cost-effective data source that could be used to analyse commuting patterns. While Telkomsel's market share in Bandung was generally significant enough to avoid under coverage, the accuracy of MPD could clearly be improved if multiple MNOs combined their datasets. Unlike conventional surveys, MPD does not provide detail on the reasons behind commuting patterns, demographics or labour information related to the data points. As a result, BPS determined that while MPD could be used as part of national statistics, it works best when compl emented by traditional survey collection methods.

FIGURE 16

BPS delineation of Cekungan Bandung's sub-districts based on mobile positioning data[129]



Evaluation and sustainability

BPS will continue to employ Telkomsel MPD for statistical analysis, including for tourism, commuting patterns and transport planning. BPS is actively identifying new relevant use cases for mobile big data to provide value to cities, including measuring the attendance of events, such as the ASIAN Games, a regional multi-sporting event.

Since 2016, the BPS-Telkomsel partnership has provided valuable insights from mobile big data across a range of use cases. Given that the partnership is set to expire, BPS will revisit the terms of the partnership with Telkomsel and determine whether they will continue to share data.

Synergies

BPS and Telkomsel have natural synergies that made this data-sharing PPP work. Before partnering with Telkomsel, BPS relied on expensive and time-consuming traditional surveys reports. Due to budgetary constraints, often surveys were only conducted every two years. Traditional surveys were also limited to the number of trained staff and a defined population sample. Training and transportation required high budgets for a dataset that only contained a small, month-long snapshot and did not cover all metropolitan areas. BPS needed to identify a new way to collect high-quality and more regular data that could be used in official statistics and therefore, in government decision making. However, BPS had significant quantitative and data analytics skills and capacities in their department.

127. Ibid.
128. Noviyanti, I. et al. (2020). "Towards big data as official statistics: Case study of the use of mobile positioning data to delineate metropolitan areas in Indonesia." Statistical Journal of the IAOS, 36. pp. 943–954.
129. Noviyanti, I. et al. (2020). "Towards big data as official statistics: Case study of the use of mobile positioning data to delineate metropolitan areas in Indonesia." Statistical Journal of the IAOS, 36. pp. 943–954..

Telkomsel was a perfect match for a partnership. The MNO dominates the Indonesian market and has maintained between 45 and 50 per cent market share.[130] In Bandung, this market share is even greater at more than 90 per cent. As a government-owned telecom operator, the partnership was easier to establish. Most importantly, Telkomsel has a large mobile big data platform that passively collects different data points from its subscribers, including MPD. Its large user base in Bandung indicates that the data is highly representative in terms of coverage and could be analysed in near-real time. By engaging with BPS, Telkomsel was also able to leverage their data as an asset to develop other external partnerships.

Challenges and enablers

While many enablers influenced the success of the partnership, three stand out: data champions, third-party capacity building and technical support and the ability to build on an existing data-sharing PPP.

Data champions: Public sector champions are critical to innovative data-sharing PPPs. In the case of the BPS-Telkomsel relationship, BPS, and more specifically the Director of Finance, IT and Tourism Statistics, Titi Kanti Lestari, drove the partnership forward. Under her leadership the team had developed strong data science capabilities while also understanding the potential and limitations of innovative data sources, such as mobile big data, and how they fit into relevant government statistical guidelines.

Third-party capacity building and technical support: When the BPS-Telkomsel partnership was first established in 2016, BPS reached out to an organisation called Positium, a data analytics company specialising in MPD for official statistics. Positium provided capacity building workshops for BPS and Telkomsel and helped to design the methodology for their first data-sharing engagement on tourism statistics. Positium was instrumental in all aspects of data and digital capacity building for this first engagement, from helping partners understand the potential value of data and building the use case together to designing the methodology and data framework and supporting the evaluation process.[131] Although BPS had strong in-house statistics and quantitative analysis abilities, they had not worked with mobile big data before so the support from Positium helped build additional capacity and shorten the learning curve. Prior to this partnership with Positium, the Government of Indonesia had not allowed any third party or foreign organisation to handle such sensitive national data.

Building on an existing data-sharing PPP: BPS applied lessons from previous PPPs to ensure this partnership was the successful. Handling raw mobile data can be challenging as this data contains a lot of noise that needs to be filtered. Following some challenges with handling data in their first partnership, BPS supported Telkomsel to build the necessary infrastructure and algorithms to clean and process raw data. This ensured that the 2020 Bandung analysis was significantly easier and more streamlined.

FIND OUT MORE

In-Depth Analysis of the BPS-Telkomsel Data Framework

BPS Comparison Analysis of MPD versus Traditional Survey Data Collection

Previous BPS-Telkomsel Partnership for Tourism Statistics

130. Statista. (2019). "Number of mobile subscribers in Indonesia"; Indonesia-Investments. (2021). *Telekomunikasi Indonesia*.
131. Dalberg stakeholder interviews.

CASE STUDY: GATHER ANTANANARIVO SANITATION DATA HUB, MADAGASCAR

Context

Madagascar is one of the poorest countries in the world, with 75 per cent of the population living below the international poverty line of $1.90 a day.[132]

The country is also rapidly urbanising. With 38 per cent of the population already living in urban areas, it is estimated that by the end of the decade half of the island's population will be living in the capital Antananarivo or other urban area.[133] Rapid urbanisation pose profound challenges for a government already struggling to meet the basic needs of its population, and these challenges are compounded by the effects of climate change, with hurricanes, rising temperatures and drought intensifying rural-urban migration, and placing pressure on informal settlements.

While Antananarivo, the country's capital, contributes to about half of Madagascar's GDP, two-thirds of the city's population lives in informal settlements without access to formal services.[134] The city also lacks adequate urban planning, such as proper drainage infrastructure, and lack of access to basic services is perpetuating poverty and inequality. A key challenge is inclusive sanitation service provision. The country has one of the world's lowest urban sanitation access rates with just 17 per cent of the urban population having access to at least basic sanitation services.[135]

Poor drainage infrastructure, including a lack of waste treatment and minimal sewer systems, has made the city extremely susceptible to flooding.[136] A flood in 2015 displaced over 100,000 people and regular flooding in the city contaminates the water with faecal waste.[137] As a result, water-borne diseases are the second highest cause of death nationally,[138] and the country loses an estimated $600 million a year from lost productivity and the health costs associated with sanitation-related diseases, which is "more than the total sum of investment in Madagascar in the last 10 years."[139] These alarming statistics highlight the critical need to make improvements in sanitation in Madagascar, particularly in rapidly urbanising Antananarivo.

Partnership formation

Gather, a company founded in 2016, uses a data-led approach to solve urban sanitation challenges. Its mission is to close the sanitation gap by transforming "how sanitation organisations collect, share, and analyse data, helping them to get toilets to people who need them most."[140] Their goal is to create a city map visualisation tool that identifies sanitation risk areas and helps government partners make data-driven decisions. Much of Gather's data innovations have focused on Antananarivo.

In November 2020, Gather unveiled the Antananarivo Sanitation Data Hub, which formalised a partnership between Gather, other sanitation players and the local government (Commune Urbaine d'Antanarivo (CUA)). Funded by UK Aid Direct, the Hub has compiled a variety of data sources and is finalising the visualisation tool.[141] The partners include Loowatt, a sanitation service provider that uses a waterless toilet system that was supported by a grant from the GSMA Digital Utilities Innovation Fund, and Water and Sanitation for the Urban Poor (WSUP), an organisation that provides technical support and capacity strengthening for the water and sanitation sectors. Gather also engaged with SAMVA, the city's waste utility. The data platform draws on the experience of all Hub partners and will be run by the government to make data-driven decisions related to the sanitation sector.

Data management

Gather was responsible for many aspects of the data management process, beginning with research, a

132. The World Bank defines the extreme poor as those living on less than $1.90/day.
133. Statista. (2021). "Madagascar: Urbanization from 2009 to 2019".
134. WSUP, Madagascar, 2020
135. JMP. (2017).
136. WSUP. (n.d.) "Madagascar: Driving change in vulnerable communities".
137. NASA Earth Observatory. (30 January 2020). "Flood Waters Overwhelm Northern Madagascar". *NASA Visible Earth*.
138. AFD. (n.d.). "Protecting the Population from Flood Risks in Antananarivo".
139. IES and Gather. (May 2020). Webinar: *Using geospatial data to end the global sanitation crisis*.
140. Gather. (n.d.). "Our Work".
141. Dalberg stakeholder interviews.

landscaping study of available and unavailable data, creation of data standards and sanitation indices and, ultimately, the development of the data hub visualisation tool.[142] Other Hub partners provided technical support. Gather also collected and analysed existing data sources from multiple stakeholders in the sanitation sector, including government and sanitation service providers like Loowatt. This data included flood risk, landslide risk and population density. Loowatt also collected data related to their toilet locations, usage, mobile payments and mobile app data.[143] These data points were collected, studied and combined by Gather.

In April 2020, Gather completed a study of existing datasets on sanitation in Antananarivo, including environmental, social and sanitation value chain data. Notably, these datasets were assessed based on availability, accessibility and accuracy.[144] In general, the assessment showed that while datasets were available and accessible, accuracy was very low. In June 2020, Gather completed another study that itemised all sanitation data required to identify where sanitation services and investment are needed.[145] The study identified large data gaps in publicly available data, particularly for the sanitation value chain. However, since the private sector held a lot of data, the study identified the need to make private data more widely accessible and prevent data silos.

The Antananarivo Sanitation Data Hub brought together key stakeholders, established a governance framework and strengthened the data ecosystem for sanitation service provision in Antananarivo. The geospatial visualisation tool developed by Gather in collaboration with Hub partners calculates the sanitation risk of an area by assessing hazard, exposure and vulnerability. The following definitions were used:

- Hazard is defined as sources of potential harm to communities and the likelihood of a hazardous event occurring;
- Exposure is the type and intensity of contact between the hazard and individuals in local communities; and
- Vulnerability is the susceptibility of individuals to suffer harm from the hazardous events.[147]

Based on these definitions, Gather calculated sanitation risk indices from various datasets, including environmental indicators (flood risk, road density, terrain movement), social indicators (population density, household density, children, households, rent, tax, open defecation), sanitation value chain indicators (households sharing a toilet, main drinking water source, toilet type, toilet location). Based on these risk indices, Gather was able to segment different areas of the fifth arrondissement of Antananarivo based on lowest to highest sanitation risk. Ultimately, the government will be able to use the visualisation platform to make data-driven decisions.

Although the current data platform only uses publicly available datasets, Gather plans to add more data from private providers. Because some private sanitation providers may not want their data to be publicly available, the tool may not remain "open". However, Gather aims to have the tool as open as possible and is considering ways to make the data accessible.[148] Gather is also working with the Benchmark Initiative to assess the ethics of location data for sanitation, and what sanitation data is being collected in 50 different countries.[149]

Impact and usage

Although nascent, the Antananarivo Sanitation Data Hub visualisation platform offers many possible use cases for the future and supports the government in data-driven decision making. While the municipal government had strong internal data capabilities, it had limited time and resources to build a tool like the Sanitation Data Hub. The government is now able to use this data to make decisions about planning infrastructure, either the provision of toilets or building drainage or sewer infrastructure. Some of these infrastructure investments will require more funding than others, and the data will allow the municipal government to make budgetary decisions that maximise the development impact of various interventions. The data platform also supports urban resilience by identifying areas susceptible to flooding, the density of households that may be affected and areas where children may suffer from a lack of sanitation services. These data points can be used to provide tailored support in specific regions of the city.

Further iterations of the data visualisation platform will incorporate waste management data to support overall sanitation efforts in the city. This includes using the GPS points and satellite data of waste collection trucks to improve and optimise waste management routes. These additional data points present even more use cases for the government to deliver better sanitation services.

