JICA + BCG

Unified Data Highways

The Next Frontier of Digital Public Infrastructure

October 2024

Note: This is an AI generated image. Image generated using Adobe Firefly

JICA is an agency of the Government of Japan which extends Official Development Assistance (ODA) in 150+ partner countries over six decades. JICA DXLab, in a partnership with BCG, is a flagship initiative of JICA that spearheads digital transformation in its ODA programs for accelerating the socioeconomic impacts to thrive in the digital age.

One of the focuses of JICA DXLab is the development and deployment of Digital Public Infrastructure (DPI) and Digital Public Goods (DPGs). The unique approach of JICA DXLab is to leverage JICA's ODA programs implemented across sectors and countries for wider and deeper adoption of DPI and DPGs in agile collaboration with governments, private sector, academia and civil societies.

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Foreword

Throughout history, roads and highways have connected distant towns, transforming isolated localities into bustling hubs of commerce and culture by enabling people to pool their expertise and resources, fostering collective prosperity. Without these highways, each locality remained a silo of its own assets, stifling innovation and missing out on lucrative business prospects. Today, in the age of digitization and in this seemingly interconnected world, we still have data lying in isolated databases, disconnected platforms, and proprietary systems, locking out the broader ecosystem from innovating and creating new business opportunities by harnessing the power of data.

Just as highways are physical commons constructed to connect people from different towns, Unified Data Highways (UDH) can be considered the 'digital commons' for a data driven world. UDH are data sharing networks built on Digital Public Infrastructure (DPI) technology principles and a robust governance framework which enable an open ecosystem to create innovative and inclusive services for public good.

While the 'Identity' and 'Payments' pillars of DPI have been the subject of many discussions, UDH have not received comparable levels of attention. This relative obscurity belies the economic potential of UDH. Our research shows that, through data sharing, UDH have the potential to unlock economic value of USD 3 to 4 trillion[1] in emerging nations annually by 2030, representing 5-6% of their collective GDP.

This report, co-authored by Japan International Cooperation Agency (JICA) and the Boston Consulting Group (BCG), unpacks the why, what and how of data exchanges, the third pillar of digital public infrastructure (DPI) that we call Unified Data Highways (UDH), by focusing on four areas -

- Understanding UDH: What are **UDH**? How has the **concept of data sharing evolved** over the years? What are some of the case studied of **successful case studies** in UDH?
- Unlocking the impact of UDH: What is the **impact potential** of UDH for emerging nations? What are the **guiding principles** observed across successful global implementations? How can UDH **overcome adoption challenges?**
- Sectoral perspectives on UDH: What is the **value creation potential of UDH** across sectors? What are the **factors** that can **explain the variation in maturity** of UDH across these sectors?
- The Road ahead for UDH: How can the integration of **Artificial Intelligence and UDH** unlock exponential impact? What are the **roles of various stakeholders in the UDH journey,** and how can a collaborative action advance the development of UDH?

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1. For additional information, please refer to the Impact Potential section of the report

Executive Summary

Imagine a world where moving to a new city feels like a breeze. Need a loan to finance relocation costs? You can readily compare the best offerings across financial service providers and easily share your financial information with your lender of choice to swiftly obtain a loan. With just a few clicks, you can share all the relevant documentation and academic records to get your child enrolled to a new school. You can grant your new healthcare provider access to your medical history, ensuring continuous and informed care. No longer do you have to frantically search for misplaced documents and provide the same information multiple times when accessing different services. For daily commute, you can access bus, metro, taxi, and rideshare options along with their precise ETA to help you pick the most cost-effective option and plan multi-modal routes. At home, you can easily monitor your energy consumption, receive customized savings tips, and readily switch to a more economical and reliable energy supplier.

This is what the future could look like with **Unified Data Highways (UDH)** as it promises to take the DPI led approach of development further to significantly simplify the life of citizens, saving them time, money, and and effort, transforming everyday life as we know it.

Unified Data Highways (UDH): The next frontier of Digital Public Infrastructure (DPI)

Digital Public Infrastructure (DPI)[2] is a set of shared digital systems that are secure and interoperable, built on open standards, to provide equitable access to public and private services at scale. DPI comprises three pillars – Identity, Payments, and Data Sharing infrastructure, which we call UDH. While we see considerable literature on the first two pillars, UDH have not been written about in depth.

UDH are data sharing networks built on DPI principles to enable open ecosystems that create innovative and inclusive services for public good. In other words, UDH are the 'digital plumbing' that enable the move to a new city described above feel like a breeze. UDH have only recently begun to gain traction. The shift towards UDH is driven by the **growing recognition of data as the backbone of the digital economy** and **the increasing accumulation of data in siloed systems,** highlighting the need for a data-sharing network accessible to all ecosystem players.

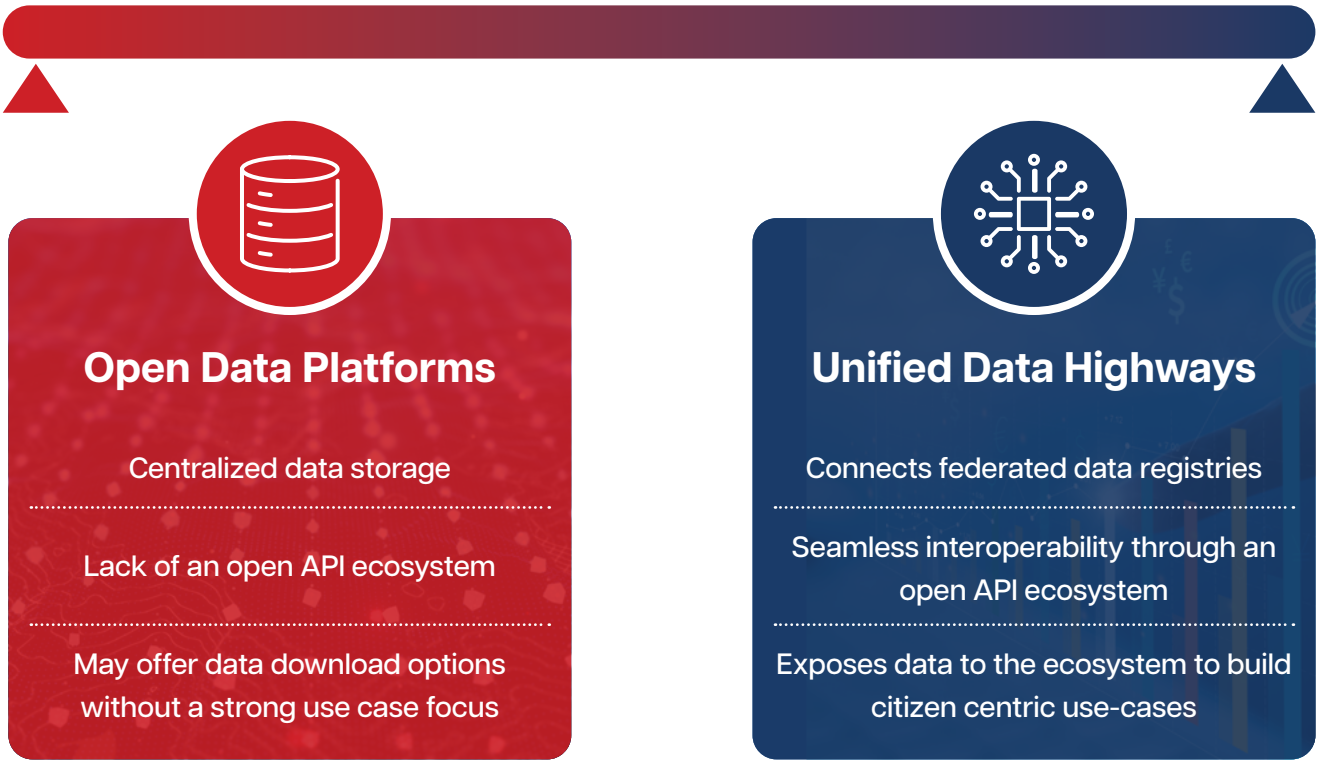
The transition from open data platforms to UDH illustrates the evolving paradigm of data sharing. There were two major shifts characterizing the evolution of data sharing as illustrated in the Exhibit above. The first major shift in data sharing occurred when data was digitized and stored in centralized registries leading to the birth of open data platforms. UDH represent the second major shift in data sharing by connecting federated data, enabling seamless interoperability, and being built with a strong focus on citizen centric use-cases.

We believe UDH are the future of data sharing and several nations are already launching initiatives to unlock the potential of their data through UDH.

2. Defined at the G20 2023 conference

Exhibit

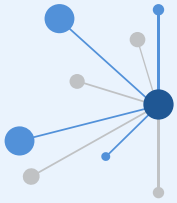
The transition from open data platforms to Unified Data Highways illustrates the evolving paradigm of data sharing



For instance, X-Road is a pioneering UDH in Estonia that effectively **integrates disparate IT systems, facilitating interoperability among over 1000 public and private sector institutions.** This integration gives citizens seamless **digital access to more than 99% of government services**

In India, the Ayushman Bharat Digital Mission (ABDM) serves as the cornerstone of the nation's integrated digital health infrastructure. It enhances operational efficiencies in the digital healthcare system through the adoption of longitudinal health records, streamlines financial procedures such as health insurance claims, and enables consent-based sharing of patient data with healthcare providers. This facilitates easy access to a wide range of services, thereby enhancing patient outcomes.

Unlocking the impact of UDH



UDH can unlock between USD 3-4 trillion dollars[3] of economic value annually for emerging nations by 2030

This would be enabled by a paradigm shift in data sharing, helping these nations transition from disconnected data silos to an integrated, data-driven future designed for innovation and inclusive socio-economic development. By simplifying data discovery and access, UDH can promote an open innovation ecosystem. They can ensure seamless interoperability by securely connecting fragmented data registries, converting untapped assets into public goods. UDH can increase market competition by lowering barriers for smaller participants to access data and innovate. Furthermore, by promoting transparency and giving users more control over their data through active consent management systems, UDH can develop citizen trust in data sharing. Finally, UDH can reduce the cost and friction of service delivery, thus improving public service accessibility and affordability.

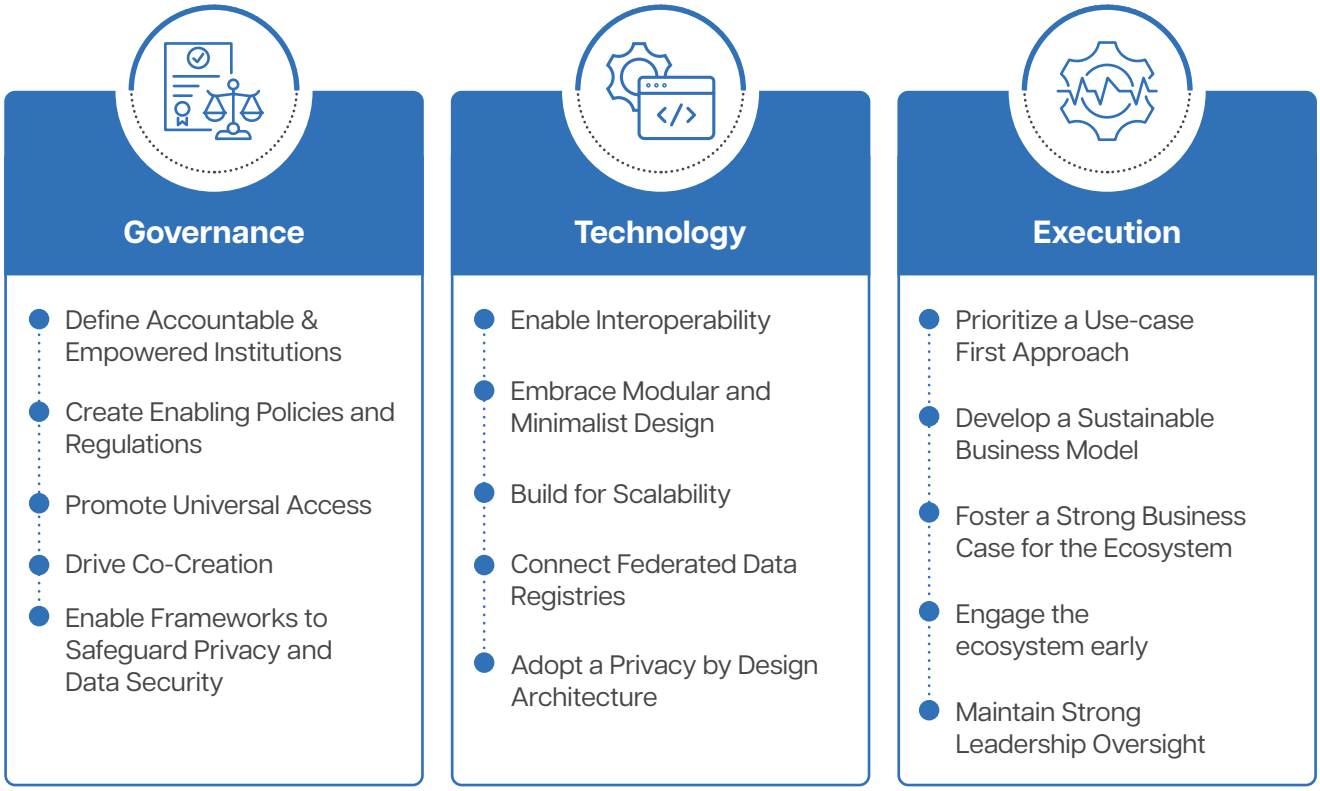
To lay the foundations for success, UDH should be built on the fifteen guiding principles of governance, technology, and execution. All three elements must go hand in hand to ensure the development and successful operations of a UDH as illustrated in the Exhibit below.

Sustainable governance involves creating and enforcing **policies and regulations** on personal data protection and cybersecurity, to minimize risks and build trust among users. An **accountable apex body** should be established to manage and regulate the network, ensure clear institutional mandates, and drive use-cases. It is essential to **promote universal access** through targeted actions to include marginalized communities minimizing the digital divide and extending the benefits of services to all citizens. UDH should be **co-created** with an active ecosystem involvement to minimize deployment and ongoing costs, ensure the relevance of data to the ecosystem's needs, and help drive the use-cases efficiently. UDH must also enable **frameworks and mechanisms** such as consent artefacts and maintaining data transaction audit logs, to ensure regulatory compliance and reinforce trust within the network.

3. USD 3-4 Trillion represents the annual social and economic value to be unlocked through data sharing across different sectors across 49 emerging nations in 2030. It does not imply an annual GDP boost of 5-6% but rather indicates that the value generated from UDH would approximate 5-6% of their projected GDP in 2030. This estimation draws on the European Data Market Study 2021-23 by the European Commission, which assesses the impact of the Data Economy on the GDP of EU countries. Our calculation assumes that the impact on GDP (as a % of GDP) is influenced by a state's ability to drive digital transformation and data sharing at scale. Consequently, the potential value unlocked as a % of GDP will vary between emerging nations and EU nations. To contextualize this data from EU to emerging nations, we have used the World Bank's GovTech Maturity Index (GTMI) as an adjustment factor. We assume that a higher GTMI score suggests a greater potential for a country to unlock value through data sharing. The World Bank GTMI index includes 48 indicators such as government cloud, interoperability framework, accessibility of government services online, open data, open government portal, and more. Considering the substantial state involvement required for the development of UDH, we selected the GTMI index as an adjustment factor. Given that UDH are typically state-led initiatives, the state's capacity for digital transformation is a crucial determinant of the value that can be created through UDH. Our calculation also assumes that UDH would be able to unlock the potential of the data economy in emerging markets. UDH lift barriers to participation in the data market, create friction-free access to data for all authorized parties, ensure privacy, safeguard against data manipulation and unregulated use of data, thus enabling nations to realize the potential of their data economy.

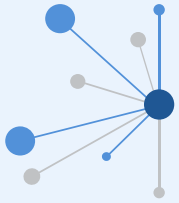
Exhibit

UDH should be built in alignment with the fifteen guiding principles of governance, technology and execution



Technological principles for UDH include **enabling interoperability** through open standards and APIs to establish seamless communication between disparate systems. **Embracing modular and minimalist design** allows for rapid, iterative development and adaptability to changing requirements. **Building for scalability** ensures that the network can expand to meet future needs, without needing a major overhaul of existing systems. **Connecting federated data registries** helps maintain data autonomy while reducing the security risks that are inherent to having a single point-of-failure. **Adopting a Privacy by Design architecture,** with consent mechanisms for access control and the use of encryption algorithms and digital signatures to prevent unauthorized access ensures safeguards for privacy and data security.

Successful UDH should also follow five execution principles to ensure a solid foundation. UDH must prioritize a **use-case first approach** to define the value proposition for end-users and build solutions to critical citizen pain points to build early momentum.



While UDH can initially be financed by the public sector, development funders, and philanthropies, it is crucial to consider a **self-sustaining** model for long-term operations

For instance, Account Aggregators charge Financial Information Users (FIUs) a small fee for every data transaction. The UDH must foster a **compelling business case** for the private ecosystem allowing them to generate substantial return on investment, hence promoting sustainable use. **Engaging a wide range of ecosystem players,** including potential users, technology providers, CSOs, think tanks, and academia early on, facilitates the development of a robust network that meets the data needs of the builder ecosystem, addresses critical concerns, and promotes inclusivity. **Maintaining strong leadership oversight** ensures a top-down push for execution and assurance of financial resources. These early actions collectively ensure that UDH are set up for success and ready for the challenge of securing wider adoption.

Sectoral perspective on UDH

UDH around the world have demonstrated strong potential to advance high-value use-cases across sectors to unlock economic and social value. To name just a few - they can streamline the digital delivery of government services, integrate patient health records for personalized healthcare, provide agri-tech data advisory services to enhance farmer productivity and income, help citizens optimize household energy consumption, and enhance the adoption of public transportation through multi-modal transport systems.

Based on the prevalence of UDH, sectors can be classified into three maturity archetypes - leading sectors, emerging sectors, and whitespaces. Healthcare, government services and agriculture are the **leading sectors** in which the highest number of UDH have been initiated thus far. Meanwhile, power, water management, and climate & sustainability are sectors where data highways are gradually gaining traction, with several nations taking initiatives in these sectors, making them **emerging sectors.** On the other hand, transportation and smart city are **whitespaces,** with very few active data highways in these sectors worldwide.

This variation in maturity of UDH across sectors can be explained by the relative intensity of government impetus and strength of the business case present in each sector. The government impetus is influenced by the relevance of the use-cases to citizens' essential needs and global push for action in each sector. The business case is driven by the size of the innovator ecosystem beyond public sector and citizens' willingness to pay for use-cases. Leading sectors tend to have comparatively high government impetus coupled with at least a moderate business case. Whitespaces show relatively low government impetus, although there may be a strong business case. Finally, in emerging sectors, while there may be moderate to high government impetus, development of UDH at scale is held back by the relative lack of a business case.

Exhibit

Unified Data Highways are poised to unlock socio-economic benefits across multiple sectors

Healthcare

~24 Mn

digital health records have been created through My Health Record which has been adopted by ~99% of general practitioners, pharmacies and public hospitals in Australia

Government Services

2%

annual GDP savings achieved through the use of X-Road for digital public service delivery in Estonia

Agriculture

250,000+

farmers in digitally underserved areas receive agri-advisory services in Kenya through KAOP

Transportation

20%

predicted boost in modal share of public transport adoption as a result of the implementation of Transport Stack in New Delhi

Power & Energy

USD 18-35 Mn

projected yearly value creation as a result of Estfeed's implementation in 0.7 Mn households in Estonia

Climate & Sustainability

85%

of all carbon credits issued globally to date have been unified by the World Bank CAD Trust within its first year of operation

Water Management

25%

improvement in water accessibility in Sierra Leone due to the implementation of WPdx for decision making

Smart Cities

USD ~2 Mn

savings generated every year in solid waste management in Varanasi, India by using data from India Urban Data Exchange

Leading Sectors | Emerging Sectors | Whitespaces

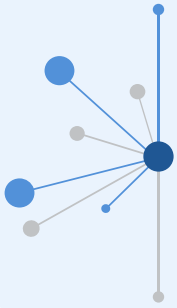
Sources: BCG Analysis; Expert calls and publicly available resources; Healthcare; Government Services; Agriculture; Transportation: JICA BCG Research; Power & Energy; Climate & Sustainability; Water Management; Smart Cities

The road ahead for UDH

The interplay between AI and UDH represents a significant leap in the evolution of DPI. This synergy creates an exponential effect, with each enhancing the capabilities of the other. AI can help improve data accessibility, while UDH can provide high-quality datasets to fuel AI innovation. This could create a powerful feedback loop where data availability drives AI advancements, and AI, in turn, enhances the efficiency and effectiveness of data utilization and exchange.

Collaboration among various stakeholders is fundamental to the success of a DPI. In the context of a UDH, every partner archetype plays an instrumental role in different parts of the journey. Funders provide the essential financial resources and maintain oversight throughout the UDH's development journey. DPI/DPG advocates drive engagement, facilitate knowledge exchange, and assist in capacity building for the UDH. DPG custodians are responsible for maintenance, technical assistance, and supporting governance to ensure the widespread adoption of the underlying technology. Tech builders assist in building the necessary IT infrastructure to lead scaling efforts. Government agencies define the vision, establish the apex institution, oversee governance, and foster collaboration among stakeholders, playing a critical role in successfully operationalizing the UDH. Lastly, academia, think tanks, and civil societies drive research and development to further innovate and advance the UDH concept.

To unlock the potential of data and drive inclusive socio-economic development on a large scale, the public and private sectors, along with the global community, must join forces to advance the development of UDH across emerging nations.



As we transition from a world of disconnected data silos to a more integrated and interoperable future, this report aims to foster informed conversation and drive greater action towards the development of UDH globally and ensuring that data is leveraged to maximize public good

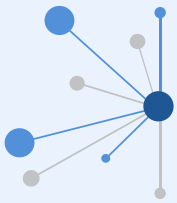
01 Unified Data Highways (UDH): The next frontier of Digital Public Infrastructure (DPI)

Chapter Summary

- **The DPI movement:** In a rapidly digitizing world, DPI are increasingly seen as the key to inclusive development, and essential to support the growing ambitions of emerging nations.
- **The next frontier of DPI:** The Identity and Payments pillars of DPI have become increasingly prevalent in several emerging nations and have been extensively studied; the data sharing pillar has not yet received similar attention, although there is growing interest.
- **Highways for data:** Just as roads and highways connect distant and disparate cities, offering swift and safe passage, fostering socio-economic development at large scale, UDH serve as digital highways connecting data of different formats residing in silos to help unlock its true potential.
- **Evolving paradigms of data sharing:** The transition from open data platforms to UDH illustrates the evolving paradigm of data sharing. Data sharing has moved from centralized data storage with limited interoperability to full-fledged UDH connecting federated data registries enabling seamless interoperability and built with a strong use case focus.

1.1 What are UDH?

In a rapidly digitizing world, societies are increasing leveraging digital solutions to address national-scale problems. **Digital Public Infrastructure (DPI) is increasingly seen as essential for inclusive development and for supporting the ambitions of emerging nations.**



DPI is defined[4] as a set of shared digital systems that are secure and interoperable, built on open standards, to provide equitable access to public and private services at scale

DPI typically comprises **three pillars – 'Identity'** (foundational digital ID as the single source of truth); **'Payments'** (system for interoperable payments), and what we call **'Unified Data Highways'** (UDH, i.e., networks for consent-based sharing of federated data).

The Identity and Payments layers of DPI have become increasingly prevalent in several emerging nations. India's pathbreaking Aadhaar system has provided unique digital IDs to 1.38 billion people, enabling access to government services, and fostering financial inclusion. By the end of 2023, 343 million[5] Aadhaar-linked no-frills bank accounts had been opened under the Pradhan Mantri Jan Dhan Yojana (PMJDY), with USD ~26 billion in deposits. In Brazil, 40 million[6] individuals made their first-ever financial transfer through Pix, the national interoperable payments ecosystem. **In comparison, UDH have not yet gained a similar level of traction, although there is a growing interest.**

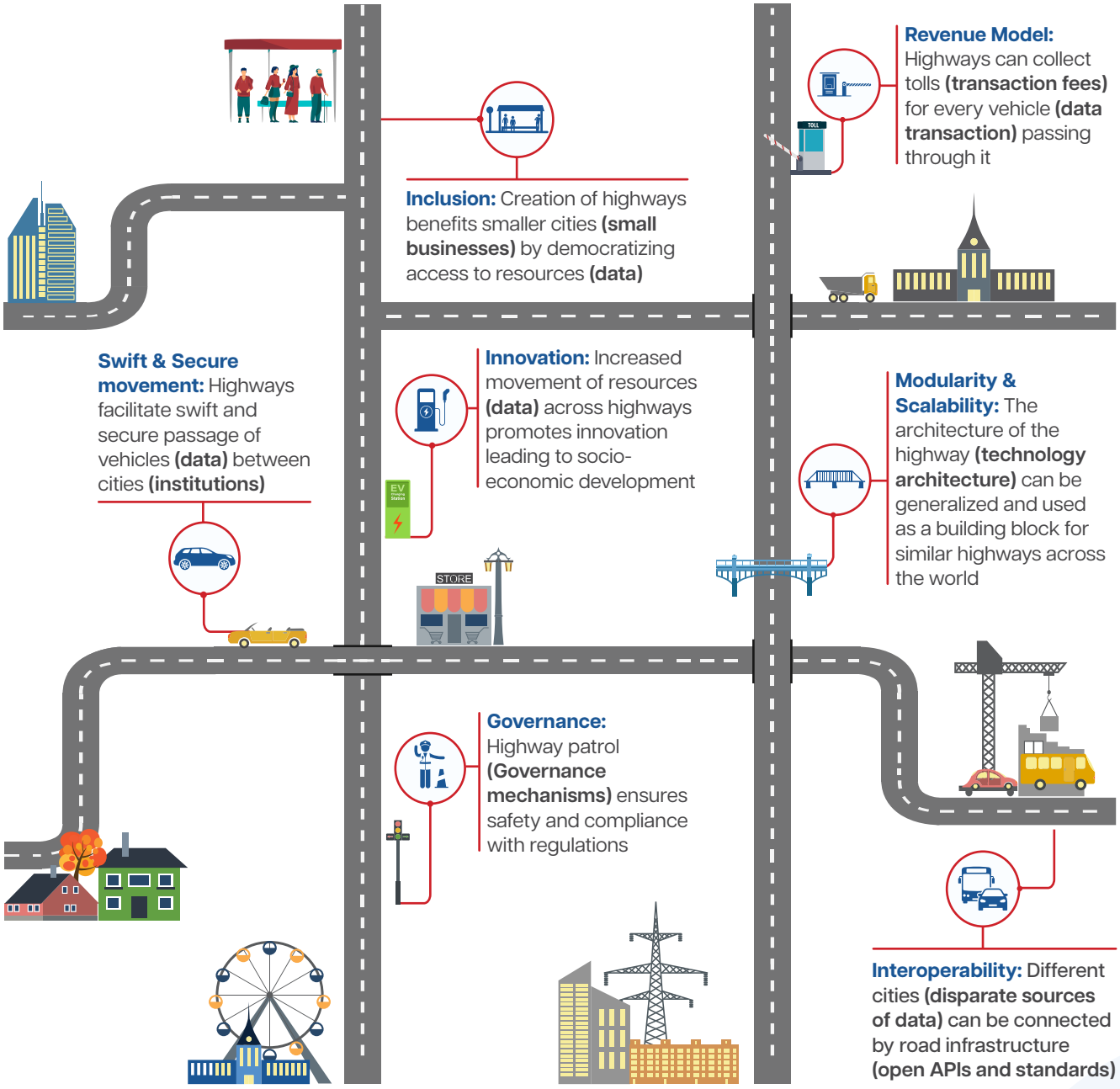
4. Defined at the G20 2023 conference; 5. Source: PMJDY Website (Pradhan Mantri Jan-Dhan Yojana | Department of Financial Services | Ministry of Finance (pmjdy.gov.in); 6. Brazilians are adopting digital payments faster than anyone else – what lessons can we learn? | World Economic Forum (weforum.org).

UDH are data sharing networks built on DPI technology principles and a robust governance framework to enable an open ecosystem for innovative and inclusive services for public good. Like the identity and payment pillars of DPI, UDH can spark ecosystem-led innovation and usher in a new paradigm of data-driven services to boost development. For instance, Estonia's X-Road[7] enables over 3,000 public and private sector e-service information systems to link up and function harmoniously, facilitating 2.2 billion transactions annually.

1.2 The core idea – digital highways connecting data silos

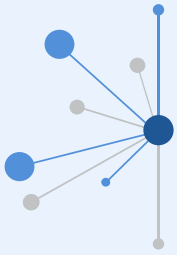
Exhibit 1.1

UDH are digital highways facilitating the movement of data between institutions



7. Source: X-Road Website (X-Road - e-Estonia).

In practice, UDH function much like their physical counterparts, as shown in Exhibit 1.1. They provide the digital infrastructure that facilitates swift and secure movement of data, democratizing access, promoting inclusion, and fostering innovation from the ecosystem. They are managed by responsible institutions and operate under well-defined regulatory policies and frameworks to minimize the risks of data sharing and ensure good governance. Built on DPI principles, UDH enable interoperability by connecting disparate federated data sources through open APIs. The technology architecture of UDH can be built through modular building blocks thus enhancing its scalability across global implementations.