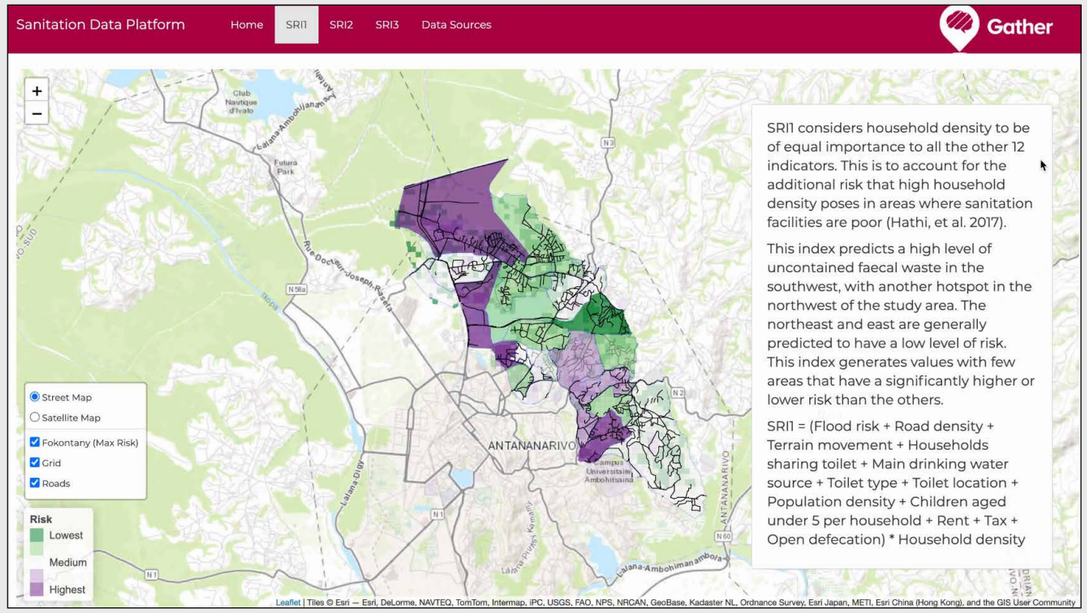
Evaluation and sustainability

Since the project is on-going, there has been no formal evaluation process for the partnership itself. On the sustainability side, the Antananarivo Sanitation Data Hub is a contractual partnership that is set to end in July 2021.[150] This date was set to align with current grant funding deadlines. However, the Hub is planning to continue the partnership beyond this deadline and is in the process of applying for additional funding. The visualisation tool for the fifth arrondissement of Antananarivo is still under development and when the tool is built, the tool will be co-owned by SAMVA, as the utility provider leads sanitation related initiatives in the city. The roles of different Hub members, including Gather, will evolve over time. However, given that the government partners have been involved since the inception of Gather's research and platform development process, and given that the Hub plans to institutionalise the platform with SAMVA, the partnership and data-related engagements is planned to continue sustainably long term.[151] The platform will be free to access, and longer term donor funding is being sought to pay for

142. IES and Gather. (May 2020). Webinar: *Using geospatial data to end the global sanitation crisis*.
143. GSMA. (2017). *Loowatt: Digitising the container-based sanitation value chain in Madagascar*.
144. Gather. (April 2020). *An Assessment of the Sanitation Data Gap in Antananarivo, Madagascar*; Gather defines availability as "whether the data exists and the ability to locate the data set." Accessibility is defined as "the effort required to download and manipulate the data." Accuracy is "the completeness and consistency of the data."
145. Gather. (June 2020). *Recommendations for the Design of a Data Standard for Sanitation Data*.
146. Gather. (2020). "Sanitation Data Platform".

FIGURE 15

Gather's sanitation risk index[146]



147. Gather. (October 2020). *Recommendations for a New Sanitation Risk Index and Geospatial Visualisations to Aide Decision Making in Antananarivo, Madagascar*.
148. Gather. (October 2020). *Recommendations for a New Sanitation Risk Index and Geospatial Visualisations to Aide Decision Making in Antananarivo, Madagascar*.
149. Gather's Benchmark Project: https://benchmark.gatherhub.org/
150. Dalberg stakeholder interviews.
151. Ibid.

platform maintenance. There are also plans to expand the tool to more areas of Antananarivo and to other cities facing similar challenges in the future.

Synergies

All stakeholders had important roles and responsibilities and brought the necessary synergies to the partnership.[152] As a private sector provider of urban sanitation, Loowatt was able to contribute a range of data, from toilet locations and usage to mobile payments and mobile app data on operations. The government also contributed their traditional datasets on sanitation and expertise as a utility provider. WSUP provided technical expertise and a history of research in the sanitation space. Gather provided research on sanitation-related data, brought stakeholders together as part of the Antananarivo Sanitation Data Hub, consolidated different datasets and is now building the data map visualisation tool.

Under this arrangement, the private sector players provide a variety of additional capacity, whether data generation, technical expertise or data analytics and visualisation. While the CUA and SAMVA have strong digital capacities, they did not have sufficient capacity or resources to generate all the data and analyse it. While the private sector players are helping to fill this gap, the involvement of government partners increases the trust and credibility of the partnership and provides the opportunity for government-led policy, regulations and actions to strengthen the entire sanitation sector.

Challenges and enablers

The Antananarivo Sanitation Data Hub has shone a light on some important challenges and enablers: Trust, transparency and reputation; government capacity; tools and infrastructure; and funding/sustainability.

Trust, transparency and reputation: The success of the Antananarivo Data Hub partnership is built on transparent data sharing and a reputation for inclusion, as it brought together technical experts along with government stakeholders. Gather was able to build trust with the government through a World Bank-facilitated conversation with key stakeholders at the CUA. The initial conversation did not address the selling of a product; rather, Gather focused on understanding the sanitation landscape in Antananarivo, the scarcity of data and additional challenges experienced by the government.[153] This allowed the partnership to conduct necessary research on data availability in Madagascar, develop a sanitation data standardisation and sanitation index that would work with different data sources and begin building a visualisation platform that government stakeholders were interested in. The inclusion of SAMVA as an additional stakeholder was proposed by the CUA, which suggested that government counterparts trusted the process and wanted to engage further with the Hub to see results.

Government capacity: In many data-sharing partnerships, governments often lack the digital capacity and data analysis skills to fully understand the potential of innovative data sources. However, in this partnership, the CUA and SAMVA had highly skilled staff, including engineering specialists, data scientists and geospatial directors.[154] As a result, private stakeholders, including Gather, did not have to push their public sector counterparts to develop an interest in innovative new data tools. However, they did not have the time and resources to develop these tools themselves as most of their time was invested in supporting and maintaining existing sanitation infrastructure in the city. Including private partners like Gather was therefore critical to advancing this innovation while the government will still have capacity it needs to use these tools for data-driven decision making in the future.

Tools and infrastructure: Key challenges that Gather aimed to tackle were data silos, data standardisation and interoperability. Publicly available data was often incomplete, not compatible with other datasets and siloed due to private sector players not sharing data or formatting their data in different ways.[155] Certain data points were formatted for specific types of data platforms and required skills and experience with ArcGIS or JavaScript. Gather aimed to create a theoretical framework to create more standardisation in sanitation data and encouraged private sanitation providers to share data.[156] Ultimately, Gather focused on developing a data platform that could utilise these different datasets in a user-friendly interface. With this new innovation, and through their work with the Benchmark Initiative, Gather hopes to increase openly available and standardised data to enhance interoperability and benefit the entire sanitation sector.

Sustainability: The financial arrangements and funding model of the Antananarivo Sanitation Data Hub have presented both benefits and challenges for the partnership. The partners have leveraged their combined skills and datasets to create a data platform for the city's entire sanitation sector offered at no cost, enabling the partners to have more social impact and enhancing trust and buy-in from government stakeholders who do not need an additional budget to use the data tool.[157] At the same time, this presents a challenge as the partnership depends on external funding to continue its work. While the current partnership and funding is set to expire in June 2021, much effort and additional time may be needed to identify new funding. Gather is seeking to identify long-term donors from development banks, large foundations and even national regulators to further the partnership.

FIND OUT MORE

Gather's Research on Data Scarcity, Standards, and Sanitation Risk Indices

Gather Discusses How Geo-Spatial Data Can Impact Sanitation

A Video Demo of the Sanitation Data Visualisation Platform

152. Ibid.
153. Ibid.
154. Ibid.
155. Gather's Benchmark Project: https://benchmark.gatherhub.org/
156. IES and Gather. (May 2020). Webinar: *Using geospatial data to end the global sanitation crisis*.
157. Dalberg stakeholder interviews.

CASE STUDY: OPENTRAFFIC, PHILIPPINES

Context

The Philippines is a highly urbanised country in Southeast Asia of 108 million people, nearly half of whom live in urban areas.[158] By 2050, the urban population is projected to account for 65 per cent of the population.[159] Currently, 14 million live in Metro Manila, the country's capital, and 2.8 million live in Metro Cebu, the second largest city in the country.[160] The rapid urbanisation of the Philippines has fuelled economic growth, and at a 6.4 per cent GDP growth rate at the end of 2019, the country is one of the fastest growing economies on the Asian continent.[161] However, the Philippines faces significant challenges related to urbanisation, with an estimated 20 million people living in slums.[162] In Metro Manila, 37 per cent of the population live in slums.[163]

A key challenge of rapid urbanisation in the Philippines is transport and traffic management. In 2019, Metro Manila ranked second among 416 cities globally in terms of worst traffic congestion, with the average commuter losing about 257 hours (almost 11 days) per year.[164] The country is estimated to be losing $73 million every day to traffic congestion in Metro Manila and $23 million in Metro Cebu.[165] The transport infrastructure is unable to meet the demands of a ballooning urban population, and rather than planning mass transit, the car-centred transport system has focused on building more roads and tollways.[166] Thus, the highly congested roads are lined with private cars, taxis, buses and jeepneys, a popular colourful mini-bus used as public transportation. Innovative new solutions are needed to address traffic congestion in the Philippines and better meet the needs of its rapidly urbanising population.

Partnership formation

In 2011, the Cebu City Government first approached the World Bank to support its traffic congestion efforts through the use of innovative data. They envisioned an "open-source platform for collecting, visualising, and analysing traffic speed data derived from taxi drivers' smartphones."[167] This first project was called Cebu Traffic, which sought to create a new and inexpensive methodology as an alternative to timely, expensive data collection and analysis for transport and congestion. To collect data, the partnership included several private sector stakeholders, including Grab (then called GrabTaxi), and Conveyal. Grab is a mobile-enabled ride-hailing company that first connected users to taxis and has since expanded to various types of transportation vehicles across Southeast Asia. Conveyal is a transport sector consultancy that specialises in open data technology.[168] The partnership created a proof of concept in 2013 through the initial Cebu Traffic pilot.

The partnership between Grab, the World Bank, Conveyal and the Philippines Department of Transportation and Communications (DOTC) formally launched in 2015 as the OpenTraffic initiative with $65,000 in funding from the World Bank.[169] OpenTraffic aimed to use anonymised GPS data from Grab drivers to address traffic congestion and road safety in Metro Manila and Cebu. The platform provided free real time and historical data on traffic peak patterns, commuting times and travel flows.[170] Data was provided by Grab at no charge during the initial two-year pilot and scaling up phases.