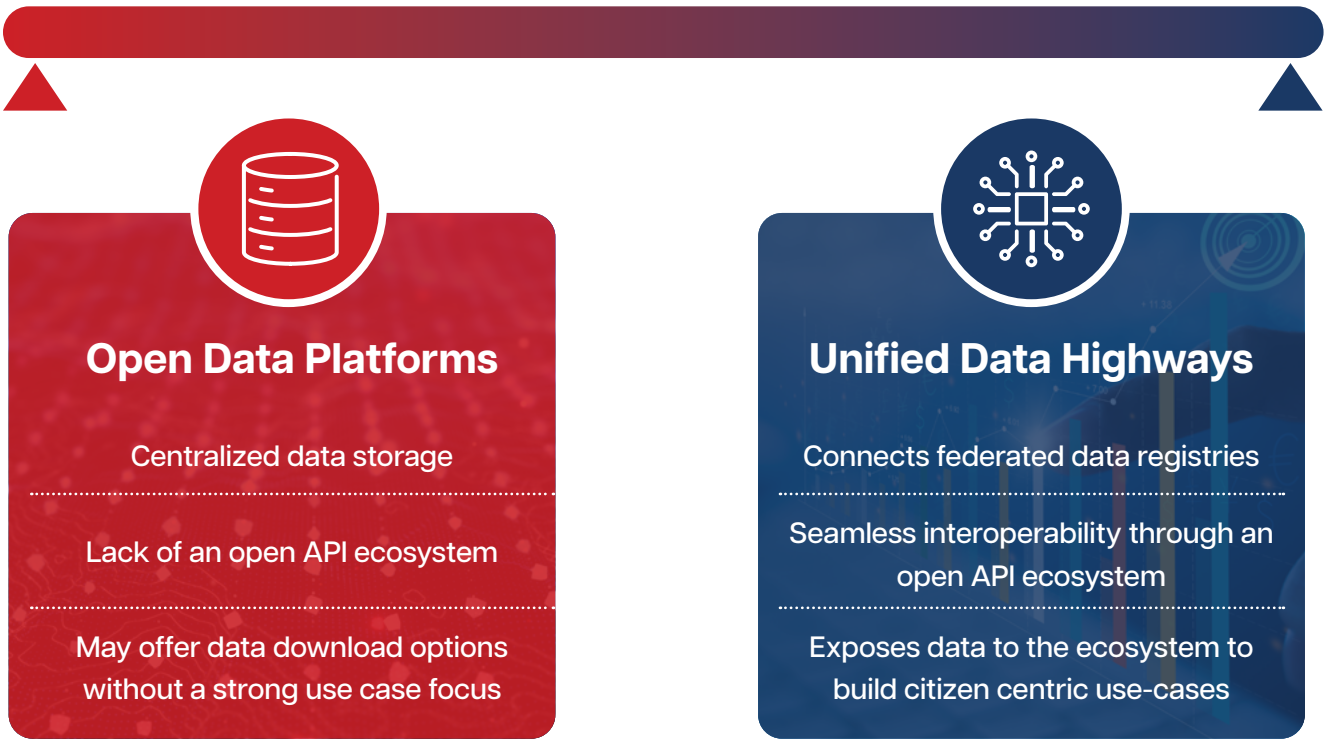
By enhancing the discoverability and access to data for all ecosystem participants, UDH can **usher in a new era** of ecosystem-led creation of citizen-centric digital services, advancing inclusive socio-economic development

1.3 Evolving paradigms of data sharing

The UDH approach represents a foundational shift in the way we leverage our data to enable ecosystem-led innovation. Over the years, the concept of data sharing has evolved significantly since the popularization of open data initiatives. Exhibit 1.2 illustrates the two major shifts that have significantly transformed data sharing initiatives over the years.

Exhibit 1.2

The transition from open data platforms to Unified Data Highways illustrates the evolving paradigm of data sharing



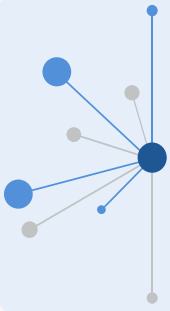
The **first major shift** occurred when data was digitized and began to be stored in **centralized data repositories.** Here, large number of datasets of different types are published with respective metadata and made available for download without a strong focus on specific use cases. However, they lack an open API ecosystem which can enable interoperability and creation of services using the data. Open data platforms include examples such as Open Data Initiative of Government of Sri Lanka, Open Government Data Platform of India, and the United States Government's open data site.

UDH represent the second major shift in data sharing. These networks are based on interoperability and decentralization, connecting federated data securely with consented access. This facilitates ecosystem participants to build user-facing solutions. Estonia's X-Road, exemplifies a UDH by providing citizens digital access to 99% of government services through secure data sharing based on open and interoperable standards.

Box 1: UDH in practice - ABDM and X-Road case studies

How Ayushman Bharat Digital Mission (ABDM) is streamlining healthcare in India?

To understand how UDH work in practice, let's examine one of the use cases of India's Health Stack, the **Ayushman Bharat Digital Mission (ABDM).** ABDM, built on DPI principles facilitates secure consent-based sharing of patient health information stored across disparate federated health systems with healthcare service providers to readily get easy access to a wide range of services. ABDM operationalizes the DEPA[8] framework in the healthcare sector in India ensuring good governance and safeguards for data privacy and security. Exhibit 1.3 outlines how ABDM can streamline the patient journey through digitization leading to enhanced health outcomes.



As of April 2024, ABDM has more than **588 million[9] registered accounts, 360 million health records linked, and over 300,000 verified healthcare providers** on the network, enabling it to position itself as the backbone of India's integrated digital health infrastructure

For citizens, ABDM improves chronic condition management by driving the adoption of longitudinal health records. It also streamlines financial processes like direct benefit transfers. For healthcare providers, ABDM helps improve clinical delivery by providing a 360° patient view to support better decision-making. It can also help enhance operational efficiencies, by optimizing record management and integration with third parties like labs and pharmacies.

8. Data Empowerment and Protection Architecture; 9. Obtained from the National Health Authority Dashboard on ABDM: ABDM-Insights.

Exhibit 1.3

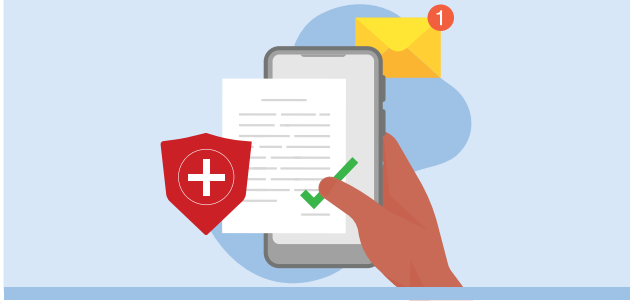
ABDM is poised to deliver seamless "patient journey of the future" with extensive focus on driving the adoption on longitudinal health records

1 Patient walks up to a Hospital. He sees a Health ID QR code on the registration desk

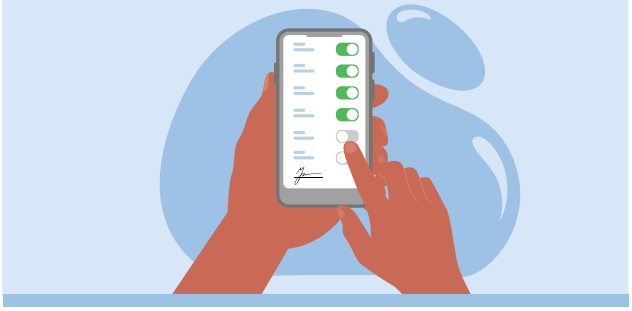
2 They pull out their smartphone, launch PHR app and scan the QR code

3 The Hospital instantly gets accurate info about the patient including Health ID, Name, Age, Gender, Mobile.–No waiting

4 The Hospital sends a consent request to the patient requesting access their medical history

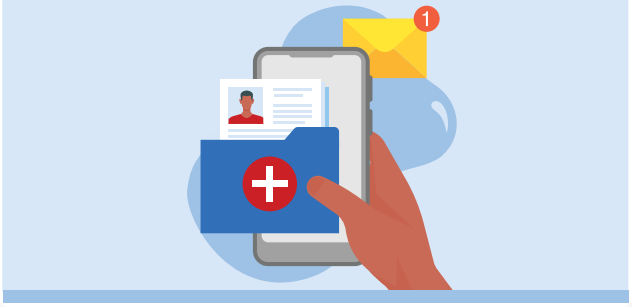


5 Patient chooses what data to share with the hospital and for how long the hospital can have access

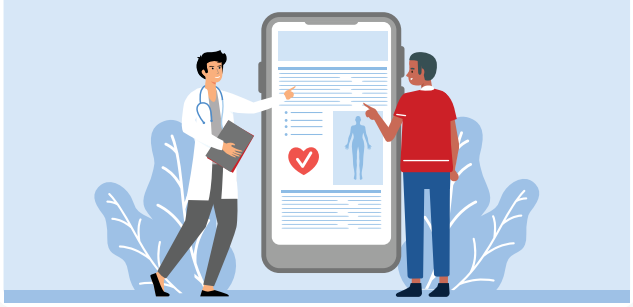


6 Consulting doctor has full medical history of the patient available when they walk into the chamber

7 Post treatment & before leaving the premises, patient gets a notification that their medical reports are ready

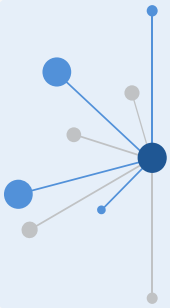


8 The doctor's treatment plan and prescription show up on their mobile & medical history is not lost



Estonia's Digital Revolution: Transformation of public services with X-Road

Estonia's X-Road integrates disparate IT systems and facilitates interoperability among over 1,000 institutions across the public and private sector to provide citizens seamless access to government services digitally.



As a UDH built on DPI principles, X-Road eliminates the need for centralized databases, can be scaled across global implementations as a modular data exchange layer, and can provide access control mechanisms for personal data by integrating consent modules when required

X-Road also has strong in-built governance mechanisms and adopts a 'Privacy by Design' architecture to ensure data protection and compliance with Estonia's Personal Data Protection Act (PDPA).

X-Road has transformed public service delivery in Estonia in several important ways:

- **Service digitization:** X-Road integrates nearly all of Estonia's governmental services, enabling the country to offer 99% of public services digitally. For instance, its e-Tax system, used by 95% of the population, allows tax filings to be completed within 3-5 minutes, demonstrating the network's efficiency and widespread adoption.
- **Economic efficiency:** The use of digital signatures to enable e-services through X-Road saves about 2% of Estonia's GDP annually.
- **Improved service delivery:** X-Road enables immediate access to e-health records and e-prescriptions, significantly enhancing the delivery of healthcare services by ensuring critical patient information is readily available during emergencies.
- **Robust privacy and security:** X-Road's architecture adheres to a 'Privacy by Design' framework and adopts strong encryption protocols to ensure data security. Furthermore, it maintains data transaction logs and empowers users to audit the use of their personal data, through a 'Personal Data Usage Monitor'. This not only allows users to enforce their data rights and emphasizes their control over their personal information.

02 Unlocking the impact of UDH

Chapter Summary

- **A 3-4 trillion-dollar opportunity:** UDH can help emerging nations unlock economic value between USD 3-4 trillion by 2030 annually, representing 5-6% of their GDP, through a paradigm shift in data sharing by enabling the transition from disconnected data silos to an integrated, data-driven future that fosters innovation and inclusive socio-economic development.
- **Guiding principles:** To set up for success, UDH should be built in line with fifteen guiding principles of governance, technology, and execution.

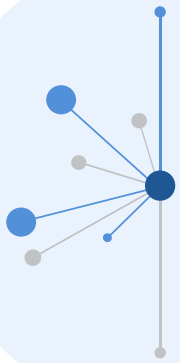
2.1 Impact potential

UDH can help emerging nations make progress towards **inclusive socio-economic development** through ecosystem led innovation, creation of accessible data driven services at a population scale and flourishing of new business opportunities. Our analysis shows that **emerging nations can unlock between 3-4 trillion dollars of value**[10] annually by 2030, which represents between 5-6% of their collective GDP, through the **implementation of UDH.** This includes the direct impact on the economy due to the exchange of data, indirect impacts due to the use of data (such as data users being able to develop better product and services), as well as induced impacts that include additional spending generated in the economy due to increased job creation or wage growth.

This value can be realized through the following paradigm shifts:

- **From an isolated to an open innovation ecosystem:** UDH enable ecosystem players to discover relevant data, access it with the owner's consent and harness it to design services for citizens. In India, for instance, Ayushman Bharat Digital Mission (ABDM) is helping private players improve their customer reach and advance new business models such as Outpatient Department (OPD) insurance.
- **From fragmented, untapped datasets to seamless collaboration:** UDH can create interoperability among previously disconnected systems and platforms to facilitate the usage of previously untapped data. This promotes informed decision making, collaboration and innovative solutions.

10. USD 3-4 Trillion represents the annual social and economic value to be unlocked through data sharing across different sectors across 49 emerging nations in 2030. It does not imply an annual GDP boost of 5-6% but rather indicates that the value generated from UDH would approximate 5-6% of their projected GDP in 2030. This estimation draws on the European Data Market Study 2021-23 by the European Commission, which assesses the impact of the Data Economy on the GDP of EU countries. Our calculation assumes that the impact on GDP (as a % of GDP) is influenced by a state's ability to drive digital transformation and data sharing at scale. Consequently, the potential value unlocked as a % of GDP will vary between emerging nations and EU nations. To contextualize this data from EU to emerging nations, we have used the World Bank's GovTech Maturity Index (GTMI) as an adjustment factor. We assume that a higher GTMI score suggests a greater potential for a country to unlock value through data sharing. The World Bank GTMI index includes 48 indicators such as government cloud, interoperability framework, accessibility of government services online, open data, open government portal, and more. Considering the substantial state involvement required for the development of UDH, we selected the GTMI index as an adjustment factor. Given that UDH are typically state-led initiatives, the state's capacity for digital transformation is a crucial determinant of the value that can be created through UDH. Our calculation also assumes that UDH would be able to unlock the potential of the data economy in emerging markets. UDH lift barriers to participation in the data market, create friction-free access to data for all authorized parties, ensure privacy, safeguard against data manipulation and unregulated use of data, thus enabling nations to realize the potential of their data economy.



In Estonia, a child is **automatically registered for benefits and enrolled in the school system** following the completion of their birth registry. X-Road makes this possible by creating interoperability between the Population Registry, the IT system of the education department, and the IT system of the Social Insurance Board

- From restricted markets to open competition: Data sharing boosts competition by helping citizens easily switch service providers. They reduce information asymmetry among market players and lower the barriers to entry. For example, Estonia's Estfeed, enables consumers to switch energy suppliers, by giving them access to smart meter data and comparison tools, which help them identify the best offers available from suppliers.
- From citizens as data subjects to data principals: UDH give users full control over their personal data and the ability to provide informed and revocable consent to share that data. For example, Account Aggregators in India allow citizens to share their financial information with banks and other financial institutions, with clear and revocable consent.
- From high-cost, high-friction to low-cost, frictionless services: Data sharing lowers the cost and improves the accessibility of public services by reducing administrative efforts and lowering the barrier to entry for private players in service provision. For instance, Vietnam's National Data Exchange handled 876 million[11] transactions in 2022, saving the state ~USD 100 million or ~12 cents per transaction.