Data management

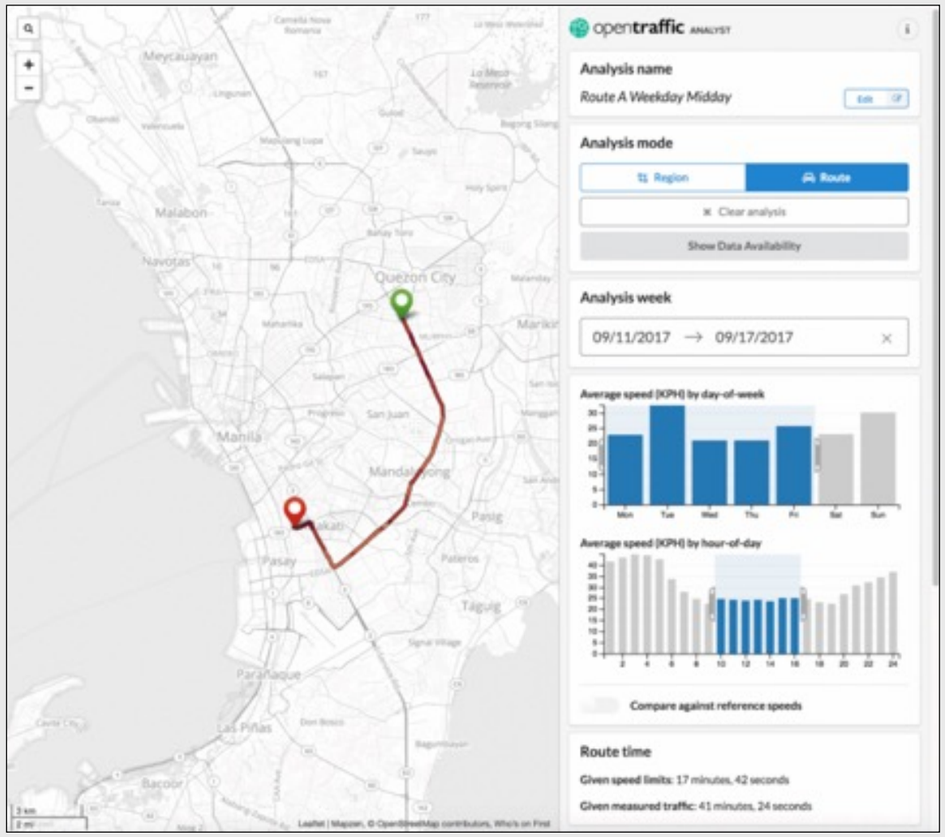
Since providing open traffic data using GPS data points was a novel approach, the partnership had to invest more time in developing the methodology to use Grab's data, anonymise the data points and measure congestion on a visual map. While Grab provided the data, Conveyal and the World Bank supported the development of the OpenTraffic platform and managed the data analysis process.

The partnership relies on both Grab driver GPS data and Open Street Map (OSM), an open and free global mapping platform that is supported by volunteers.[171] OSM does not have licensing requirements and can be freely updated by anyone using OSM tools. Once the partnership was underway, OSM provided over 87 million data points of mapped roads, expressways and unpaved rural streets. Grab collected raw data from over 64,000 vehicles that refreshed every six seconds and included vehicle ID, a time stamp and GPS coordinates (latitude and longitude).[172] The data was converted into a comma-separated value format (CSV) and uploaded automatically onto an Amazon cloud computing platform. With each iteration, the process became more efficient and aggregated, uploading real-time data streams collected from multiple global sources into one data stream on the cloud computing platform.[173]

158. Statista. (2021). "Philippines: Urbanization from 2009 to 2019"; World Bank. (2019). "World Development Indicators".
159. World Bank. (2017). *Philippines – Urbanization review: fostering competitive, sustainable and inclusive cities*.
160. Britannica. (n.d.). "Manila".
161. Statista. (2021). "Philippines: Urbanization from 2009 to 2019".
162. World Bank. (2019). "Population living in slums (% of urban population)".
163. The Borgen Project. (27 July 2019). "10 Facts About Slums in Manila". *The Borgen Project Blog*.
164. Subingsubing, K. (31 January 2020). "Metro commuters lost 257 hours to traffic last year". *Inquirer.net*.
165. Israel, D. (15 October 2019). "Cebu province declares 'traffic crisis'". *CNN Philippines*.
166. Rappler.com. (14 October 2020). *Metro Manila's traffic problem explained*.
167. Krambeck, H et al. (2015), Combining taxi GPS data and open-source software for evidence-based traffic management and planning.
168. Krambeck, H. et al. (2015). *Open Traffic: Big Data Challenge Project Completion Report*. The World Bank.
169. Ibid.
170. Open Traffic: https://opentraffic.io/
171. Krambeck, H. et al. (2015). *Open Traffic: Big Data Challenge Project Completion Report*. The World Bank.
172. Ibid.
173. Ibid.
174. Dara-Abrams, D. (12 December 2017). "Open Traffic platform released". *Mapzen*.

FIGURE 13

The OpenTraffic tool visualising a route in Manila[174]



To utilise the GPS data, the team converted data into travel times mapped onto roads, which enabled average traffic speeds to be measured on different road segments at different times. Grab calculated estimated travel times using the distance and speed at which a vehicle passed two intersections, and these millions of data points on an OSM base map could visualise which road segments were congested. The data excluded driver information and individual GPS points.

This visualisation map could be used to conduct a system-level analyses of average travel speeds, peak congestion times and locations, congestion variability and areas that were susceptible to traffic accidents. The first iteration pilot of OpenTraffic in July 2015 focused on Cebu with the Cebu City Transportation Office providing feedback in discussions. The tool could be accessed by government partners in both Cebu and Manila to make data-driven decisions based on real-time visualisations of Grab's traffic data.

Impact and usage

OpenTraffic offered an inexpensive alternative to traditional traffic data collection tools used by transport agencies, such as surveys and sensors. These methods required significant upfront capital, lengthy training and logistics and had a limited scope. However, with over 500 million Grab driver data points, OpenTraffic provided fast and inexpensive traffic visualisations that government officials and city planners could use for traffic planning, route optimisation and investment decisions.

OpenTraffic provided quick, real-time answers to peak traffic times and corridors, estimated travel times, the susceptibility of different areas to accidents and commuting patterns. City authorities could leverage this information to design travel management policies, quantify commuting times and use patterns to identify opportunities for investment and implement safety measures for high-risk locations.[175] Officials could also communicate with the public on the best transit routes to save time and money. Furthermore, city planners could understand how to plan new infrastructure to ensure that public funds are spent effectively.[176]

In 2015, the Philippines established national regulations for ride-sharing companies, and Grab was the first registered platform to legally operate within this regulatory framework.[177] In Manila, the OpenTraffic platform and partnership with Grab has supported transport planning around the Ninoy Aquino International Airport (NAIA). The data supported impact studies to design a new expressway to the airport, and the government was able to conduct an impact study on providing free toll access to commuters. In Cebu, the World Bank used OpenTraffic to support the optimisation of traffic signals to alleviate congestion.

Evaluation and sustainability

As a World Bank-funded project, OpenTraffic incorporated an evaluation process, and a full report of the project was published and disseminated. OpenTraffic was built at no cost to governments as a long-term and real-time traffic analysis tool for the Government of the Philippines. The platform is expected to be scaled to other cities. In 2016, the World Bank announced the Open Transport Partnership (OTP), which built on the OpenTraffic platform and engaged several more partners, including MapZen, WRI, NDrive, Miovision and the National Association of Transportation Officials.[178] The data would also include two additional ridesharing platforms called Easy Taxi and Le.Taxi. The OTP would expand to become a platform that could show transport networks across multiple cities and countries, and ultimately enable governments and transport agencies around the world to improve traffic management and planning. In 2017 the OTP announced a new project in Malaysia in partnership with the Malaysia Digital Economy Corporation (MDEC).[179] to help the Malaysian Government develop data-driven traffic solutions and strengthen the country's technology ecosystem. In 2018, the OpenTraffic platform was discontinued in the Philippines, likely due to one of the key partners, MapZen, shutting down operations.[180]

Despite this, the OTP created a lot of traction for usingd ride-hailing data to support traffic analysis initiatives with the public sector across the region:

- Grab continued its engagement with the MDEC beyond the OTP to support the development of the Malaysia City Brain initiative.[181] The initiative combined many different datasets, including Grab data, CCTV video data, traffic light data, social media data and traffic information from local agencies to create an AI and cloud computing platform to efficiently manage city traffic in real time.[182]
- Grab also works very closely with the Government of Singapore, leading the Shuttle Bus project with GovTech and creating an AI Lab with the National University of Singapore to transform the transport sector and develop smarter cities.[183]
- Grab partnered with UN Pulse Lab Jakarta to understand traffic flows on different days of the week and during major public events.[184]
- Grab established a PPP with the Cambodian Government and UNDP Cambodia to support traffic safety and infrastructure development.[185]
- Grab entered a data-sharing PPP with the Tourism Authority of Thailand to enhance local transportation and tourism initiatives.

175. World Bank. (5 April 2016). *Press Release: Philippines: Real-Time Data Can Improve Traffic Management in Major Cities*.
176. Ibid.
177. Teng, N. (18 May 2016). "Grab's proactive approach to regulatory affairs". *ITUNews*.
178. World Bank. (19 December 2016). *Open Traffic Data to Revolutionize Transport*.
179. Grab. (10 April 2017). *Grab and MDEC together with the World Bank Group Launch OpenTraffic Platform in Malaysia to Combat Local Traffic Woes*.
180. Marshall, A. (4 January 2018). "An Open Source Startup Dies as Mapping Gets Hotter Than Ever". *Wired*.
181. Bhunia, P. (20 April 2018). "Malaysia City Brain initiative to use real-time, anonymised traffic data from Grab". Open Gov.
182. Tao, A.L. (4 May 2016). "Real-time data helps manage traffic in Philippines". Computer Weekly.com.
183. NUS News. (19 July 2018). Grab and NUS open AI lab to transform cities and transportation in Southeast Asia.
184. Pulse Lab Jakarta. (12 April 2019). "Analysing Transportation Data from Ride-Hailing Services to Improve Transport Integration". Medium.
185. Grab. (27 September 2018). "Understanding Big Data to Unlock the Future of Smarter Transportation".

These examples show how Grab built on its experience in the Philippines and significantly expanded engagement with the public sector by leveraging their large data platform across Southeast Asia.[186] Generally, this data is provided to governments at no cost.

The World Bank also used Grab data to support another open data platform, Data for Road Incident Visualisation, Evaluation and Reporting (DRIVER), which provides traffic accident analysis tools for public stakeholders.[187] DRIVER is being developed and used in a variety of countries, including the Philippines, Thailand, Lao PDR, Vietnam, Brazil, Mumbai and Bangladesh.[188] The World Bank, IMF and IDB have also jointly created the Development Data Partnership, a new platform designed to "facilitate the use of third-party data in research and international development."[189] This new platform has many private partners, including Google, Facebook, Mapbox, Esri and Waze. The platform scales up the use of big data to support a variety of digital services, including a large transportation sector component, and creates a governance framework for ethical and responsible data use.[190]

Although the OpenTraffic platform may not continue to be developed or expand, the data-sharing PPP has pushed forward many new innovations and collaborations between the public and private sector to support better transport planning.

Synergies

The partnership had many synergies that made the OpenTraffic platform successful. The public sector needed more data and information to support its large traffic congestion problem, particularly in the two largest metropolitan cities where the government had to employ expensive traditional data collection methods. However, the government can now make large-scale changes in transport policies and investments in infrastructure to ease congestion and increase safety. For Grab, engagement with the government held the promise of stronger relationships, greater brand recognition and the opportunity to improve transport links, which would ultimately benefit Grab's customers too. This type of data analysis was very new at the time, and Conveyal was able to provide the additional data analysis support necessary to create the OpenTraffic platform. Meanwhile, the World Bank was an initial funder of the idea and a key facilitator of the PPP.

As the partnership expanded beyond the pilot to include the OTP, many other stakeholders signed a formal memorandum of understanding (MOU).[191] Grab, Easy Taxi and Le.Taxi provided additional driver data points in more than 30 countries. MapZen provided analytics support, Miovision provided traffic data, NDrive provided auto navigation data and the WRI created research and technical training programmes and connections with other stakeholders.[192] Grant funding was provided by the Korean Green Growth Trust Fund.

Challenges and enablers

As a new data collection tool, several key challenges and enablers were encountered during the OpenTraffic project. These included varying digital capacities, existing data infrastructure and mapping tools, commercial data-sharing agreements and long-term sustainability.

Varying digital capacities: Since the methodology for this project was new, conversations started as early as 2011 between the government and World Bank. A key challenge for both the OpenTraffic partnership in the Philippines and future Grab engagements with governments in Southeast Asia has been government capacity.[193] While Grab today has one of the strongest data analytics capabilities globally, the partnership began with the World Bank and Conveyal leading the data analysis efforts. Transport agencies, including Manila and Cebu, have been strongly attached to traditional methods of data collection, and with the exception of the Government of Singapore, which has very strong data analytics capacity, governments have generally not fully grasped the potential of the data and lack the data analytics capacity to run these initiatives in house.

Existing data infrastructure and mapping tools: The OpenTraffic platform experienced several data-related challenges during the implementation phases. First, data from Grab needed to be processed and anonymised on a cloud computing platform that was growing exponentially every six seconds.[194] The data also needed to be standardised in an interoperable way everywhere Grab operated and to ensure that future data applications could use the data. Grab's data was used for many different government engagements, as well as the World Bank DRIVER project, which uses a similar platform for traffic safety and accident response.[195] The initial use of data posed challenges with the OSM database since it was completely volunteer-run and not as robust as other private sector geographical data and traffic tools like Google Maps and Waze.[196] Although OSM provided a free source of data with millions of data points, some streets and locations were not fully captured in the dataset. Thus, some data points from Grab would float in empty areas and needed to be adjusted to the methodology and analysis. However, the partnership provided an opportunity to fill in these missing road segments and incomplete data to enable future open source transport-related initiatives to use the global OSM platform.

Commercial data-sharing agreements: Interestingly, Grab's engagements with these various partnerships, including OpenTraffic, have not had an established commercial model and have been shared at no cost. While this may seem like a missed opportunity for Grab, the company works in very different country contexts. For example, certain governments require Grab to provide the data in order to operate in the country, which prevents Grab from establishing a commercial model to share data with the public sector. In other cases, Grab has used this as an opportunity. During this time, ride-hailing was still a new concept in many Southeast Asian countries with limited regulatory frameworks. There was also heightened competition between different ride-hailing players in the region.[197] In Indonesia, the government was threatening to shut down ride-hailing platforms due to protests from traditional taxis. With such turbulent operating environments, Grab proactively built trust with governments. In 2015, the data-sharing collaboration with the Government of the Philippines helped the country become the first in the region to establish national regulations for ride-sharing platforms, while Grab became the first platform to register and legally operate within this new regulatory framework.[198]

Sustainability: A key challenge with the OpenTraffic platform partnership has been sustainability. While the partnership has been largely successful, the subsequent iteration of the partnership, OTP, has seemed to have fizzled out. The project brought in several more stakeholders, but it did not scale to as many countries in the region as intended. Grab's data capabilities have grown significantly as a result of the partnership, however, allowing the company to provide a stand-alone offering to governments and strike up more partnerships with country governments (beyond the scope of this partnership). Despite the discontinuation of the OpenTraffic and OTP partnerships, the entire sector has learned from their pilot initiatives.[199] Many ride-hailing companies are now engaged in open data sharing with governments, donors and civil society organisations so that the data can serve the public and social good.

FIND OUT MORE:

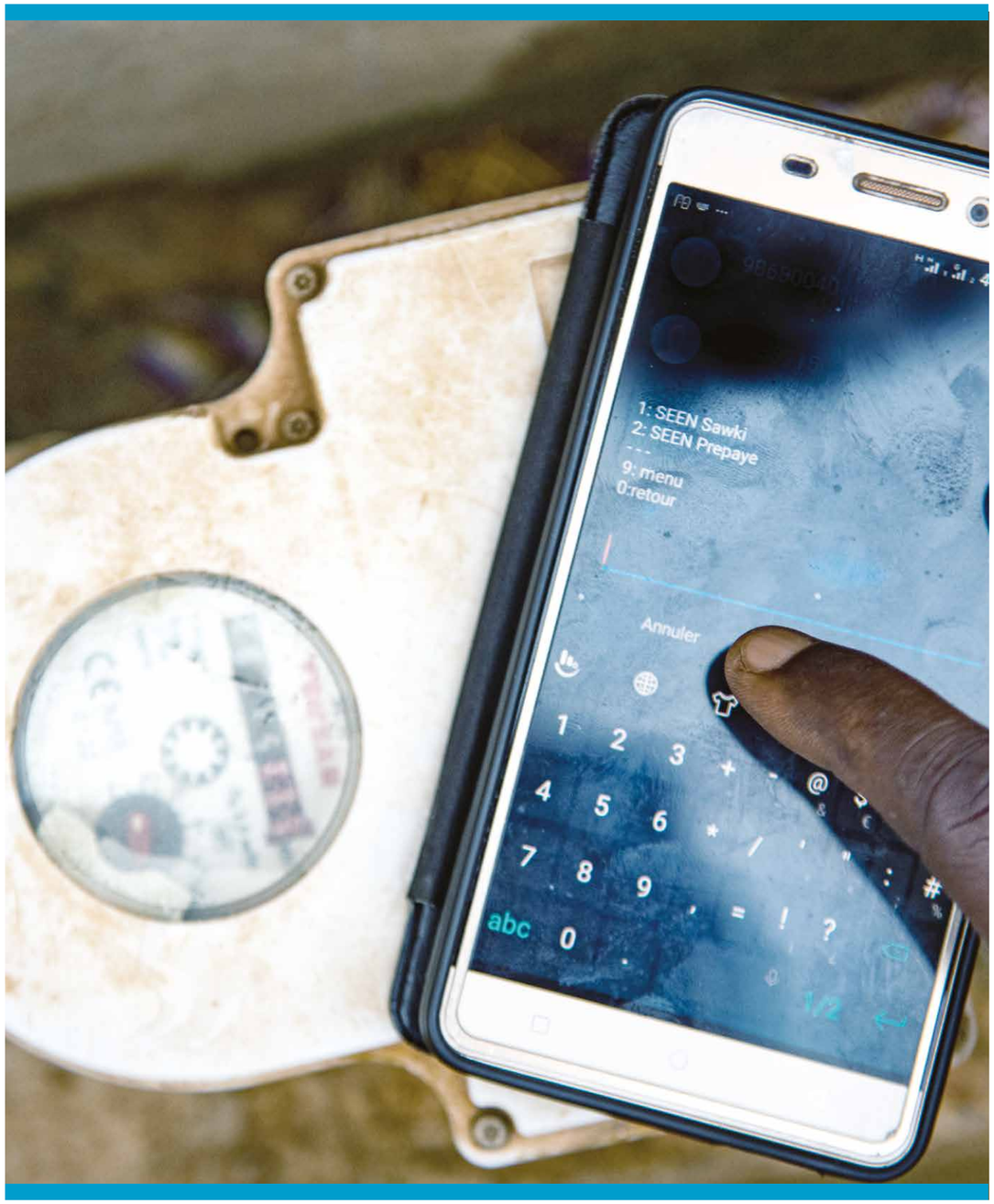
The OpenTraffic Pilot's Data Management Framework

Grab's Numerous New Public Sector Engagements in Southeast Asia

OpenTraffic Website

186. Ibid.
187. World Bank, DRIVER Report, 2019
188. Burlacu, A. (14 June 2019). Presentation: DRIVER: The World Bank's Tool for Crash Data Visualization, Evaluation and Reporting. The World Bank.
189. Development Data Partnership. (n.d.). "About".
190. The World Bank Digital Development Partnership (DDP): https://www.worldbank.org/en/programs/digital-development-partnership.
191. WRI. (13 January 2017). *Press Release: WRI Ross Center for Sustainable Cities Joins Partnership to Open Traffic Data and Help Cities Improve Decision Making for Better Mobility.*
192. Ibid.
193. Public Service Transformation Academy. (2018). *Public Service: State of Transformation – 2018 Case Studies from the Public Service Transformation Academy*; Dalberg stakeholder interviews.
194. Krambeck, H. et al. (2015). *Open Traffic: Big Data Challenge Project Completion Report*. World Bank.
195. World Bank, DRIVER Report, 2019
196. Krambeck, H. et al. (2015). *Open Traffic: Big Data Challenge Project Completion Report*. World Bank.
197. Chilkoti, A. (5 April 2016). "Southeast Asia scheme taps taxi app to ease traffic jams". *Financial Times*.
198. Teng, N. (18 May 2016). "Grab's proactive approach to regulatory affairs". *ITUNews*.
199. World Bank Digital Development Partnership (DDP): https://www.worldbank.org/en/programs/digital-development-partnership.

Recommendations



While there is no standard method or model for implementing data-sharing partnerships in different country contexts, some common patterns and factors have contributed to the success of some of the case study examples. This report offers three sets of recommendations to help ensure the success of data-sharing PPPs.

1. **Recommendations for establishing a new data-sharing PPP**

    - **Leverage the influence of technical or financial partners to attract key stakeholders**

      Many data-sharing PPP do not emerge naturally, usually due to lack of interest or understanding of the data's potential. However, third-party organisations, such as the World Bank, Gates Foundation or the GSMA are able to open up conversations and bring stakeholders to the table. This is key for smaller private utility service providers if they do not have strong relationships with government partners already or if they are unable to get buy-in from government partners due to lack of influence. They can also act as a neutral coordinating agent throughout the partnership, which is even more critical if a partnership has many different stakeholders.

    - **Recruit a public sector champion to push the partnership forward**

      There is a strong need for a senior-level champion in government to push the partnership forward, usually individuals or departments with strong data capacity or a demonstrated commitment to the partnership's success. This champion may be found in government statistics or ICT departments where there is strong data capacity and digital literacy. Other municipality officials or heads of ministries may be driven to create a "legacy" project or champion a specific issue like transportation or energy. These senior-level champions play a major role in propelling the partnership and are particularly important to data-sharing PPPs.

    - **Properly assess and formalise capacities, responsibilities, processes and use cases upfront**

      Partnerships should clearly assess and agree upfront on stakeholder capacities, responsibilities and the use case through a contract or memorandum of understanding. An early conversation allows both government and private companies to understand the additional capacities the partnership needs and to provide an accountability framework for partnership agreements and processes. Similarly, a clearly defined set of processes for decision making and engagement, such as monthly meetings or regular calls, ensure continuous engagement. The development of the use case also creates buy-in from all stakeholders and creates a cohesive understanding of the objectives and outputs of the project.

    - **Build trust in innovative data through capacity building and integration with more traditional data**

      Since data capacity and digital literacy still pose major barriers to data-sharing PPPs, partners that have them have a critical responsibility to find ways to make the partnership successful. To address government inclination to trust public and more traditional data, the partnership can offer training to build data capacity and develop methodologies to combine public datasets with private innovative data sources. This not only helps to build trust in the data and outputs, but also to secure buy-in from public partners.