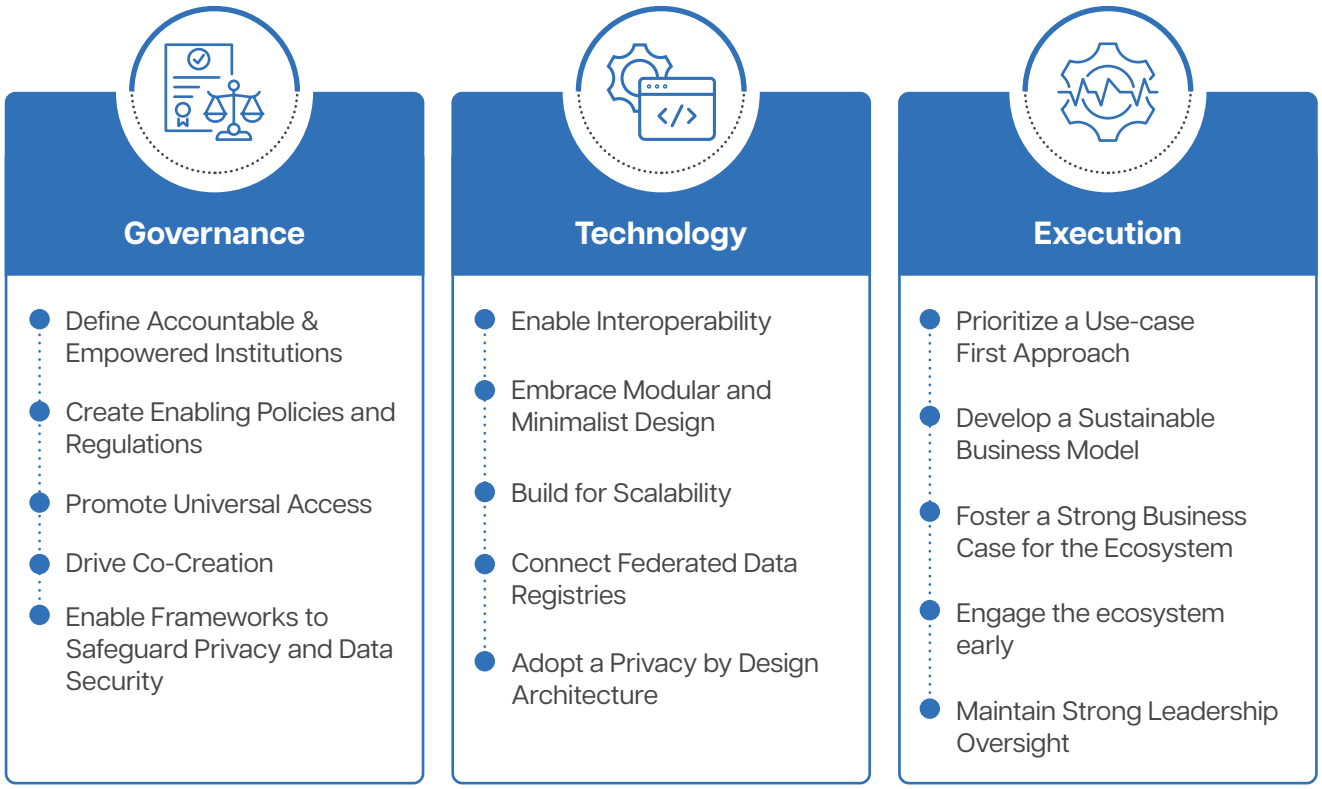
11. Source: Vietnam Investment Review.

2.2 Guiding principles: Governance, technology, and execution

To set up for success, UDH should be built on **fifteen guiding principles** of governance, technology and execution as illustrated in Exhibit 2.1.

Exhibit 2.1

UDH should be built in alignment with the fifteen guiding principles of governance, technology and execution

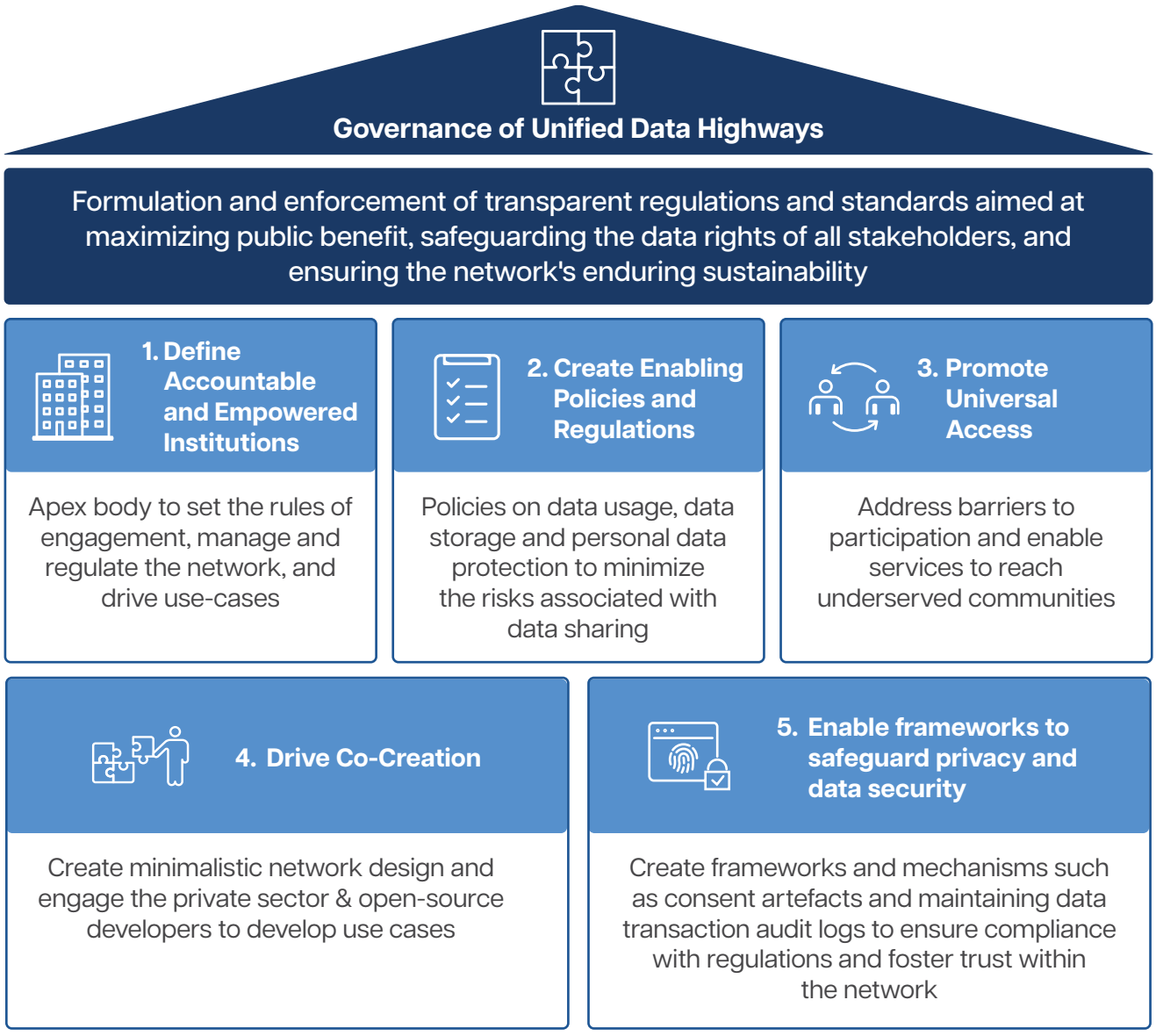


2.2.1 Governance principles

UDH should develop governance mechanisms in line with the guiding principles to define clear responsibilities and regulations, ensure data protection, foster collaboration, and achieve inclusive outcomes as shown in Exhibit 2.2.

Exhibit 2.2

Five Guiding Principles can help ensure Good Governance of UDH



1. Data Principal: Persons both natural and legal, to whom any data relates (PDP Bill)

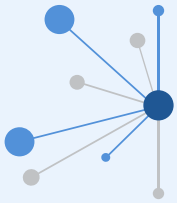
Define accountable and empowered institutions: An apex body should be instituted to manage and regulate the network, set the rules of engagement and drive use-cases. Furthermore, there should be clarity in institutional mandates to enforce accountability.

Create enabling policies and regulations: Comprehensive policies on personal data protection and cybersecurity are critical to minimize the risks associated with data sharing. When enforced properly, they help ensure the security of the network by reprimanding offenders and empowering citizens thus building trust in the system.

- **Promote universal access:** UDH should be built to maximize inclusion and bridge the digital divide. For instance, this can be achieved by offering access to the user interface in regional languages or by providing services to the digitally underserved through SMS. By doing so, even those lacking digital literacy or advanced technology can have equal access to the benefit from these services.

- **Drive co-creation:** The goal of a UDH is to help the business ecosystem build applications that benefit the public. To this end, they should be developed through an **iterative process**, in **collaboration** with ecosystem partners, considering their needs and expectations. This improves the likelihood of rapid adoption upon implementation. The network design should be **minimalistic** to ensure easier adaptability and faster deployment. This enables the private sector and open-source developers to collaboratively develop use-cases.

- **Enable frameworks to safeguard privacy and data security:**



Establishing frameworks and mechanisms for privacy and data security helps strengthen regulatory compliance and builds trust in the system

For instance, India's DEPA framework governs personal data sharing by institutionalizing an entity called the 'Consent Manager.' It ensures data can only be accessed with consent, which is programmed to be secure, revocable, granular, auditable, and provided with notice. UDH should also adopt data privacy principles such as data minimization and purpose limitation and maintain data transaction audit logs. Recommended data security mechanisms include authorizing the identity of transacting parties, conducting regular internal audits, and establishing disclosure obligations for data breaches.

2.2.2 Technology principles

UDH follow the **five DPI technology principles**[12], which differentiates them from traditional data sharing efforts and open data initiatives:

- **Enable interoperability:** The use of open-source code, open standards, and open APIs allows disparate digital systems to communicate, exchange, and use information seamlessly.

- **Embrace modular and minimalist design:** Develop iteratively following a modular or "building blocks" approach. This approach can help adapt to changing requirements, through reusable independent building blocks which can be integrated into different systems as modules to activate new features.

- **Build for scalability:** Adopt a flexible design such that the network can be scaled up to meet expansion requirements and more use-cases can be enabled in the future in response to the changing ecosystem needs without needing any overhaul on existing systems.

12. Adopted and modified from Centre for Digital Public Infrastructure (CDPI) DPI Tech Architecture Principles.

- **Connect federated data registries:** Connect data sources rather than creating a centralized database to help overcome the privacy and security risks of a single point of failure, while maintaining autonomy and promoting collaboration between institutions.
- **Adopt a Privacy by Design Architecture:** A Privacy by Design architecture and robust access control mechanisms ensures necessary safeguards on data privacy. Implementing secure data encryption protocols, using digital signatures, certificates, and multi-factor authentication to verify transacting parties can help prevent unauthorized access and data breaches.

2.2.2.1 An illustrative architecture for UDH[13]

UDH can be visualized as a network of data providers and solution builders connected through open APIs and rules governing the exchange of data. To build this connection, a robust technology architecture comprising of a **data sharing layer, verification layer, consent layer and security servers** must be operationalized to enable interoperability and ensure data privacy and security. The below stack diagram in Exhibit 2.3 illustrates the value chain of UDH demonstrating their ability to unlock the power of data securely through its multiple layers:

- **Analytics (Open-source functions and algorithms):** Foundational functions and algorithms to be used for development of applications on top of them to enable appropriate utilization of data
- **Data governance (Open APIs and Standards, data model):** Open APIs and standards to ensure interoperability, and data model and taxonomy to make the data more structured
- **Infrastructure (server and monitoring) and Helpdesk:** A central server for maintaining a list of registered network participants and configuration requirements, and a helpdesk provide technical support, manage incidents and address grievances
- **Consent and verification layer:** A consent layer can be integrated in cases dealing with personal data to incorporate access control mechanisms; Verification layer is necessary to verify the identity of transacting parties through authentication mechanisms such as digital signatures, digital certificates, multi-factor authentication, etc.
- **Security servers:** Security servers are necessary to route the movement of data requests and data between the registries and the ecosystem; they also ensure data security by encrypting the data during transit and maintaining timestamped audit logs for all transactions

13. The nature of data in a UDH—whether personal or non-personal—requires careful architectural and governance decisions. Personal data, or Personally Identifiable Information (PII), demands stringent measures such as consent artifacts, secure servers, encryption, data protection policies, and certification for ecosystem participants. Strict protocols in data collection, storage, and sharing are essential to maintain security, ensure responsible usage and gain user trust.

Exhibit 2.3

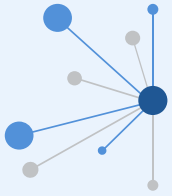
Illustrative UDH architecture

Source: 50+ global DPI expert interviews, BCG analysis.

2.2.3 Execution principles

UDH around the world have followed certain best practices for execution that have been pivotal to their overall success. These foundational execution principles alongside the governance and technology principles lay the groundwork for effective implementation of UDH:

- **Prioritize a use-case first approach:** The UDH must take a use-case first approach to define the value proposition for end-users and identify the ecosystem play. The pilot use-cases should be created in close collaboration with the ecosystem before prioritizing technology build. For instance, Estonia identified over a thousand services to be enabled by X-Road before developing the software.



In the early stages, prioritizing use cases that solve critical citizen pain points and **deliver immediate public benefits** is crucial

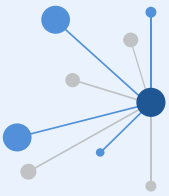
These quick wins can build early momentum to demonstrate the value proposition, onboard a critical mass of users and engage the broader ecosystem.

- **Develop a sustainable business model:** While UDH can initially be financed by the public sector, development funders, and philanthropies, it is crucial to consider a self-sustaining model for long-term operations. UDH can explore revenue streams such as usage-based fees, as seen in India, where Account Aggregators charge Financial Information Users (FIUs) a small fee for every transaction. UDH may also earn revenue from customization fees, deployment fees for setting up and maintaining instances, and for regular upgrades, training, and technical support. For instance, Primero[14], an open-source DPG designed to provide a secure system to manage and exchange data about vulnerable children and survivors of violence, offers multiple packages including deployment support, remote training, technical support, and regular upgrades. Ushahidi[15], a DPG for crowdsourcing information from communities, offers enterprise plans for technical expertise, ongoing support, and customizations. Reinvesting savings is another viable approach for UDH, with the savings generated due to UDH being reinvested to fund their operations. For example, X-Road in Estonia has enabled annual savings equivalent to 2% of its GDP, which can be reinvested to fund the operations of the UDH. While generating revenues is essential for reducing long-term dependency on external financing, full cost recovery might not always be feasible, and continuous support from the government or donors may be necessary to maintain accessibility and citizen participation, which may be justifiable given the social ROI of specific UDH.