    - **Use external funding to pilot the partnership**

      Many potential data-sharing PPPs do not move forward because stakeholders either lack the funding for innovative projects or the willingness to allocate funds to these new projects. In these cases, external funding can be an important catalyst for pilot engagements that bring different stakeholders together.

External funding is an important first step towards a more sustainable financing model.

2. **Recommendations for managing an established data-sharing PPP**

   - **Ensure a data governance framework is in place that emphasises data privacy and protection in different country contexts**

     Since different countries have varying levels of data governance frameworks for data privacy, partnerships should adhere to strict and universal data guidelines that provide space for innovation, such as the GDPR and the GSMA COVID-19 data guidelines. As the appetite for data sharing in public and private sectors grow, the questions and frameworks related to data privacy and personal data will become even more important. Thus, strengthening global governance structures and consensus is necessary to ensure that new types of data-sharing PPPs do not come at the expense of individual privacy.

   - **Build data tools and infrastructure that prioritise accessibility, quality, usability and interoperability**

     Since digitisation varies from country to country, partnerships should ensure that data tools and infrastructure are accessible, user friendly and allow all stakeholders to engage. The tools and infrastructure should also be high quality, use accurate data sources and provide the relevant capabilities needed to answer key questions. The data tools that are used and developed should also prioritise interoperability, use open source technologies, and ensure data is accessible and usable for the intended users. More broadly, these guidelines prevent data silos and governments from becoming locked into expensive proprietary, licence-based solutions.

   - **Tailor engagement and solutions to the cultural context**

     Cultural perceptions, political motivations and social dynamics may vary significantly between and within countries. The partnership should take the cultural context into account and ensure that the rules, processes, data solutions and services are tailored to it. This requires both sectoral and contextual expertise from the outset of the partnership. Such complex expertise may come from an interdisciplinary team with diverse backgrounds and a mix of local and foreign experts.

3. **Recommendations for the sustainability of the data-sharing PPP**

   - **Create a clear and sustainable business and impact case**

     Since a key barrier to sustainable partnerships is lack of interest or understanding the data and the potential of the partnership, developing clear business and impact cases is vital. The business case for private partners should highlight the potential financial and non-financial incentives for their businesses while, for the public sector, the impact case should show how the data-sharing PPP will have social impact and benefit the public by institutionalising the data insights into policies, strategies and regulations. These business and impact cases can serve as important enablers of the partnership and help to align definitions of mutual success.

   - **Evaluate the partnership rigorously to assess its utility and generate and share lessons for future iterations and partnerships**

     Many large donor-funded partnerships have an evaluation stage built into their projects, but other partnerships are more focused on research outputs or immediate implementation. Many data-sharing PPP evaluations and public reports highlight the successes of a pilot without communicating the complex challenges involved. Members of the partnership should develop evaluation frameworks that assess best practices, challenges, lessons and financial and non-financial impact. Such an evaluation not only supports the partnership during implementation, but also facilitates the sustainability of the partnership by demonstrating the impact and value created. Evaluation frameworks can also provide a major opportunity for lessons to be shared through forums, webinars and even future partnership engagements.

   - **Promote and institutionalise financing models beyond donor-funding and adapt them to different use case characteristics**

     Rather than relying on donor funding as the only possible source of funding, partnerships should establish an institutionalised financing model that secures buy-in from all stakeholders and enables long-term engagement. Such a financing model requires recurring internal budgets and resources to cover costs related to the partnership. Private companies may have an incentive to engage if the potential returns (financial and non-financial) are clearly identified. For government stakeholders, securing such budgets and resources may demand a clear demonstration of the impact of data insights on utility services and, eventually, the communities that are served. Once a financing model is in place, public sector stakeholders will continue to have a mandate and budget to continue the partnership even if governments or administrations change. It is also important to certain sectors and use cases may be more advanced in terms of commercially sustainable partnership models (see transport), while others may be still emerging, or might simply require more public and donor funding due to their public and social value (i.e. sanitation).

   - **Fill the gap in sustainable financing**

     In several of the case studies, long-term sustainable financing was a key issue beyond the donor-funded pilot stage. While an institutionalised financing model is ideal, pilot projects often do not create these business models and financial agreements, and lack the funding to scale up. There is a major opportunity for financial partners to fill this financing gap and push these partnerships forward.

In addition to the general recommendations outlined above, stakeholder-specific recommendations can be formulated depending on the respective roles and resources of partners (see Data-driven PPPs: identifying synergies).

FIGURE 19

Stakeholder-specific recommendations for successful data-sharing PPPs

Big data holders (with a specific focus on mobile operators)

- Develop governance structures for mobile big data-sharing PPPs while leveraging the influence and expertise of public sector champions and third-party technical partners.
- Create a dedicated team or department responsible for handling data requests or supporting external partners with data analytics, such as Orange's Flux Vision. They should also have the mandate to facilitate non-corporate partnerships that do not include direct financial incentives. Since certain countries have legal and regulatory restrictions on sharing mobile big data across borders, this staff, as well as the technical infrastructure they use to manage the data, may need to be located in the country where the data is originally generated.
- Proactively engage with governments on the potential of mobile big data and other innovative data sources to expose stakeholders to the potential of the data.
- Identify senior-level champions in the public sector, at both municipal and national levels, with strong data capacity and digital literacy.

Private utility service providers

- Develop governance structures for data-sharing PPPs while leveraging the influence and expertise of both public sector champions and third-party technical partners.
- Continue identifying new synergies and use cases for innovative data to support governments with urban planning and utility service provision.
- Proactively engage and share data with the public sector to expose stakeholders to the potential of the data.

- Identify collaboration opportunities with the public sector to combine public and private datasets for sector-specific impact.
- Identify senior-level champions in the public sector, at both municipal and national levels, with strong data capacity and digital literacy.

Technical partners

- Leverage convening power to bring multiple stakeholders into partnerships.
- Support public and private sector partners to build governance structures and data frameworks for these types of engagements.
- Help with data analytics where digital literacy and capacity is lacking while working with governments to institutionalise the analysis.
- Conduct training that helps private and public sector partners understand the potential of data and support the development of use cases.
- Help public and private sector partners follow and adhere to data privacy guidelines.

Financial partners

- Provide funding for promising data-sharing PPP pilots while ensuring that the stakeholders follow the recommendations above.
- Fill the gap in sustainable financing and provide financial opportunities for successful pilot PPPs to scale up their impact.
- Support data-sharing PPPs to develop innovative commercial models that move beyond donor-dependent funding structures.
- Initiative conversations and make suggestions on innovative funding models, including impact investment that attracts new types of private players.

Municipal government

- Proactively seek out private partners to explore the potential of innovative data sources for sector-specific impact.
- Involve technical and funding partners to develop innovative ways to leverage data.
- Institutionalise lessons from data-sharing PPPs into strategies, policies, regulations and budgets for long-term partnerships.
- Identify ways to combine publicly generated datasets with private sector innovative data sources for robust analysis.
- Build partnerships and networks with other municipal governments that are seeking, or have already implemented, data-sharing PPPs to exchange insights and build capacity.
- Build internal data capacity and culture to join and leverage future data-sharing PPPs.
- Ensure staff have a strong understanding of the cultural context throughout the partnership.

National government (ministries, agencies, etc.)

- Establish national innovation and digital transformation policies while encouraging municipal governments, national ministries and public utilities to engage in more data-sharing PPPs.
- Proactively seek out private stakeholders with large data platforms and identify ways to build use cases that support national initiatives.
- Support the institutionalisation of data insights into strategies, policies, regulations and budgets.
- Help successful use cases and partnerships scale up to other cities.
- Create clear data policy and regulatory frameworks that foster data privacy and security while enabling data-sharing partnerships.

Conclusion

With urban populations in Africa and Asia expected to increase by more than one billion people, rapid urbanisation will be one of the most pressing and complex challenges in LMICs for the next several decades. As populations grow, urban areas are transforming quickly, usually expanding into informal settlements along city peripheries. Without a plan for inclusive growth and urban planning strategies that integrate these settlements, low-income urban populations will increasingly be excluded from vital services and economic opportunities, including essential utility services and transport. However, governments lack the data they need to respond effectively, especially timely and granular information on low-income urban populations and areas, including supply and demand for utility services. Data scarcity makes it difficult to craft effective policies and urban planning strategies and solutions that meet the needs of the low-income urban populations.

By establishing a data-sharing PPP, public and private sector actors can take advantage of mutually beneficial synergies. While governments can access more cost-effective, timely and accurate data sources, private companies have the potential to create a new form of revenue, increase brand recognition and meet their impact-driven strategic objectives. By reviewing the role of innovative data sources in urban planning and the provision of water, sanitation, energy and transport services, this report has identified a diverse range of use cases. By exploring the journey, incentives, key challenges and enablers for data-sharing PPPs across Asia and Africa, the report has also revealed that the success of these partnerships depends on a complex set of factors. The findings validate the importance of partnership governance models and data privacy and management frameworks.

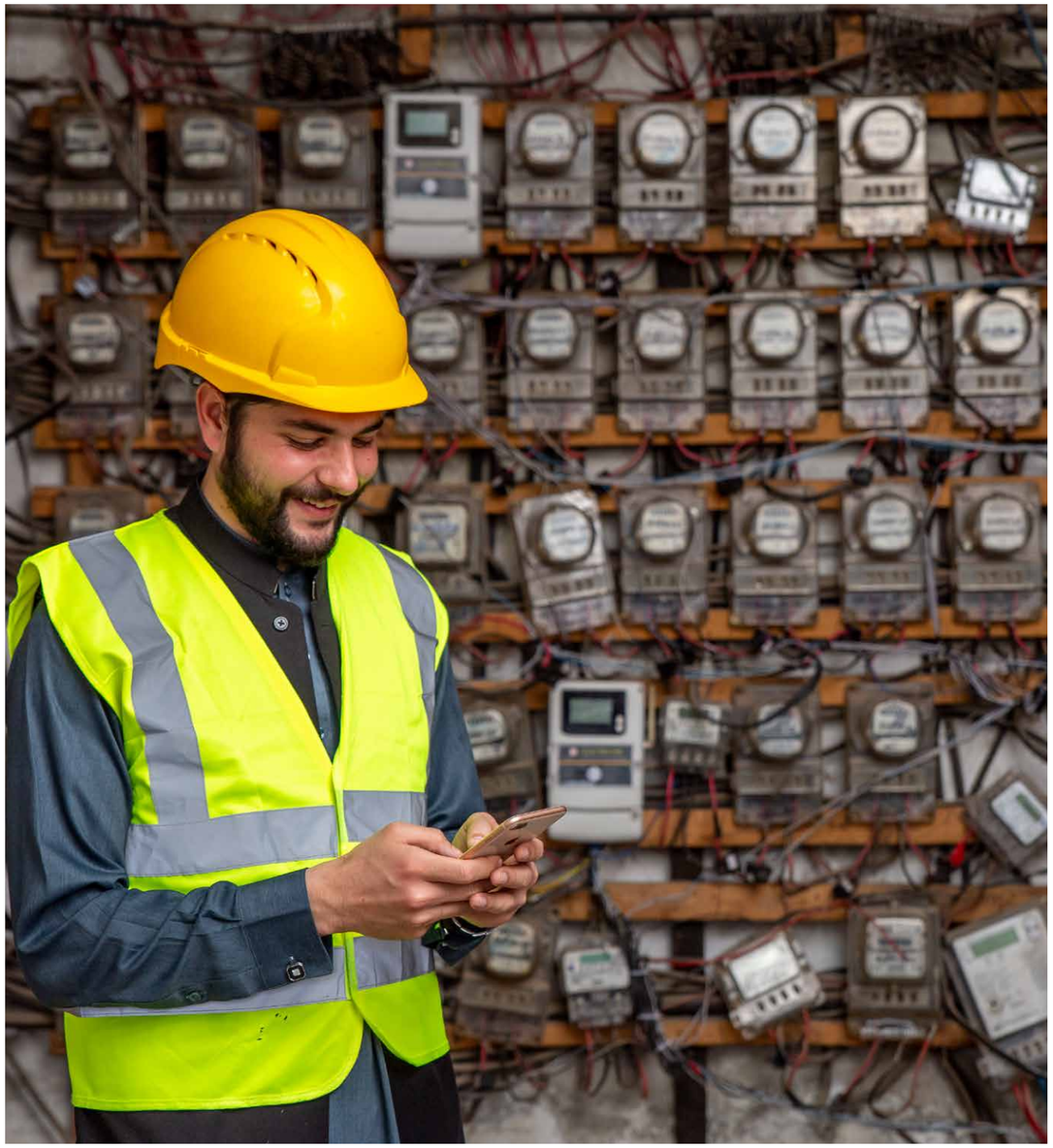
Insights have also revealed that while the public and private sectors have natural synergies, they still need the support of enabling organisations to convene stakeholders and clearly define a joint business and impact case to share data. In addition, while innovative data-sharing PPPs have rapidly expanded within the urban planning and urban utility services space, sustainable financing models have largely curtailed the long-term impact of these partnerships beyond their pilot phases. An emerging and notable player is government statistics agencies, historically underfunded and underresourced departments that have renewed prominence due to their advanced data analytics capabilities and the critical need to combine innovative new data sources with traditional survey datasets. These findings highlight that there is not one linear path to establishing data-sharing partnerships, and the possibilities will only grow as more innovative data sources, use cases and stakeholder partnerships emerge.

The findings indicate that the number and impact of data-sharing PPPs for urban planning and utility service provision will continue to increase in the coming years. Some of the factors that will foster this trend include: (i) The establishment of new data policy and regulatory frameworks in Africa and Asia; (ii) The commercialisation of data and analytics services by private companies like telecom operators that have a strong presence in cities; (iii) The investment in information technology infrastructure in Africa and Asia, such as the creation of domestic data centres and deployment of 5G and IoT; (iv) The increasing availability of data and ability to digitally connect with urban populations due to the growing adoption of digital solutions, including smartphones; and, more broadly, (v) The growing data culture and readiness to use innovative data to improve urban policymaking and service delivery.

Given the fast-evolving nature of this space, there is significant room and opportunity to support the growth of more data-sharing PPPs for urban planning and utility service provision. Public and private stakeholders should continue to partner on new data-sharing initiatives that apply the recommendations outlined in this report. These new partnerships will help to advance data-sharing PPPs as a whole as different stakeholders become more exposed to data and build their data capacities. With each new engagement, stakeholders will be better equipped to define new use cases and promote additional partnerships in new contexts with growing urbanisation challenges.

At the same time, there is a real need to prioritise sustainability and scale up successful data-sharing PPPs beyond the pilot stage. Of the many data-sharing PPP pilots showing promise, public and private partners must now identify partnerships to scale based on clear success criteria shared by all members of the partnerships. This will require PPPs to set up evaluation frameworks to measure both the impact on utility service provision and targeted urban communities, as well as the added value created for private stakeholders.

Whether a pilot can be scaled up successfully and sustainably depends on the ability of partners to institutionalise a financing model that ensures recurring internal budgets and resources are allocated to continue the partnerships. These budgets could be complemented by support from financial partners willing to cover the costs of scaling up. The wider enabling environment also has a role to play. Some critical areas of support include: (i) Creating data governance frameworks tailored to Asian and African contexts; (ii) Building the data capacity of municipal and national government institutions; (iii) Assisting with relationships with stakeholders instrumental to scaling up, such as financial partners; and (iv) Facilitating knowledge exchange between LMICs on data-sharing PPPs at different stages of maturity. As part of this enabling environment, the GSMA is committed to supporting even more innovative data-sharing partnerships in the urban planning and utility service provision sector in the future.



ANNEX: Additional case studies

CASE STUDY: NYU ETHIOPIA URBAN EXPANSION INITIATIVE, ETHIOPIA

Context

Ethiopia is currently one of the least urbanised and poorest countries in the world, yet its cities are undergoing rapid transformation. Just 20 per cent of the country's 112 million people lived in urban areas in 2019, but by 2040 this is projected to reach 60 per cent.[200] Rapid urbanisation presents a major opportunity for Ethiopia's cities to become massive engines of economic growth. The World Bank currently projects that Ethiopia will become a middle-income economy by 2030, but the challenges of this rapid transformation will need to be overcome.[201] Improper management or insufficient urban planning can result in uncontrolled poverty in urban peripheries. For example, although Addis Ababa's population increased by 17 per cent from 2007 to 2014, the city's urban boundaries expanded nearly three times as much (51 per cent).[202] If cities cannot adequately meet the needs and demands of Ethiopia's urban population, there will be significant problems with poverty, infrastructure, utility services, jobs and housing for several decades to come.

Urban planning efforts in Africa have largely centred around Comprehensive Master Plans (CMPs) that include a range of potential variables for effective urban growth. These plans can take several years to finalise, require significant data collection and large amounts of funding. While CMPs have been created in Ethiopia, Kenya, Rwanda, Nigeria, Angola, Zambia and Zimbabwe, New York University (NYU) has noted that these plans "almost never get implemented."[203] A core problem with traditional CMPs is that the plans are not government led and do not provide a simple implementation plan. Therefore, if governments do not engage with data and urban planning, they will not have the incentive or motivation to implement these visions. To address growing urbanisation challenges in Ethiopia, the government must lead a data-driven approach to urban planning that incentivises them to implement their own strategies.

Partnership formation

In 2013, NYU established a partnership with the Ministry of Urban Development and Construction (MUDC) called the Ethiopia Urban Expansion Initiative.[204] With a funding commitment of $500,000 from NYU, the initiative focused on helping the government create a 30-year plan for urban expansion of four secondary cities in Ethiopia, and an implementation plan to secure land within those plans. The four cities identified were Hawassa, Mek'ele, Adama and Bahir Dar. These cities were chosen because they were not a primary city, had a population of more than 100,000 as of 2010 and a projected population growth of three per cent annually, which meant that the population would double within 20 years. The plans aimed to address urbanisation challenges before these urban centres sprawl into informal settlements.

NYU created the methodology for the project while ensuring that the project was owned by municipal government stakeholders. The Ethiopia Urban Expansion Initiative had four key steps:[205]

1. Realistic mapping: Using satellite imagery data to forecast urban growth and creating realistic maps that identify land required for urban use in the next 30 years;
2. Generous city limits: Expanding the city boundaries and jurisdiction of one municipal agency that can execute these plans;
3. Arterial road grid: Identifying and securing land for 30-metre wide arterial roads through one kilometre by one kilometre grids throughout the expanded area; and
4. Selective protection of public open spaces: Identifying a hierarchy of open public spaces throughout the expanded area.

200. World Bank. (2019). "World Development Indicators"; Alemayehu, A. (27 March 2019). "Why should Ethiopians care about urbanization? Jobs, infrastructure, and formal land and housing". *World Bank Blogs*.
201. Ibid.
202. World Bank. (2015). *Ethiopia – Urbanization review: urban institutions for a middle-income Ethiopia*.
203. Lamson-Hall, P. et al. (19 October 2015). *A New Plan for African Cities: The Ethiopia Urban Expansion Initiative. NYU Marron Institute of Urban Management*.
204. Angel, S. et al. (18 August 2013). *The Ethiopia Urban Expansion Initiative: Interim Report 2*. NYU Marron Institute of Urban Management.
205. The Urbanization Project. (6 February 2015). *The NYU Urban Expansion Program: A Primer*. NYU Marron Institute of Urban Management.

An MoU was signed by the MUDC that outlined all the roles and responsibilities of stakeholders, including NYU, municipal governments, regional authorities and the Ministry.[206] A technical team was created for each of the four cities to oversee planning and implementation. NYU conducted an initial satellite imagery analysis and then provided technical assistance to develop the plans.

Data management

NYU was responsible for conducting a realistic mapping exercise for the data analysis and urban growth projections. Most of the subsequent analysis, planning and implementation of the next three steps were led by the city technical teams with support from NYU.

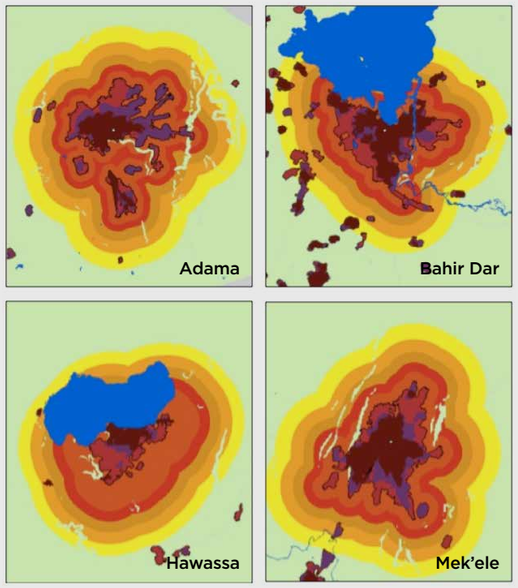
The realistic mapping exercise aimed to measure the growth of the city by identifying the outer built-up edge of each of the cities using satellite imagery from 1990, 2000 and 2010.[207] Satellite imagery from 2020 was used more recently to create a fourth map. The satellite imagery data was taken from the Landsat program, a joint initiative of NASA and the US Geological Survey (USGS). The Landsat program offers the longest continuous record of satellite imagery (since 1975). These satellite images were combined with census data and machine learning-based algorithms that analysed the value of the pixels to identify changes in land use and land cover over time, and ultimately produced highly detailed maps of the growth of the cities.[208] NYU set up a team of analysts in partnership with UN Habitat, which was responsible for conducting this geospatial analysis.[209]

Spatial data was combined with population data to forecast the spatial limits and density of the four cities in 2040. Based on these projections and assuming a 1.5 per cent annual increase in built-up area per person, Mek'ele would grow by 5.1 times its size in 2010, Adama would grow by five times, Hawassa would grow by 8.9 times and Bahir Dar would grow by 6.6 times.[211] To verify the analysis, the projections were also compared with growth rates of other rapidly growing cities globally.

206. Lamson-Hall, P. et al. (19 March 2018). "A New Plan for African Cities: The Ethiopia Urban Expansion Initiative". *Urban Studies, 56(6)*.
207. Angel, S. et al. (18 August 2013). *The Ethiopia Urban Expansion Initiative: Interim Report 2*. NYU Marron Institute of Urban Management.
208. Dalberg stakeholder interviews
209. The Urbanization Project. (6 February 2015). *The NYU Urban Expansion Program: A Primer*. NYU Marron Institute of Urban Management.
210. Angel, S. et al. (18 August 2013). *The Ethiopia Urban Expansion Initiative: Interim Report 2*. NYU Marron Institute of Urban Management.

FIGURE 20

Projected urban expansion of four secondary cities in Ethiopia[210]



Impact and usage

Based on the NYU analysis, technical teams from selected municipal governments were able to design concept expansion plans and begin implementing these plans in their respective cities.