- **Foster a strong business case for the ecosystem:** The UDH must foster a compelling business case to attract and retain the private ecosystem onto the network. Ensuring regular availability and discoverability of quality data and adopting a business model that does not impede participation helps the private players generate substantial return oninvestment, thus incentivizing sustainable long-term use.

14. Read more about business model and pricing of Primero here; 15. Read more about pricing plans of Ushahidi here.

Engage the ecosystem early: A wide range of ecosystem players, including potential users, technology providers, Civil Society Organizations (CSOs), think tanks and academia must be engaged early on to seek their perspectives on shaping the architectural design and policy framework of the UDH. This engagement is crucial for several reasons. Firstly, it facilitates the development of a robust network that meets the data needs of the builder ecosystem, enabling innovation by combining diverse expertise and perspectives, to develop applications that can leverage shared data effectively. Secondly, an engaged ecosystem can help the network address critical concerns such as privacy, security, and ethical use, which are essential for public trust and widespread adoption.



Finally, the involvement of diverse stakeholders also promotes greater inclusivity and equity, ensuring that the benefits of UDH reach all segments of society, including marginalized communities

For example, Estonia's collaboration with the private sector led to the key recommendation to adopt a distributed technological architecture over a centralized one. Ecosystem participants, including healthcare providers, startups, civil societies, think tanks, technology vendors and individuals provided their inputs on design, implementation, and policy for ABDM.

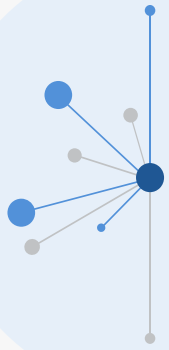
Maintain strong leadership oversight: Direct oversight from the top leadership in the country is critical for facilitating a top-down push to execute the initiative and securing financial resources. In India, direct commitment from the Ministry of Finance and the Reserve Bank of India was fundamental in setting up the Account Aggregator ecosystem.

Box 2: Overcoming the challenges of adoption

UDH often encounter challenges in adoption despite having successfully implemented the requisite technology and foundational steps. This underscores the necessity for a coordinated strategy aimed at fostering adoption, ensuring long term growth and sustainability of UDH. A range of strategies can be employed to onboard and retain end-users and the ecosystem players onto the network.

- **Where necessary, issue enabling mandates:** When used judiciously in a manner that promotes public interest, mandates can help ensure responsible sharing and usage of data. For example, in Brazil, the Brazilian Forest Code mandates that all rural properties must be registered on the Environmental Rural Registry (CAR). While mandates may help speed up the process of achieving scale, in the long run, voluntary adoption based on a strong value proposition to all market players and citizens is more sustainable at driving impact[16].

- **Offer need-based monetary incentives:** Adoption of UDH may be supported by incentive mechanisms during early phases especially if the duration of value realization by ecosystem players is not immediate.



For instance, My Health Record in Australia, has incentivized healthcare providers by offering monetary rewards of up to USD 6.50 per patient[17] they enroll onto the network. This initiative helps offset the costs associated with digitizing data and promotes the adoption of new digital practices required for the UDH

Incentives are a useful mechanism for the initial push for adoption but cannot be used sustainably, and hence have to be followed up by other strategies to sustain the momentum.

Emerging discussions: DaaS models

Till date, countries that have adopted UDH have chosen to build the network either from scratch or by leveraging open-source DPGs as foundational building blocks. With advancements in technology, discussions are emerging on the DPI-as-a-service (DaaS)[18] model referring to packaged, cloud-deployable DPI adhering to global standards and built on open-source DPGs. It proposes to reduce the deployment time and eliminate the need for extensive in-house technology management infrastructure.

16. CDPI documentation; 17. Source: The Guardian; 18. To read more: Carnegie thesis | CDPI documentation.

- **Drive awareness by leveraging innovative partnerships and brand ambassadors:** Increasing general awareness of the UDH's services and benefits through campaigns, advertisements, competitions such as hackathons and innovative partnerships can enhance the scale of adoption of UDH by driving a network effect, especially in those use-cases where direct or indirect participation of citizens is critical. For instance, a renowned celebrity was brought on board by the Reserve Bank of India to endorse Account Aggregators, as part of a public awareness campaign to explain how individuals could share their financial data securely through the UDH.

- **Utilize strategic nudges:** Nudges can be employed as subtle, non-coercive, and cost-effective cues to enhance citizen participation. When strategically placed at key points in the user journey, these prompts can effectively onboard a significant user population. For example, Digiyatra, a biometric based identity verification service for contactless air travel, sends text messages to air passengers in India through the respective airlines a few hours before their journey to download and share their boarding pass through the application to avail expedited check-in services at the airport.

Cross-border data sharing

Cross-border data sharing presents both opportunities and challenges in today's interconnected world. While it enables crucial collaborations such as response to global health crises and flow of migra nt worker remittances, broader adoption of cross-border data sharing faces significant hurdles due to concerns around national security and data privacy. Global efforts such as Japan's Data Free Flow with Trust (DFFT) initiative signal a growing recognition of the importance of facilitating secure data sharing on an international scale. DFFT, which was unveiled at the 2019 G20 Summit in Osaka, aims to foster an international environment for free and efficient sharing of secure data among countries, while ensuring that personal data and sensitive information are protected.

Overcoming regulatory obstacles and ensuring robust safeguards will be vital for realizing the full potential of cross-border data sharing. To this end, UDH can help advance cross border data sharing by addressing technical complexities and enhancing trust among participants. Examples like the X-Road Trust Federation, which enables data sharing between Estonia and Finland demonstrate that progress is possible through strategic partnerships and innovative digital solutions.

03 Sectoral perspective on UDH

Chapter Summary

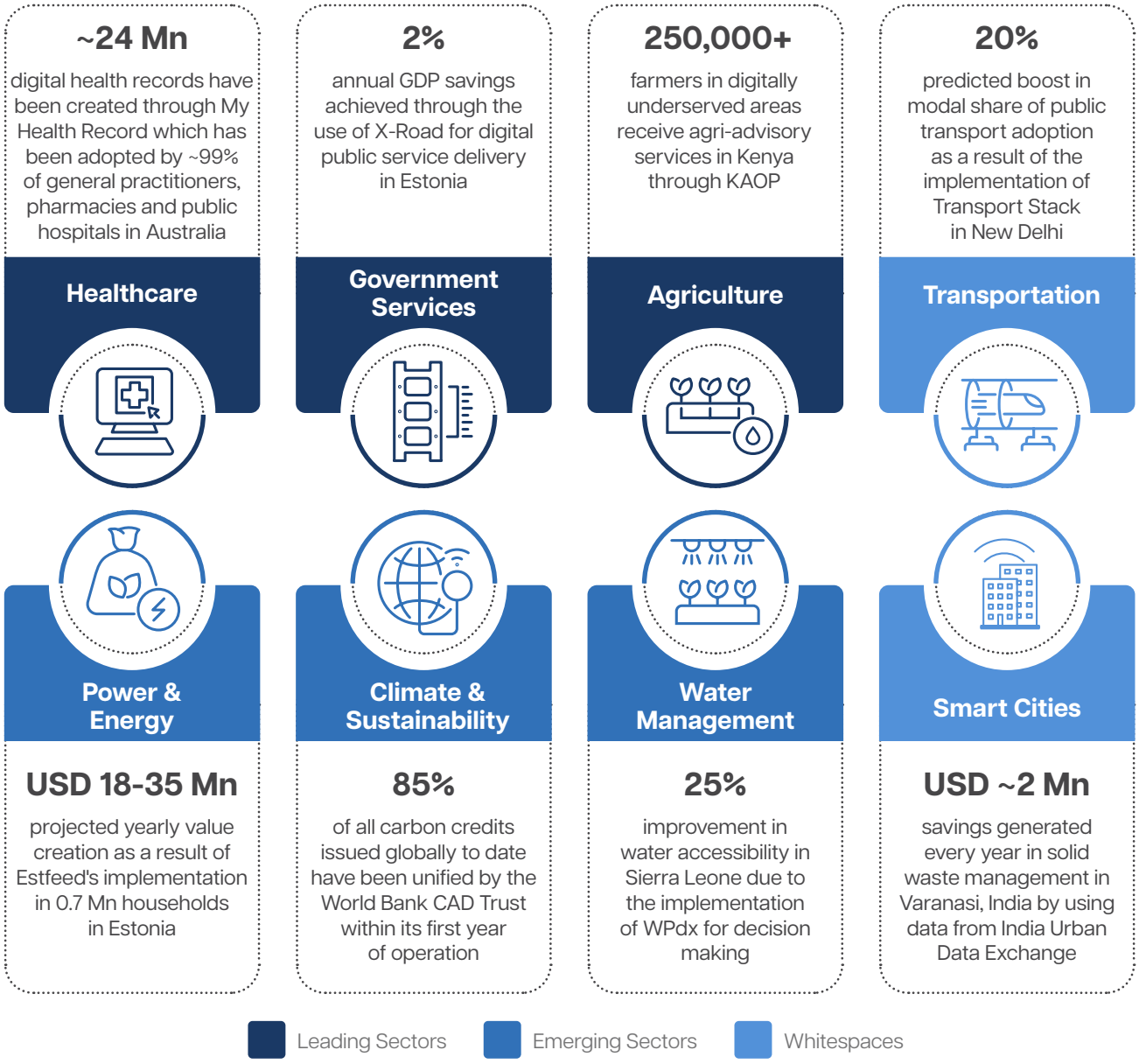
- **Value unlocked across sectors:** UDH around the world have demonstrated immense potential to advance high-value use-cases across various sectors to unlock significant economic and social value.
- **Sectoral maturity:** Based on the prevalence of UDH, sectors can be classified into three maturity archetypes: leading sectors (government services, healthcare, and agriculture), emerging sectors (climate & sustainability, water management and power), and whitespaces (transportation and smart cities).
- **Critical factors influencing maturity:** The variation in maturity of UDH across sectors is influenced by the intensity of government impetus and the strength of the business case in each sector. Government impetus is influenced by the relevance of the use-cases to citizens' essential needs and global push for action in each sector, while the business case is driven by the size of the innovator ecosystem beyond the public sector and citizens' willingness to pay for the use-cases.

3.1 Value creation across sectors

By facilitating seamless data exchange across various sectors, UDH empower ecosystem players to develop innovative services and applications tailored to the needs of the populace. This section delves into how UDH are being utilized in different sectors to unlock their potential. Exhibit 3.1 illustrates examples of UDH across sectors that have demonstrated the potential to create significant socio-economic impact at population scale.

Exhibit

Unified Data Highways are poised to unlock socio-economic benefits across multiple sectors



Sources: BCG Analysis; Expert calls and publicly available resources; Healthcare; Government Services; Agriculture; Transportation: JICA BCG Research; Power & Energy; Climate & Sustainability; Water Management; Smart Cities

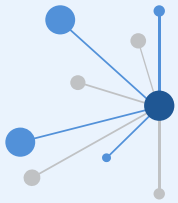
3.1.1 Healthcare

In Australia, the My Health Record[19], enables interoperability of health information among different healthcare providers enabling secure sharing of patient health data to enhance digital healthcare service delivery. As of January 2024, My Health Record holds over **23.5 million records** and has helped **curtail test duplication by 18%,** saving consumers significant time and money. **99% of all pharmacies and general practitioners are registered** on the network and have used its services.

19. Source: Statistics (digitalhealth.gov.au).

3.1.2 Government services

In India, the DigiLocker[20] initiative of the Ministry of Electronics and IT (MeitY) facilitates the secure storage and sharing of personal documents between public and public institutions through a digital wallet.



Digilocker now has ~**285 million registered users** and has issued over **6.7 billion digital documents,** which can be digitally verified and seamlessly shared by users

3.1.3 Agriculture

In Ethiopia, the Digital Agricultural Advisory Services (DAAS)[21] enables secure agricultural data sharing to enable farmers to get access to data driven agri-tech advisory services that can help increase their productivity and income from agriculture. DAAS has enhanced the livelihood of more than **3.5 million Ethiopian farmers** through cost-effective advisory services.

3.1.4 Water management

The **Water Point Data Exchange** (WPdx), a global effort aimed at enhancing clean water accessibility, has made a significant impact in emerging economies. WPdx's open network for data sharing allows public and private players to build country level solutions and make data driven decisions through water point data. The network hosts data from **50+** countries and has enabled **1200+** stakeholders to design solutions using the data. In Sierra Leone, for instance, analytical tools drawing water point data from WPdx have **driven a 25% increase[22] in water accessibility.**

3.1.5 Power

Estonia's **Estfeed** helps energy suppliers provide personalized services to consumers, which help them manage consumption and trade electricity on the grid. Estfeed draws on smart grid data from over 800,000 energy consumption points across the country and is estimated to have **saved ~1 TWh[23] of energy** and **enabled value creation of USD 18-35 million** in 0.7 million households in Estonia. Estfeed has also helped pilot cross-border energy exchange between Estonia and Lithuania.

20. Source: DigiLocker: An Initiative Towards Paperless Governance; 21. Source: DAAS Factsheet March 2021 (farmstack.co); 22. Source: WPdx – The Water Point Data Exchange; 23. Source: Avaleht | Elering.

3.1.6 Climate and sustainability

Launched in late 2022, the **Climate Action Data (CAD) Trust** is a global open-source decentralized data sharing network designed to harmonize national carbon credit registries to enhance the integrity of carbon markets worldwide. It aims to avoid double counting, strengthen trust in carbon credit data and build confidence in carbon markets through improved transparency. Till date, the CAD Trust has **grown to cover 85%[24] of all carbon credits issued globally till date** and is expected to expand coverage further.

3.1.7 Transportation

While the transportation sector is a whitespace, there are promising early signs showing the potential impact that could be achieved through UDH in this sector. In India, the planned Delhi Transport Stack is likely to increase the modal share of adoption of public transportation services by **20%** in the city. A bus occupancy and fleet management system designed with the help of data from India Urban Data Exchange[25] (IUDX) is helping the city of Surat save ~**USD 5.6 million** annually in costs and generate ~**USD 0.3 million more in revenues** annually.