City technical teams used the NYU spatial analysis and additional technical support to draft expansion plans that integrated local data and knowledge of their own cities. This included economic growth, existing urban planning strategies, understandings of current land uses, availability of non-urban land and growth of informal settlements.[212] The teams then created arterial road grid plans of their cities. The grid layout was one kilometre by one kilometre macroblocks with 30-meter wide arterial roads spaced one kilometre apart. The technical teams also integrated open public spaces and created a 150-metre buffer along lakes and rivers.[213]

The implementation plan involved purchasing and securing land to build the arterial road map. Under the 1995 Constitution, all land in Ethiopia, including rural and urban land and all natural resources, is owned by the national government.[214] Occupants of land hold long-term leases, but the government can obtain land for public use by providing compensation for the land's value. The government can also 'formalise' informal settlements by providing a "lease document that entitles them to city services, and they are expected to make regular payments for the duration of the lease."[215]

City teams calculated the expected compensation costs needed to acquire the land to build the arterial road plan. Given that land costs are significantly lower if land is purchased prior to urbanisation, a data-driven acquisition strategy can generate major cost savings for municipal governments.[216] The expansion plans projected that the compensation process would take three to five years, require municipal governments to prepare and auction more land for urban use in the future and involve a single and continuous municipal government capacity to implement the plan within the projected expanded borders.[217]

After undergoing a budgeting request and allocation process, the governments in the four cities implemented their expansion plans and secured the land. As of 2018, the four cities have secured or constructed 570 kilometres of arterial roads and sold $77 million worth of leases in expanded areas, producing a major new stream of revenue for municipal governments.[218] The implementation also addressed issues of growing informal settlements. In Hawassa, 7,000 informal settlements were resettled and provided with formal leases in the city's new expanded areas, which added 140,000 new residents and more than 26,000 jobs.[219] The total land compensation process cost about $35 million over five years.

Evaluation and sustainability

The partnership had a built-in evaluation process and key lessons learned were compiled in a series of interim and final reports. The Ethiopia Urban Expansion Initiative did not have a specific sustainability plan, especially in terms of data. The geospatial analysis was conducted as a one-time exercise for the four cities, but there may be future exercises to compare actual city growth projections after one decade and plan for course correction.[220] The partnership adopted a long-term perspective and developed a city expansion plan until 2040, providing significant foresight for municipal governments across a range of potential interventions. Notably, most of the initiative was led by municipal governments and city technical teams, which strengthened the technical capacity and expertise of the government to continue the implementation long after NYU's involvement.

211. Lamson-Hall, P. et al. (19 October 2015). *A New Plan for African Cities: The Ethiopia Urban Expansion Initiative*. NYU Marron Institute of Urban Management.
212. Ibid.
213. Ibid.
214. Lamson-Hall, P. et al. (19 March 2018). "A New Plan for African Cities: The Ethiopia Urban Expansion Initiative". *Urban Studies, 56(6)*.
215. Ibid.
216. Dalberg stakeholder interviews.
217. Angel, S. et al. (18 August 2013). *The Ethiopia Urban Expansion Initiative: Interim Report 2*. NYU Marron Institute of Urban Management.
218. NYU Marron Institute of Urban Management. (10 September 2020). *Urban Expansion Program Concept Note*.
219. NYU Marron Institute of Urban Management. (10 September 2020). *Urban Expansion Program Concept Note*.
220. Dalberg stakeholder interviews.

NYU has applied the methodology of this project to partnerships in other cities. With support from the Government of Ethiopia and an additional $200,000 in funding from the Cities Alliance, the Ethiopia Urban Expansion Initiative conducted a Phase II of the partnership, which expanded it to include 14 additional cities. This second phase did not provide any additional implementation support and it concluded in 2016. A third phase is underway without NYU and with the participation of the Cities Alliance and the Swiss Development Cooperation (SDC).[221] This is a regionally focused initiative that will help to create and implement urban expansion plans in nine cities: two in Somalia, four in Ethiopia and four in Uganda.

Synergies

The key partners in this case study were NYU and the respective urban planning teams in each city. NYU used publicly available data, including census records and Landsat satellite imagery. They also provided technical assistance, methodological design and data analytics support. Meanwhile, the government navigated the regulatory frameworks for land development within each city, developed an urban plan that designated an arterial road grid based on local knowledge and implemented strategies for securing land. Notably, this was a very direct partnership with minimal additional stakeholders involved, including an additional funding source. The partnership was incredibly successful and provided the necessary data capacity for the government to lead most of the partnership.

Challenges and enablers

Despite its success, the partnership encountered some key challenges and enablers, including the development of use cases, government-led partnership sustainability, a government champion and funding.

Use case development: The Ethiopia Urban Expansion Initiative was successful because of its methodological design and the integration of implementation into the design of the engagement. As mentioned earlier, many Sub-Saharan African countries, including Ethiopia, have created CMPs that are often not implemented. In this partnership, municipal governments created urban planning maps and designed implementation strategies, including plans for land compensation and the construction of arterial roads. Governments had a clear plan to move beyond these maps, and ultimately built more than 500 kilometres of roads and sold land leases worth $77 million.

Government-led partnership sustainability: While the satellite data analysis was a one-time exercise, the implementation of the expansion plan had long-term consequences for the Government of Ethiopia and the city administrations. The methodology of the partnership ensured that technical assistance would be provided throughout the partnership, but most of the exercises were led directly by the municipal government teams.[222] This ensured that urban planners and engineers in the government would acquire the technical capacity needed to implement the plan long term. However, this institutionalisation and government-led partnership sustainability came with challenges. It is important to recognise that the cities in the initiative were not homogeneous. Bahir Dar and Adama faced government turnover, Hawassa was surrounded by agricultural land and Mek'ele was surrounded by marginal land. Adama was also experiencing violence in the Oromia Region and stopped participating in the initiative in 2016.[223] These differences required adjustments to methodologies and implementation strategies. Changes to government administrations created widespread staff turnover that, in turn, required renewed technical assistance and public sector buy-in. In Bahir Dar and Adama, where city managers and mayors changed between the plan completion and funding allocation stages. Although the urban planning teams remained the same, they engaged in implementation "without the understanding of their own management."[224] The initiative was still able to proceed, however, and efforts were made to quickly secure land while the same government administration was in place. Ultimately, NYU had to serve as a long-term bearer of institutional memory for engagements with new government administrations.

A government champion: In Hawassa, former city manager Biru Wolde stood out as a government champion[225] who propelled the initiative forward despite the challenges. With an understanding of

the value of a 30-year plan and a desire to make the expansion plan part of his legacy, Wolde put his full energy into the project and made the engagement process much smoother.

Funding: The NYU partnership used university seed grant funding of $500,000 for the first phase of the project. The subsequent phases were funded by the Cities Alliance. This funding supported the inclusion and travel of international staff whod provide technical assistance to local municipal teams. The support was provided for free to government staff, with the Government of Ethiopia allocating a budget to support the implementation of the plan. The return on investment was very positive: the government spent about $35 million but sold $77 million in land leases.[226] The government understood that could spend significantly less by purchasing land before peripheral areas urbanised, and became incentivised to quickly implement their urban planning maps.

FIND OUT MORE:

An Overview of the Ethiopian Urban Expansion Initiative

A Video Documentary with Government Stakeholders

NYU Urban Expansion Programs in Other Country Contexts

221. Ibid.
222. Ibid.
223. Lamson-Hall, P. et al. (19 March 2018). "A New Plan for African Cities: The Ethiopia Urban Expansion Initiative". *Urban Studies, 56(6).*
224. Lamson-Hall, P. et al. (19 October 2015). *A New Plan for African Cities: The Ethiopia Urban Expansion Initiative*. NYU Marron Institute of Urban Management.
225. Dalberg stakeholder interviews.
226. NYU Marron Institute of Urban Management. (10 September 2020). *Urban Expansion Program Concept Note*.

CASE STUDY: NIGERIA ELECTRIFICATION PROJECT (NEP), NIGERIA

Context

Nigeria is the largest economy in Africa, and the most populous country on the continent. The national population is expected to double by 2050 and the urban population is growing even faster at 4.3 per cent a year.[227] Nationally, 45 per cent of Nigerians have access to energy: 36 per cent in rural areas and 55 per cent in urban areas.[228]

With large oil, gas, hydro and solar resources, Nigeria has the potential to generate 12,522 megawatts (MW) of electricity from existing plants, but currently only generates 4,000 MW, not nearly enough to power the country.[229] While the federal government has pushed forward many ambitious electricity reforms, energy access rates have improved slowly due to crippling electricity infrastructure. As Nigeria's population continues to grow rapidly, extending the electrical grid throughout the country, especially in more remote areas, will become more difficulty and costly. Off-grid energy services are therefore seen as an excellent opportunity to accelerate the electrification of Nigeria, to reach communities that will not be able to connect to the main electricity grid in the medium to long term and to allow utilities to focus on industrial demand and large cities.

Partnership formation

The Nigeria Electrification Project (NEP) was established in 2018 as a five-year project to increase access to electricity services in underserved areas.[230] The programme was designed by the World Bank and implemented by the Rural Electrification Agency (REA) of Nigeria. With $350 million in funding from the World Bank and $200 million from the African Development Bank (AfDB), the NEP is an innovative programme to kick-start off-grid electrification through grant funding, create an energy database with detailed energy market data and provide technical assistance.[231] The NEP uses a market-based approach through which private companies are expected to develop mini-grids or deploy SHS with subsidies from the REA. The NEP has four main components:[232]

- **Component 1:** Solar hybrid mini-grids for rural economic development

  The REA provides subsidies and/or performance-based grants to private mini-grid developers, which must build solar hybrid mini-grids in underserved rural areas.

- **Component 2:** Stand-alone solar systems for homes, enterprises and farms

  The REA provides market-based incentives to private companies responsible for deploying and installing SHS for underserved households and SMEs in designated areas. These incentives are in the form of output-based funds, with the REA covering a percentage of the costs associated with each SHS deployment.

- **Component 3:** Power systems for public universities and teaching hospitals

  The REA supports the construction and operation of solar mini-grids for universities and teaching hospitals.

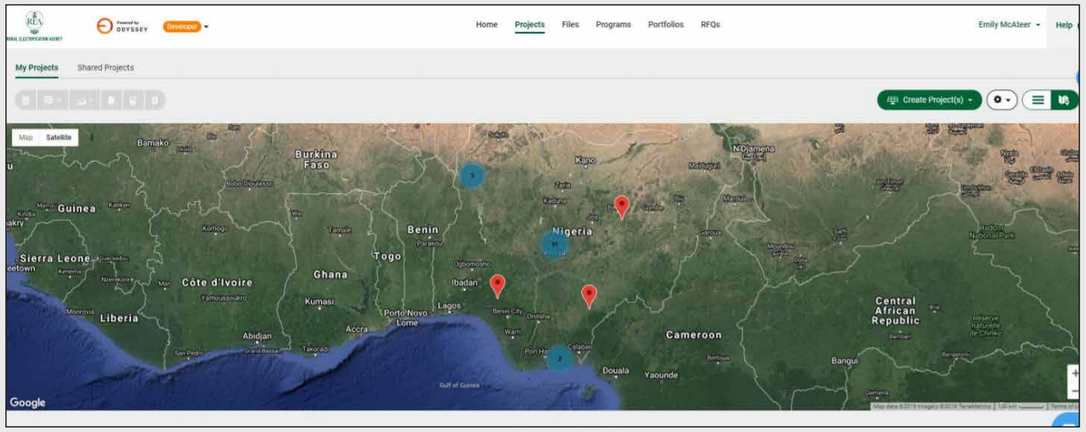
- **Component 4:** Technical assistance and support

  The World Bank provides overall technical assistance and support for the implementation of the project to build the capacity of the REA.

The NEP includes multiple stakeholders from across the public and private sector. Each component of the project includes a project manager, who is also responsible for contracting different aspects of the project to a private stakeholder, including grant management, procurement, data management and data analytics. These stakeholders include, but are not limited to, Odyssey, USAID, Fraym, Deloitte and Inensus. As part of the World Bank programme framework, the NEP incorporates a variety of public-private data sharing. The NEP is on-going and is expected to end in 2023.