3.1.8 Smart city

India's IUDX, data sharing initiative focuses on urban concerns, and has enabled the creation of a waste management application in the city of Varanasi. The application uses waste weight, GPS location of collection trucks, traffic density and crowdsourced grievance information to optimize waste collection. IUDX has helped Varanasi **save ~USD 2 million annually** in solid waste management. In Pune, IUDX has also helped Safetipin, a social organization dedicated to make public spaces safer and more inclusive, **launch an application that recommends safe night-time travel routes for citizens.**

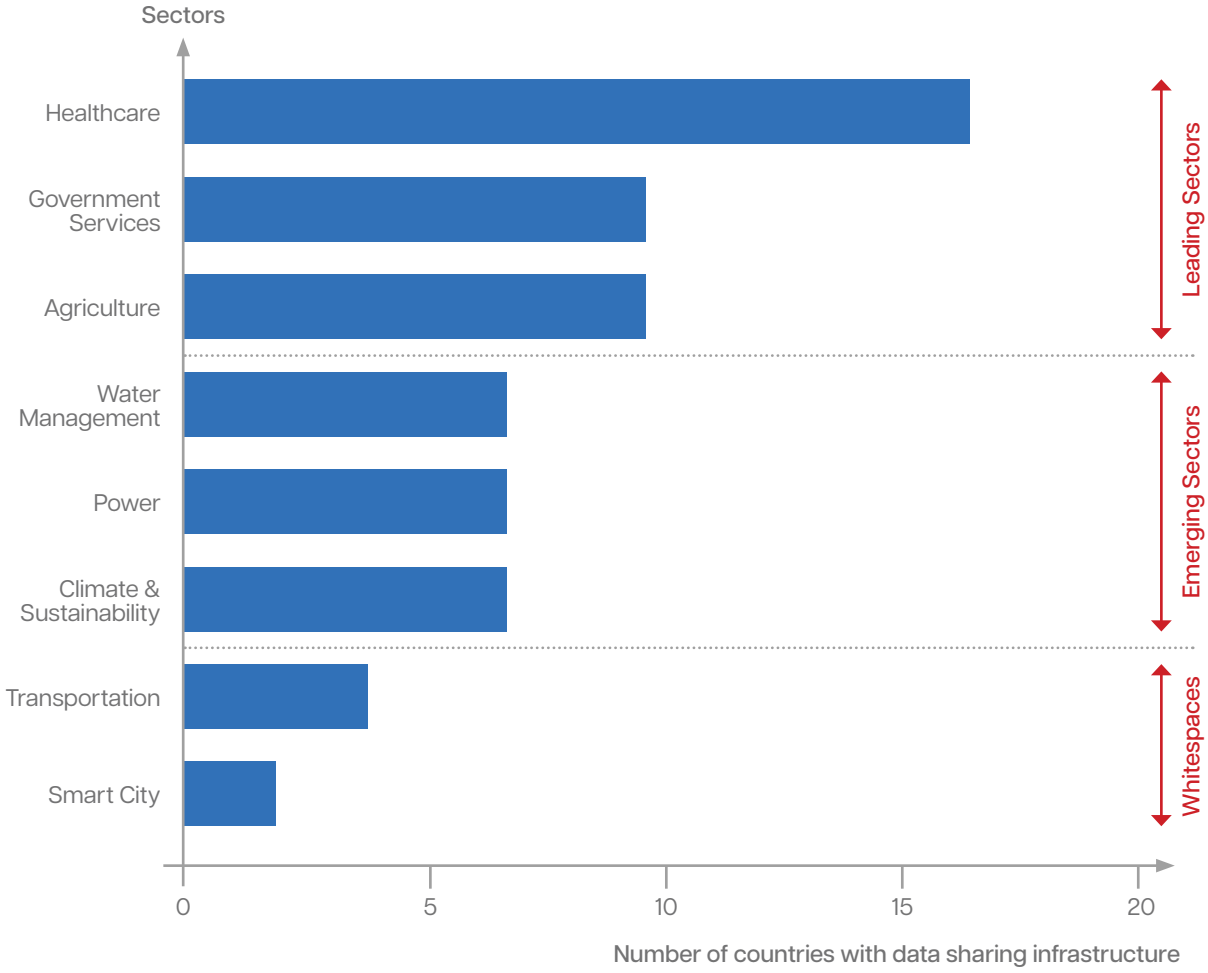
3.2 Leading and lagging sectors

We analyzed 65 data sharing infrastructure across 24 countries, spanning eight sectors: healthcare, government services, agriculture, water management, power, climate and sustainability[26], transportation, and smart city. As seen in Exhibit 3.2, health, government services, and agriculture are leading sectors, with at least 10 countries having data sharing infrastructure in each. Water management, power, and climate and sustainability are emerging sectors, with data sharing infrastructure established in seven countries each. Meanwhile, transportation and smart city sectors remain nascent, with only four and two countries with data sharing infrastructure identified, respectively.

24. Source: Reported by Benedict Chia, DG of Climate Change at the National Climate Change Secretariat of Singapore. Obtained from The Straits Times; 25. Source: Data Exchange - IUDX; 26. While climate and sustainability permeates multiple sectors as overarching theme, it is also considered a separate sector to highlight the unique opportunities associated with it.

Exhibit 3.2

Landscaping of emerging nations identifies 3 sector groups – Leading, Emerging & Whitespaces

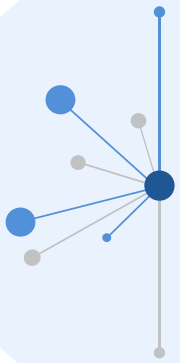


Note: Illustration is not exhaustive. 24 emerging countries were studied for the analysis, 11 from Africa, 10 from Asia-Oceania and 3 from Latin America; The analysis includes the entire spectrum of data sharing infrastructure, ranging from open data platforms to UDH.

3.2.1 Leading sectors

From our landscaping of emerging nations across the world, we have observed that **healthcare, government services** and **agriculture** are the 'Leading sectors', with the greatest proliferation of UDH.

In the healthcare sector, UDH are helping in creation of longitudinal health records for improved patient outcomes, smoothen the delivery of digital healthcare services and streamline digital insurance claims, all of which have a significant impact on the patient experience. Australia's My Health Record is used by patients, general practitioners, pharmacies, public hospitals, and specialists to upload and view documents. It provides advanced access controls where patients can decide which healthcare providers can view their records.



In the government services sector, UDH are making it possible to eliminate data duplication among government agencies and seamlessly share data by enabling interoperability, **improve citizens' access to and ease of obtaining services** (such as filing for income taxes, voting etc.), **and significantly reduce service delivery costs**

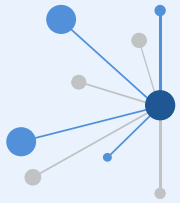
Indonesia's SATU Data is an example of a UDH that streamlines access to public data and government services. It enhances data governance, promotes government transparency and accountability, and supports data-driven decision-making to benefit citizens, investors, and businesses alike.

In the agriculture sector, UDH such as Kenya Agriculture Observatory Platform (KAOP) areimproving agricultural practices by offering customized data-advisory services to more than 50,000 farmers a month, fostering collaboration, enhancing data accessibility, and promoting sustainable agricultural practices through consent-based data sharing.

3.2.2 Emerging sectors

The sectors of **climate and sustainability, power,** and **water management** have seen new opportunities begin to emerge, with some nations planning UDH in these sectors.

UDH in the water management can facilitate real-time exchange of data to reduce leakage, and improve water quality and distribution efficiency at scale. UDH in the power sector can unlock multiple use cases such as consumption optimization, facilitate peer-to-peer renewable energy trading, and streamlined access to public EV charging infrastructure.



UDH in the climate and sustainability sector could unlock several use cases across **climate mitigation** and **adaptation** strategies

Harnessing the power of data as a public good could enable **anticipatory response to climate-induced disasters,** improve transparency and supply chain traceability to aid **sustainable use of forests,** facilitate evidence-based proactive policies for sustainable **blue economy,** and **boost liquidity in carbon markets** through transparency in emissions reporting.

3.2.3 Whitespaces

Sectors labelled as 'Whitespaces' have a relatively lower presence of UDH, most of which are at a nascent stage. **Smart city** and **transportation** are two examples of sectors with a comparatively lower presence of UDH offering relatively untapped avenues for the introduction of UDH.

Given the breadth of possible use cases, complex stakeholder mapping, and limited infrastructure readiness, very few UDH have thus far been built with a smart city focus. UDH in smart city sector can unlock diverse use cases including urban planning, smart tourist guide, faster emergency response, resource optimization, waste management, accident prevention and many more. In the transport sector, UDH hold a promising future as they can enable use cases such as end-to-end multi-modal journey planning, intelligent traffic management systems, parking management systems, improved infrastructure planning, and EV charging management.

3.3 Explaining the sectoral maturity of UDH

Four factors, taken together can help us explain the varying sectoral maturity of UDH. These may be classified into two categories – **'Government impetus'** and a **'Business case'.** The Government impetus creates a push for developing UDH to solve a pressing social problem, while the Business case drives the utilization of the data to develop solutions and advance use-cases. The **four factors**[27] are as follows:

Government impetus

- Relevance to essential citizen needs
- Global push for action in sector

Business case

- Innovator ecosystem beyond public sector
- Citizens' willingness to pay for use cases

Understanding the interplay among these four factors is crucial for policymakers and ecosystem stakeholders alike, as it can provide insights into how to catalyze the development of UDH within specific sectors.

3.3.1 Government impetus

Our examination of the DPI landscape in 24 countries has shown that the **initiative to develop a UDH often originates from the State.** To develop a successful UDH, governments can invest capital, coordinate an effort involving a multitude of stakeholders, and maintain a continuous focus on governing the network to ensure best practices are followed and its objectives are met. As seen in Exhibit 3.3, the government impetus is coming from two sources:

27. These factors will vary based on the use-cases within a sector and the unique context of the country in which the UDH is being developed. Additonally, the government impetus and business case can change over time due to shifts in technology, legislations, geopolitical priorities, economies, and societies. The interplay of these four factors explains why UDH are more common in some areas than others, but any one of these factors can also potentially move the needle. The assessment presented in this section is on a relative scale, which means that if a sector is scored low on relevance of its use-cases to essential citizen needs, it should be intepreated as less relevant compared to the other seven sectors, not as having low relevance as an absolute.

Relevance to essential citizen needs: This factor indicates the extent to which use-cases of UDH can serve essential needs. When data sharing in a sector enables better provision of essential services and helps fulfill crucial needs of citizens, it encourages the states to develop UDH.

Data sharing in **government services, healthcare, agriculture, water management,** and **climate & sustainability** sector can help address fundamental needs such as public service access, healthcare quality and affordability, food security, clean water supply, and climate disaster resilience, making them **highly relevant to serving essential citizen needs.** Conversely, UDH in **transportation** and **smart city** primarily enhance urban living convenience with use-cases like seamless travel planning and smart tourist guides, which can enhance the quality of urban living but may be considered **less critical** compared to necessities. Finally, data sharing in the **power** sector, through UDH, can optimize power consumption, enhance supplier choice, and integrate renewables, offering considerable benefits but with **moderate** essentiality compared to basic needs like food and water.

Global push for action in sector: A global push for action is created when data sharing in a sector can address issues of global consequence, requiring large-scale international collaboration. When there is global momentum for data sharing in a sector, it can guide states to leverage this trend and create UDH to address critical national and global issues.

There is **strong global momentum** for data sharing in **government services, healthcare, agriculture,** and climate & sustainability sectors. Data sharing in these sectors can enable effective global coordination in crime control and crisis response, manage cross-border public health threats, promote worldwide food security, and help address climate concerns that are inherently borderless in nature. In contrast, **transportation** and **smart city** sectors focus on localized urban improvements, resulting in **comparatively lower** global engagement. Meanwhile, the **power** and **water management** sectors have seen moderate global push for action. In the power sector, data sharing can advance efforts to integraterenewable energy into the grid and promote clean energy transitions, which are gaining gradual international momentum. Similarly, international actions in the watersector aim to enhance global access to clean water through data sharing. However, these sectors Exhibit comparatively lower cross-border implications and collaboration needs, leading to a moderate global push for data sharing initiatives.

Exhibit 3.3

All three Leading Sectors show a strong presence of factors that drive Government Impetus

	Sector	Relevance to Essential Citizen Needs	Global Push for Action in Sector
Leading Sectors	Government Services	Improves the reach and efficiency of government services that are critical for citizens	Streamlines global immigration processes, improves coordination in combatting international criminal activities
	Healthcare	Helps improve the quality and affordability of healthcare	Enhances global response to public health emergencies
	Agriculture	Helps improve crop yield and contribute to national food security	Advances sustainable farming practices and helps avoid food shortages which may lead to regional instability
Emerging Sectors	Climate & Sustainability	Improves climate disaster resilience and bolsters anticipatory response, potentially saving many lives	Climate concerns are inherently cross-border and require global cooperation
	Water Management	Access to clean drinking water and prevention of water shortages can be life saving	Lesser degree of cross border implications leading to comparatively moderate global push
	Power	Can help improve access to and affordability of power	Certain use-cases such as Renewable Energy integration are gradually gaining traction
Whitespaces	Transportation	Primarily focused on making commute more convenient for urban dwellers	Comparatively low cross border implications of underlying problems
	Smart City	Designed to enhance the quality of living for urban residents	Use-cases are of low cross border implications and require comparatively lesser global collaboration

High Medium Low

3.3.2 Business case

At its core, a UDH is designed to reduce friction in the discovery and usage of data by the broader ecosystem players, enabling them to develop solutions that serve the people. Therefore, the presence of a vibrant ecosystem of builders beyond the public sector significantly strengthens the case for developing a UDH. Moreover, the greater the willingness of citizens to pay for these services, it is more likely that businesses are to design services for the wider population. As seen in Exhibit 3.4, the demand for data from innovator ecosystem and the citizens' willingness to pay for these services, together strengthen the business case for a UDH. The strength of this business case is a crucial determinant of whether a UDH is widely adopted and succeeds in bringing about inclusive societal development.

- Innovator ecosystem beyond public sector: This factor measures the breadth of the innovator ecosystem beyond the public sector, that will use the data to design citizen-centric solutions. The impact of data sharing in a sector is significantly influenced by the size of the innovator ecosystem and its demand for using the data to advance the use-cases.

  Use cases in the **healthcare, agriculture,** and **transportation** sectors have a **strong innovator ecosystem** beyond the public sector, with diverse players such as healthcare and insurance providers, agri-tech firms, and mobility players leveraging data from UDH to innovate. **Smart city** encompasses diverse use-cases, such as smart tourism, which engages players across the travel, tourism, and hospitality industries. Consequently, this sector benefits from a **robust innovator ecosystem** due its extensive breadth. Despite limited private activity in certain areas like citizen-state interactions, **government services** sector also has a relatively **broad ecosystem,** due to significant private engagement in use-cases such as tax filing and welfare distribution. For example, when UDH are used to improve transparency and efficiency of welfare delivery, several private sector players such as mobile financial services platforms, bank and non-bank financial institutions, and fintech firms can be involved in the distribution of the welfare. On the contrary, the **water management** sector has a **limited builder ecosystem** since the data is primarily used by government organizations and utilities. In the **power** sector, the builder ecosystem is of **moderate size** primarily involving large utilities but also engaging non-public sector innovators in advancing use-cases such as consumption optimization. Similarly, the climate and sustainability sector Exhibits a **moderate** builder ecosystem, comprised of climate-tech firms, NGOs, and research organizations, utilizing UDH data for disaster prediction and mitigation.

- Citizens' willingness to pay for use-cases: This factor measures the willingness of citizens to pay for the services that can be designed using the data shared through the UDH. Given that UDH are created to enable the design of population-scale services to serve citizens, this factor is indicative of the economic viability of a UDH as well as its potential impact on citizens' lives. Higher the willingness for citizens to pay, greater is the incentive for businesses to leverage the data to create solutions, speeding up adoption and increasing the potential impact of the UDH.

  The **healthcare** sector sees a **high willingness to pay** among citizens due to demand for telemedicine offerings such as remote consultations, remote patient monitoring, and prescription management. Similarly, in smart city and transportation sectors, UDH could help create services such as safe travelling and multi modal journey planning, for which citizens tend to be **highly willing to pay.** On the other hand, the **water management** and **climate & sustainability** sectors see **lower** willingness to pay as their solutions do not directly lead to G2C[28] or B2C[29] transactions in most cases. **For government services,** the overall willingness to pay can be considered **moderate**; while

28. G2C: Government-to-Citizen; 29. B2C: Business-to-Consumer.

use-cases such as welfare distribution do not involve citizen payments, people are likely to pay for advisory services offered by businesses such as digital tax filing. In the **agriculture** sector, farmers, who are the target beneficiaries, may show a comparatively **moderate willingness to pay** for advisory services aimed at improving crop selection, disease containment, and fertilizer usage due to limited disposable income and low awareness. Finally, in the power sector, while direct financial interactions with citizens are limited, there is a relatively **moderate willingness to pay** for user-facing solutions that offer transparent billing information and opportunities for cost reduction.

Exhibit 3.4

All Emerging Sectors have medium to low presence of a business case, hindering the prevalence of UDH rather than proliferation

	Sector	Innovator Ecosystem Beyond Public Sector	Citizen Willingness to Pay for Use-Cases
Leading Sectors	Government Services	Data can be used by a wide-range of private sector players to improve their operational efficiency	Several Use-Cases such are not monetizable
	Healthcare	Creates new business opportunities for healthcare providers, insurers, health tech startups and more	Enables the design of lucrative services such as discovering and consulting doctors online
	Agriculture	Helps fintech, agritech, and other businesses offer more tailored financial products and advisory services to farmers	Primary beneficiaries are farmers, whose willingness to pay may be limited by financial constraints and limited awareness
Emerging Sectors	Climate & Sustainability	A moderately sized ecosystem of climate tech firms, aid organizations, NGOs, and research organizations	Primary use-cases do not involve commercial interactions with citizens
	Water Management	Most data sharing will be between public utilities due to limited presence of private players in the sector	Majority of use-cases do not involve monetizable G2C or B2C transactions
	Power	Data can be used by innovators to provide value-added services to consumers	Citizens will be willing to pay for Use-cases such as Consumption Optimization
Whitespaces	Transportation	Data can be used by firms in the mobility space to improve operations and offer better services	Use-cases such as Multi-Modal Transportation will be highly attractive to urban citizens
	Smart City	A wide range of businesses operating in the urban space can use Smart City data	As use-cases can improve convenience of urban living, citizens will be willing to pay

High Medium Low

3.3.3 Insights from Interplay between Government Impetus and Business Case

Given the analysis presented in this section, **we can conclude that strong government impetus is necessary, but not enough by itself, to create global momentum for building UDH in a sector.** As depicted in Exhibit 3.5, where high impetus for the State to drive several use-cases in a sector is coupled with a demand for the data from innovator ecosystem and citizens' willingness to pay, we are likely to observe a greater density of UDH, making it a **leading sector**. But despite a strong public sector impetus, development of UDH may be impeded due to a lack of incentives for the citizens and innovators to engage with the UDH, such as in the case of the water management sector.

Exhibit 3.5

Government impetus helps initiate the journey of UDH, while the Business case determines the potential for gaining widespread momentum

On the contrary, **when the impetus for the state is low for most of the primary use-cases, states are unlikely to take the initiative to develop UDH regardless of the strength of the business case.** This is evident from the relatively few UDH built in the transport and smart city sectors, which remain whitespaces today.

Therefore, **Government impetus helps initiate the journey of UDH in a sector, while the Business case influences whether UDH gather widespread momentum in that sector.**

Box 3: Climate action: The promise of UDH

Climate change represents an existential threat to humanity. As we aim to scale both mitigation and adaptation efforts, UDH can play a significant role in accelerating our collective response. Effective mitigation and adaptation efforts require coordinated action and exchange of data across various ecosystem actors including government, businesses, citizens, non-profits, funders, and academia, often extending beyond national boundaries. As depicted in Exhibit 3.6, there are at least 10 distinct use cases where UDH can play a significant role in driving progress.

Exhibit 3.6

Unified Data Highways can unlock 10 use-cases on Climate & Sustainability action

1. Climate Disaster Resilience: Interoperability of weather data, historical disaster and impact data, geospatial data and population exposure data can help countries identify areas prone to weather related disaster risks and enable **impact-based proactive response systems**

2. Forest Conservation: Access to satellite data, in-situ forest data, land registry data, trade data, climate and soil data can help governments, private sector and organizations to **track and predict forest activities, curb deforestation and initiate targeted recovery measures**

3. Ocean Accounting for Sustainable Blue Economy: Interoperability of ocean economic data on ocean industries and environmental data on ocean ecosystems can enable countries to **assess economic potential of ocean economy and ecosystem services**, enabling evidenced-based ocean policies, and private sector financing for blue carbon restoration

4. Greenhouse Gas Emissions Reporting and Verifications: Help countries maintain open and transparent emissions data for a **reliable GHG inventory and reporting mechanism** to measure progress against their NDC and aid carbon trading

5. Harmonized Carbon Credit Data for Carbon Markets: Establishing a unified and verifiable mechanism for measuring, sharing, and validating carbon credit registries can strengthen the **integrity of national and global carbon trading markets** by preventing double counting and greenwashing

6. Harmonized Green Credit Data for Trading: Green credits are generated through environmental sustainability actions that extend beyond emissions reduction or removal, such as green cover restoration, water conservation, and sustainable agriculture; establishing a uniform and reliable mechanism for measuring, verifying, and sharing activity-based green credit data can **improve the transparency and accountability of green credit trading markets**

7. Climate-smart Agricultural Policies: Access to farmer information, soil data at the farmland level, and weather forecasts can help governments tailor **anticipatory agricultural policies** to local conditions. For example, Data in Climate Resilient Agriculture (DiCRA), a collaborative digital public good, provides open access to datasets to strengthen evidence-driven policy making for climate-resilient food systems.

8. Urban Heat Island Mitigation: City planners can **monitor the health of urban green spaces and predict potential heat islands** by exchanging geospatial, building density, and canopy data to plan effective cooling interventions

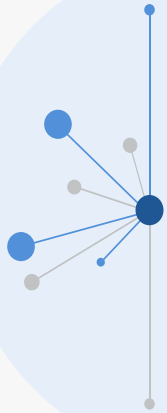
9. Enhancing Public Transport Usage: Open exchange of real-time transport related data (routes, fares, active capacity, schedules) can enable loyalty programs and carbon calculators to **incentivize multi-modal public transport usage**

10. Renewables Integration in Power Grids: Exchanging power consumption, generation, and climate data can support renewable energy trading, credit exchanges, and management platforms, **enhancing integration of renewable energy into conventional grids**

Source: BCG analysis

For a deeper understanding of the practical applications and potential benefits of UDH, we look at four use-cases in greater detail.

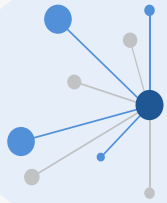
Climate disaster resilience: The number of climate-related disasters has tripled over the last 30 years.[30] Climate change is affecting the global water cycle, leading to increased frequency and severity of floods, storms, heatwaves, and droughts.[31] Over the last 15 years (2009-2023), 2.4 billion people[32] were affected by climate induced disasters[3], accounting for over 314,000 fatalities[6], and causing economic losses amounting to ~USD 2,500 billion[33] – 50% higher[6] than in the previous 15-year period.



Establishing a UDH can **transform disaster response from a reactive to an anticipatory approach.** While a lot of climate data exists and is used, it is often in silos. Democratizing access to historical weather data, weather forecast data, historical disaster data, and geospatial datasets could enable the generation of more accurate disaster prediction models for early warning systems

It can also amplify the efforts of humanitarian organizations in planning anticipatory cash and in-kind relief actions, and facilitate better disaster-resilient farming advice.

Pilots have demonstrated more timely disbursement and up to 50% cost savings[34] in anticipatory aid due to pre-shock efficiencies.



Explore a **demonstration** of these scenarios on the Climate Resilience Data Highways, conceptualized by JICA and FIDE

Click here

Forest conservation: Enhancing transparency in forest data is essential for advancing the role of forests in climate change mitigation efforts. UDH can facilitate seamless discovery and exchange of geospatial data, on-site forest data, soil data, climate data, and restoration project update data. This streamlined data sharing can enable prioritization of areas needing restoration, creation of targeted restoration plans, and monitoring the impact of restoration projects.

A range of stakeholders, including government officials, researchers, private businesses, civil society, philanthropists, academia, and citizens possess valuable data. Without UDH,

30. Source: World Economic Forum; 31. Source: IPCC Sixth Assessment Report: Chapter 8; 32. Source: EM-DAT Database, Center for Research on the Epidemiology of Disasters (CRED); 33. Includes hydrological, meteorological, and climatological disasters as defined by EM-DAT Database; 34. Source: UN OCHA .

these datasets remain isolated in silos, limiting visibility and access among ecosystem players. Streamlined discovery and access to these datasets can enhance transparency, and significantly bolster forest conservation efforts by reducing cost and improving effectiveness of such efforts.

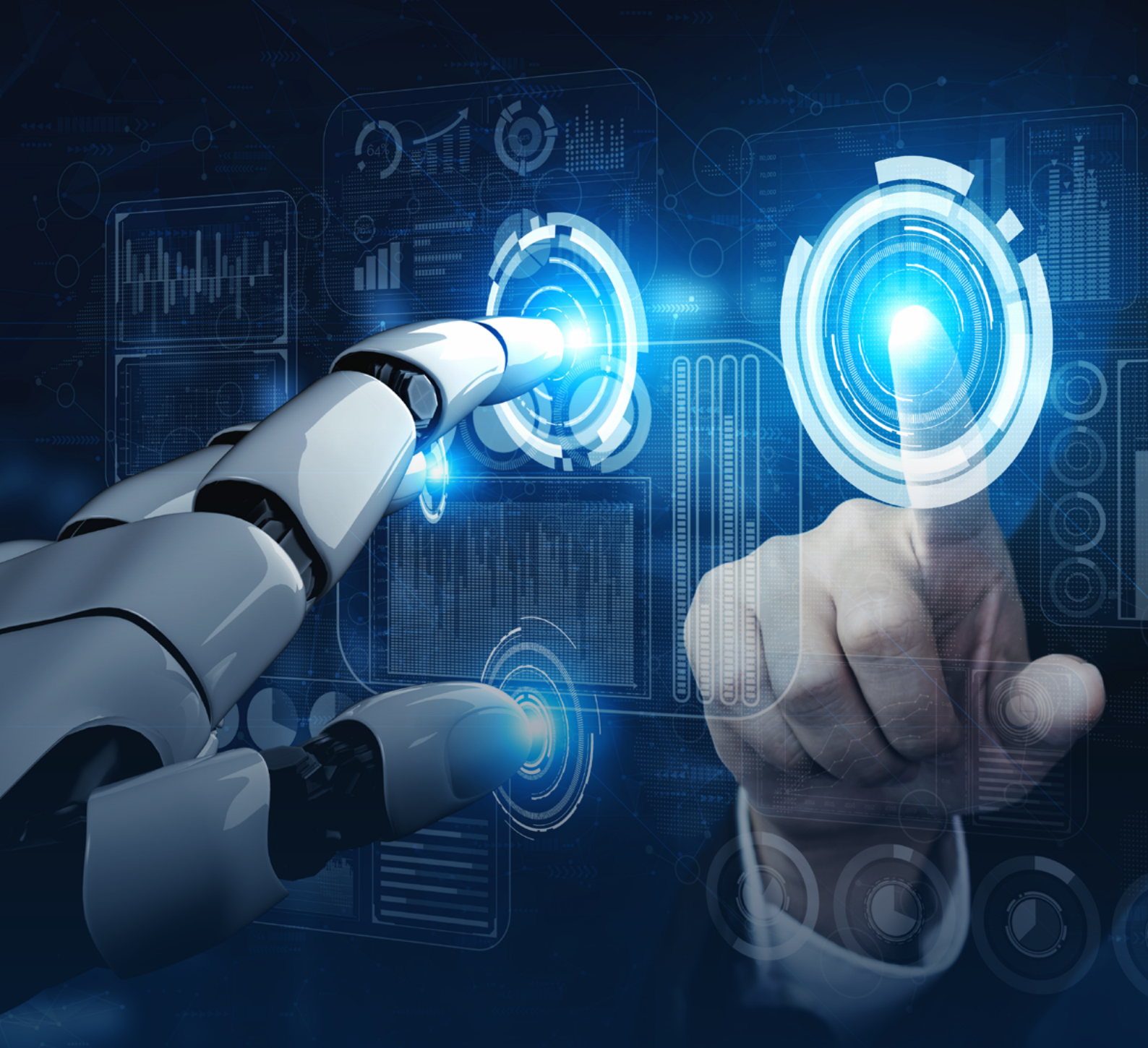
Ocean accounting for sustainable blue economy: Sustainable Blue Economy[35] initiatives require informed decision-making through Ocean Accounting—a transparent approach to measuring and monitoring ocean economic activities, ecosystem conditions, and the services ecosystems provide. Dispersion of data across various entities including statistical authorities, sectoral ministries, ocean industries, marine academic and scientific communities, and civil societies makes this process time-consuming and resource intensive.

Access to interoperable data on ocean economic activities and ecosystems could **support evidence-based policies** such as Marine Spatial Planning[36], Integrated Coastal Management, and fiscal strategies tailored to the impacts of ocean industries on adjacent ecosystems. Secure and consent-based access to this data could help private financiers identify blue carbon ecosystems that need restoration and maintain transparent records of the blue carbon credit[37] potential of these projects.