FIGURE 21

A visual of the Odyssey platform[233]



Data management

As part of Component 2, the REA engaged 19 private companies, including Lumos, to support the deployment of SHS. These companies were part of a very selective group subject to strict criteria. Companies were required to demonstrate they had a track record in the country, the ability to deploy solar tools and had to be certified by Lighting Global. This was to prevent the participation of private companies that might sell substandard quality products. Lumos was part of the initial round of discussions before the NEP was established, when the World Bank and the REA engaged many private stakeholders to better understand Nigeria's private off-grid electrification market. Conversations also informed the output-based funding structure. The REA calculated the average retail cost of the SHS, categorised the products into tiers and set the cost reimbursement based on the products sold in each tier.

Private companies, including Lumos, would then take a market-based approach to deploying SHS units. With each SHS deployment, companies were required to upload customer information onto a data platform developed by Odyssey, including customer name, geographic location, serial number of the SHS product and phone number. This data was then verified by the REA to reimburse the private companies a fixed cost of the SHS.

As the programme continued, the REA gathered a large database of energy customers. This enabled Odyssey to visualise where SHS were being deployed and identify customer segments. Notably, this data collection supplemented the even larger Nigerian Energy Database (NED), which was also being compiled with data from other components, as well as population and energy market-related data collected by the Nigerian Government. The NED became a partly-publically available database of energy, community and grid data that not only promoted transparency in the sector, but also provided accessible information for private companies involved in the NEP. Many private companies

227. URBANET. (23 October 2018). *Infographics: Urban Development in Nigeria*.
228. USAID. (2021). "Nigeria Energy Sector Overview". *Nigeria Power Africa Fact Sheet*.
229. Ibid.
230. REA. (2017v). *The Off-Grid Electrification Opportunity in Nigeria*.
231. REA. (January 2019). *The Rural Electrification Agency's Impact Report*.
232. AfDB. (2018). *Nigeria Electrification Project; World Bank*. (2018). *Nigeria Electrification Project Document*.
233. REA. (June 2019). *Creating an Enabling Environment for a 10,000 Mini Grids Market*.

involved in Component 1 (mini-grid deployment) were able to use population and market information to better understand where to build mini-grids and which communities were most in need. While some level of the NED is publicly available, private companies could request more detailed information from the REA to glean more in-depth market knowledge.

Finally, the data was analysed by several different stakeholders, including NoMAP and Fraym, which conducted a joint geospatial analysis to identify commercially viable off-grid communities suitable for mini-grid or SHS deployments. This geospatial analysis was first conducted in October 2018 in parallel with the data collection efforts of the NEP.[234] NoMAP was interested in collecting more data to help private and public energy stakeholders make more informed decisions while Fraym is a geospatial data analytics expert. The analysis was conducted in 10 states across Nigeria and included additional parameters such as "distance from grid, history of violence, level of productive activities, presence of anchor customers, willingness and ability to pay, and other important socio-economic indicators."[235] The results of the analysis was shared with multiple stakeholders, including private companies, and was also made publicly available on NoMAP's and the REA's websites to support the deployment of solar products to other markets.

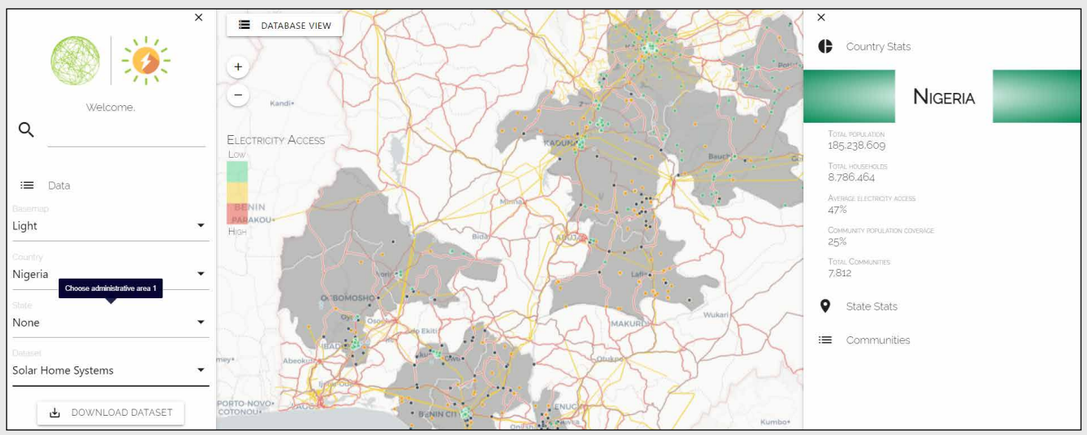
Impact and usage

As part of NEP Component 2, the data collected on the Odyssey platform allows the REA to validate the deployment of SHS by private companies like Lumos and then issue output-based funding for these deployments. Lumos is one of the top-performing SHS private companies in Component 2. This has become a win-win solution for off-grid electrification efforts between the public and private sector, and a very quick model of results-based financing. The REA is also able to use Odyssey to identify where their SHS energy customers are and better understand the SHS market. The analysis conducted by Fraym in October 2018 also fed back into the solar product deployment by private SHS and mini-grid companies.

234. NoMAP. (2020). "Fraym and NoMAP Complete Geospatial Analysis of Off-Grid Communities in 10 States". *NoMAP Blog*.
235. Ibid.
236. Fraym. (2018)

FIGURE 21

A visual of the geospatial analysis[236]



The NED is being used for broader government policies and regulation efforts to support the growth of the energy sector.[237] The REA holds a lot of data that other agencies will need for asset pricing and tariff setting, regulatory planning and network expansion planning. The data helps the government understand the number of companies involved in the space and the types of equipment needed in the sector. The government is also able to assess multiple tiers of panels, quality and necessary regulatory standards. Furthermore, the data is informing government understanding of environmental protection and degradation policies. Given that solar products use a lot of batteries and produce electronic waste, the government can also plan for an increase in waste generation. The government can also get a clearer picture of the needs of off-grid communities, what services they require and how to plan infrastructure to better meet these needs.

Evaluation and sustainability

As a five-year World Bank programme, the NEP has not yet conducted a full evaluation nor does it have a built-in plan to continue for longer than intended. Although many World Bank programmes have a second iteration if it is deemed successful and necessary, the NEP is still tentatively projected to end in 2023.

By the end of the NEP, the REA will have built a significant NED, which will support the growth of the energy sector and inform government policies and decisions for years to come. However, after the results-based financing ends along with the NEP, many private SHS and mini-grid companies will lack the financial incentive to share their data – a competitive advantage – with the REA. Additional agreements may therefore be necessary for the REA to continue sharing and compiling this data.

The NEP model is a potentially replicable model for other country contexts that may need additional institutional and funding support to kick-start the off-grid electrification market quickly. While the NED is extremely robust with on-going data collection and additional analyses by organisations such as Fraym, there is an opportunity to add even more innovative sources of data, including mobile phone data. Mobile phone activity has been shown to have a strong correlation with electricity consumption, therefore, mobile big data may provide a cheaper and faster alternative data source for smart energy planning when large donor funding is not available.[238]

Synergies

NEP combined the synergies of the public and private sectors. While not a traditional PPP, the programme created a contractual partnership involving data and cost sharing. Rather than a programme designed to improve public energy utilities, the NEP was envisioned as a market-based solution (e.g. the expansion of on-grid electricity networks). The first "win-win" of the partnership was this shared definition of success and impact.

The second synergy was the NEP's funding structure and the REA's capacity to provide funding subsidies for private companies. The results-based financing approach was a business model that could quickly deploy private sector capabilities to the market. The programme also provided segmented support for different types of solar products, including SHS and mini-grid private companies.

The third synergy was the REA's allocation of different capacities and skills to external private companies. Although the REA's main program management unit had significant skills and knowledge, the NEP by design used external contractors to support programme operations, including contractors for procurement, grant management, verification processes, data collection and data analysis.

Finally, the REA had the capabilities to create policy solutions that would support the growth of Nigeria's off-grid energy sector. As mentioned earlier, the REA had compiled a large NED with a significant number of data points. This data was then used to support various programmatic, policy-related and regulatory agendas of the Nigerian Government to better support off-grid electrification. This created a feedback loop in which private companies provided data to REA that the REA and other government agencies then used to create an enabling environment for private companies to expand their services.

237. Dalberg stakeholder interviews.
238. Emerging Technology from the arXiv. (29 July 2019). "How much electricity does a country use? Just ask cell-phone users". *MIT Technology Review*.

Challenges and enablers

As a large-scale programme with multiple components and a growing list of stakeholders, the three key defining enablers of the NEP have been community alignment and processes; financial agreements; and trust, transparency and reputation.

Community alignment and processes: The NEP is halfway through its project cycle and the number of partners involved has continually grown. Nineteen private companies were involved in Component 2 alone. As a result, the REA has had to explicitly delineate the roles and responsibilities of stakeholders, decision-making and accountability mechanisms and mutual understanding of partnership terms. As part of the partnership process, the project manager for each component ensured that all stakeholders were aligned and understood the contractual terms of the engagement. The REA also had a degree of flexibility to add stakeholders to the engagement when needed, including NoMAP and Fraym to conduct geospatial analyses. As part of Component 2, Lumos and the other companies involved held a monthly roundtable discussion with the REA to discuss various challenges and resolve potential difficulties.

Trust, transparency and reputation: This enabler builds on community alignment and processes. A key aspect of the NEP was that it was designed to include many different external stakeholders to provide "checks and balances". With multiple stakeholders managing different parts of the engagement process, a built-in accountability and transparency mechanism was created to prevent fraud. A key challenge of multiple checks and balances was that some parts of the NEP process were much slower, particularly the verification process for SHS deployment, which required a call to every customer to verify the data provided by the private sector partner. Many times, customers did not answer or lived in remote regions where connectivity was inconsistent, which delayed verification and subsidy funds. This is in contrast to Togo's off-grid solar subsidy programme, which pays customers a subsidy directly via mobile money, and it is verified by mobile operator and postal company partners.[239]

Given that the NEP was backed by the World Bank and AfDB, private sector partners had reassurance that even though the funding process might be slow, they would receive payment eventually. The REA also established strong credibility and transparency with private stakeholders who were not engaged in the partnership. If a private company applied to be part of the NEP but did not meet the necessary qualifications or criteria, this was transparently communicated to give all applicants the opportunity to reapply.

Financial agreements: Financial agreements were undoubtedly the core of this data-sharing PPP. With $350 million from the World Bank and $200 million from AfDB, the NEP could provide significant funding-based incentives to join the partnership and share data with the government. Given that the energy database consolidates publicly available market information to support national off-grid electrification efforts, the provision of data from private companies may also cause them to lose a degree of competitive advantage. However, participation in the NEP offers large cost savings and the opportunity to scale up their operations significantly over the course of five years. The results-based financing model is clearly outlined in the contractual agreements and the verification process allows clear and transparent channels for feedback on the deployment and data collection processes.

FIND OUT MORE:

The Nigeria Electrification Project document from the World Bank

An Analysis of the Off-Grid Electrification Opportunity in Nigeria by REA

An Overview of REA's Impact and Various Ongoing Programs (2019)

How Mobile Technology Can Be Leveraged in Smart Energy Planning

239. Bauer, G. and White, Z. (25 March 2021). "Smart subsidies and digital innovation: Lessons from Togo's off-grid solar subsidy scheme". *GSMA Mobile for Development Blog*.

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