Greenhouse gas emissions reporting and verification: In many developing economies, greenhouse gas emissions reporting often depends on manual processes and outdated systems. Digital reporting systems typically use proprietary software with limited integration of established digital infrastructure, leading to reduced transparency in emissions and emissions reduction data.

Digital Emissions Registry[38] (DER) can enhance the transparency of facility-level emissions reporting. Secure and consent-based access to facility-level DER, combined with weather data and satellite imagery, can aid accredited third-party auditors to remotely verify emissions data. These interoperable DERs can enable sectoral ministries to report greenhouse gas emissions at a sectoral level for national reporting purposes. Nodal ministries responsible for global emissions reporting can access verified sectoral DERs to efficiently produce reliable greenhouse gas inventory reports for international disclosure and track progress against Nationally Determined Contributions (NDCs). Furthermore, climate funds can access verified DERs to monitor the impact of green financing on emissions reduction projects.

35. According the World Bank, "The Blue Economy is sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health." For further details, refer What is the Blue Economy?; 36. According to Intergovernmental Oceanographic Commission, "Marine Spatial Planning is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process. " For further details, refer Marine Spatial Planning; 37. Carbon credits derived from the conservation and restoration of coastal and marine ecosystems, such as mangroves, salt marshes, and seagrasses; 38. Digital Emissions Registry (DER) is a digital database to collect, record, track, and manage data related to GHG emisssions.



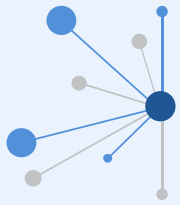
04 The road ahead for UDH

Chapter Summary

- **Harnessing the power of AI:** The advancement of AI, marks an important moment in the evolution of DPIs, especially UDH. AI improves data accessibility, while UDH provide high-quality datasets that drive inclusive AI innovation, creating a powerful feedback loop.
- **Need for collaboration:** Collaboration among DPI stakeholders such as funders, DPI/DPG advocates, DPG custodians, tech builders, government agencies, academia, think tanks and civil societies is fundamental to the success of UDH.
- **Call to action:** UDH offer a promising pathway to a more connected, equitable, and data-driven world. JICA calls on all stakeholders to join forces in advancing UDH, ensuring that we create a digital economy that works for everyone, and that data is leveraged to maximize the public good.

4.1 Harnessing the power of AI

The interplay of AI with UDH represents a significant leap forward in the evolution of DPI, particularly for the emerging nations. The synergy between AI and UDH is not merely additive. Rather, the combination of AI and UDH can create an **exponential effect**[39], with each enhancing the capabilities of the other. AI can help in improving the accessibility and reach of UDH by transforming complex data into actionable insights that users can easily understand. Conversely, UDH can securely provide diverse, and high-quality datasets essential for developing robust AI models.



AI and UDH can create a powerful **feedback loop** where data availability drives AI innovation, and AI, in turn, enhances data accessibility for UDH

AI amplifying the power of UDH:

Integration of AI with UDH can significantly **reduce accessibility barriers and promote inclusion,** particularly in emerging nations where digital literacy may be low. By interpreting complex datasets and providing insights in an easily understandable manner, AI can help bridge the digital divide. For example, personalized agricultural advisory services can be generated by accessing diverse datasets through UDH. AI can further enhance this service by delivering advisories in the local language of farmers, thus empowering them to make informed decisions. Similarly, a financial services company has developed an AI-enabled personal financial management application[40] that leverages the Account Aggregator system to analyze user's financial behavior. This application offers tailored financial advice through a conversational chat interface on WhatsApp, thereby making financial management more accessible and user-friendly.

39. Inspired from a keynote address by Mr. Nandan Nilekani, Chairman and Co-Founder, Infosys, and Founding Chairman, UIDAI (Aadhaar) at Global Technology Summit 2023. Learn more at Keynote: Digital Public Intelligence: What comes next for DPIs & AI in India;
40. Source: Mint

UDH advancing Artificial Intelligence:

Domain-specific datasets are essential for fine-tuning foundation models. UDH can significantly enhance AI by enabling secure access to these specialized datasets to develop fine-tuned AI models with greater ease. UDH can streamline the process of establishing agreements for data sharing by enabling secure access to datasets for a specific period and purpose, thus fostering innovation and inclusivity. For instance, UDH can facilitate the secure sharing of medical datasets, enabling the fine-tuning of models to perform specific tasks such as diagnosis, recommending personalized treatment, and predicting patient outcomes.

4.2 Need for collaboration

Collaboration amongst the DPI community is fundamental to ensuring the success of a DPI. In the context of a UDH, six archetypes of partners, as illustrated in Exhibit 4.1, are identified. Each archetype plays an instrumental role in the journey from inception to operationalizing and further scaling. These partners ensure the UDH's robust technology build, adherence to strong governance framework, and adoption by the intended community.

- Funders play a key role in orchestrating the UDH's journey. They not only provide the necessary funding to operationalize it, but they also assist countries to define the vision, identify challenges and opportunities while providing necessary oversight on the UDH's design and implementation. There are three categories of funders active in the DPI space many of whom have already made investments in UDH:
  - Multilateral Development Banks and Development Financial Institutions (e.g., World Bank, IMF, Asian Development Bank, etc.)
  - Bilateral & Multilateral Agencies (e.g., USAID, UNDP, GIZ, Norad, etc.)
  - Foundations & Intermediaries (e.g., BMGF, Co-Develop, The Rockefeller Foundation, etc.)
- DPI/DPG advocates catalyze engagement and drive the conversation forward, leveraging thought leadership and knowledge exchange to drive implementations of UDH. Their advocacy sets the stage for capacity building and promotes the global adoption of DPGs as a starting point for the development of UDH. For example, Digital Public Goods Alliance (DPG) advocates for the global implementation of DPGs and maintains registry of DPGs to increase their discoverability.
- DPG custodians take up the responsibility of being the guardians of a UDH. Their commitment to maintenance, technical assistance and supporting governance is crucial for the stability, reliability, and widespread adoption of the DPG across global implementations. For example, DHIS2 is a software DPG used by 80+ countries for collecting and analyzing health data.[41]
- Tech builders bring the architectural vision to reality, providing the necessary IT infrastructure, executing pilot initiatives, and leading the scaling efforts. These technology entities are often the engines that power the UDH, enabling it to handle extensive volumes of activity effectively. This includes global tech builders such as Microsoft and Accenture as well as regional builders such as eGov Foundation and Protean.
- Government agencies play a critical role in leading important decisions such as defining the vision of the UDH, overseeing its governance, setting up institutions to govern and lead it, and

41. Learn more about DHIS2 at Home - DHIS2.

fostering collaborative relationships with the rest of the partners in the journey to drive successful implementation and adoption of the UDH. Typically, for a country-specific UDH, the apex body is a government-associated agency to ensure that it upholds public interest and has sufficient autonomy in driving important decisions to ensure socio-economic developmental outcomes.

Academia, think tanks and civil societies drive research and innovation on the UDH to constantly develop its technology architecture, strengthen the fundamental focus on trust and security while extending its build and adoption across use-cases and nations globally.

Exhibit 4.1

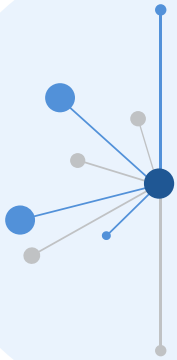
Global DPI community must collaborate to help realize the vision of UDH

	Primary Responsibilities	Examples
Funders	Provide funding and oversight in design and implementation of the project	• DFIs & MDBs: World Bank, IMF, Asian Development Bank, etc. • Multilateral Agencies: USAID, KfW, GIZ, etc. • Foundations: BMGF, Co-Develop, The Rockefeller Foundation, etc.
DPI/DPG Advocates	Drive engagement, innovation, knowledge exchange, and capacity building to promote DPI/DPGs	• DIAL (building GovStack platform in Rwanda) • DPGA (Enabled a platform to support DPI safety and inclusivity in India)
DPG Custodians	Support governance and implementation of respective DPGs in specific use-cases globally	• X-Road (Implemented as a DPG in Estonia, Finland, Brazil and multiple other countries) • DHIS2 (managed immunization of 35 Mn+ children in Bangladesh)
Tech Builders	Build and integrate IT infrastructure, conduct pilot runs and drive implementation	• Global tech builders: AWS, Microsoft, Accenture, etc. • Local tech builders: Protean, eGov Foundation, etc.
Government Agencies	Orchestrate the implementation of UDH by setting up governance mechanisms, assist in scaling adoption and achieve development outcomes	• Sector-specific ministries, departments and agencies • National Digital Transformation governing bodies • Project-specific SPVs
Academia/ Think Tanks/ Civil Society	Drive R&D and thought leadership to spark innovation and strengthen focus on trust and security	• Global academia and think tanks prominent across priority sectors • Country-specific academia and think tanks with national/sector prominence

Source: Expert interviews, Secondary research, BCG analysis

4.3 Call to action

In this report, we have explored the foundational concepts of UDH and illustrated the impact potential of UDH. For nations interested in this journey, we have defined a set of design principles for developing UDH and laid out early actions that could set them up for success. To truly harness the potential of UDH, governments must foster a conducive regulatory environment, build strong partnerships with ecosystem participants, promote industry collaboration, explore multi-source funding arrangements, and invest in technological advancements to ensure the responsible and sustainable deployment of UDH. Only through proactive and collaborative action can we fully realize the benefits of UDH. Furthermore, long-term capability building and continuous engagement with all relevant stakeholders, including tech companies, academia, and civil societies, are crucial for advancing an inclusive and sustainable UDH ecosystem. More importantly, stakeholders must collaboratively create a robust governance framework, one that can evolve with the changing landscape of the data sharing space, to mitigate the inherent risks of a large-scale data sharing initiative and ensure fair distribution of benefits among all citizens.



Looking ahead, UDH offer a promising pathway to a more connected, equitable, and data-driven world. The **collective efforts of the public and private sector** are crucial to **harness the transformative potential of UDH**, paving the way for unprecedented opportunities in socio-economic development and innovation

We call on all stakeholders to join forces in advancing UDH, ensuring that we create a digital economy that works for everyone, and that data is leveraged to maximize the public good.

Box 4: Japan and JICA's outlook on UDH

JICA is dedicated to its mission of accelerating socio-economic development in emerging nations. In line with this commitment, JICA DXLab was set up in 2022 to embrace the power of digital transformation and create a society where everyone can achieve well-being through digital technology and data.

JICA's focus on investing in DPI directly complements its investments and experience in physical infrastructure projects such as the Delhi Metro. Within the DPI agenda, while Identity and Payments have seen massive focus, UDH – the third pillar – has been relatively understudied.

JICA believes that robust UDH can play a vital role in creating public value across sectors. For instance, JICA's commitment towards enhancing citizen outcomes is demonstrated through its work on the Transport Stack in New Delhi which is a UDH that aims to address public transportation and traffic management challenges in the city.

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By focusing on DPI, JICA seeks to create a more interconnected development landscape that aligns with its long-term goals of sustainable growth, inclusivity, and resilience. In this journey, JICA recognizes the importance of collaboration to maximize impact, and welcomes your partnership to advance initiatives globally.

Appendix 1: Acknowledgements

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Appendix 2: Glossary

Acronym	Full Form
AA	Account Aggregator
ABDM	Ayushman Bharat Digital Mission
ADB	Asian Development Bank
AI	Artificial Intelligence
API	Application Programming Interface
AWS	Amazon Web Services
B2C	Business-to-Consumer
BMGF	Bill & Melinda Gates Foundation
BNDA	Bangladesh National Data Architecture
BSD	Berkeley Software Distribution
CAD	Climate Action Data Trust
CAR	Rural Environmental Registry (Brazil)
CDPI	Centre for Digital Public Infrastructure
COVID	Coronavirus Disease
CSO	Civil Society Organization
CV	Curriculum Vitae
DaaS	Digital Public Infrastructure as a Service
DEPA	Data Empowerment & Protection Architecture
DER	Digital Emissions Registry

Acronym	Full Form
DFFT	Data Free Flow for Trust
DFI	Development Finance Institution
DHIS	District Health Information Software
DIAL	Digital Impact Alliance
DIKSHA	Digital Infrastructure for Knowledge Sharing
DPG	Digital Public Goods
DPGA	Digital Public Goods Alliance
DPI	Digital Public Infrastructure
ETA	Estimated Time of Arrival
EV	Electric Vehicle
FIDE	Foundation for Interoperability in Digital Economy
FIP	Financial Information Providers
FIU	Financial Information Users
G20	Global G20 Summit
G2C	Government-to-Citizen
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPS	Global Positioning System
ID	Identification

Appendix 2: Glossary

Acronym	Full Form
IIIT-B	International Institute of Information Technology, Bangalore
IMF	International Monetary Fund
INR	Indian Rupee
IPR	Intellectual Property Rights
IT	Information Technology
IUDX	India Urban Data Exchange
JICA	Japan International Cooperation Agency
KAOP	Kenya Agriculture Observatory Platform
MDP	Multilateral Development Bank
MIT	Massachusetts Institute of Technology
MOSIP	Modular Open-Source Identity Platform
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organization
NHS	National Health Service
NIIS	Nordic Institute for Interoperability Solutions
NITI	National Institute for Transforming India
OPD	Outpatient Department
PDPA	Personal Data Protection Act
PII	Personally Identifiable Information
PM	Prime Minister
PMJDY	Pradhan Mantri Jan Dhan Yojana
PPP	Public-Private Partnership
ROI	Return on Investment
SALT	Seafood Alliance for Legality & Traceability
SATU	Satu Data Indonesia
SDG	Sustainable Development Goals
SMS	Short Message Service
SNNP	Southern Nations, Nationalities, and Peoples' Region
SPV	Special Purpose Vehicle
TDP	Training Data Providers
UDH	Unified Data Highways
UIDAI	Unique Identification Authority of India
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USD	United States Dollar
WPdx	Water Point Data Exchange

Appendix 3: Methodology

The views shared in this report are based on an extensive analysis of the potential for UDH in 8 sectors across 24 emerging nations, 50+ consultation sessions with global experts, extensive examination of case studies on UDH, and a rigorous study of the DPI literature and publicly available data. We have closely scrutinized the DPI landscape and generated insights to advance the DPI literature, with the intention of aiding nations in their efforts to build UDH.

Our research on landscaping the development of data sharing in emerging nations has helped us identify the emergence of UDH, facilitating data sharing by connecting federated databases securely and enabling interoperability. We have also landscaped the sectors and segregated them into 3 categories – leading, emerging and whitespaces, based on the prevalence of data sharing infrastructure seen in them. Our analysis of various case studies of successful DPI has helped us identify the best practices and outline fifteen guiding principles of governance, technology and execution that can help set up UDH for success.

In addition to this, we have also estimated the potential of UDH. Our analysis shows that **emerging nations can unlock between 3-4 trillion dollars of value** annually by 2030, which represents between 5-6% of their collective GDP, through the **implementation of UDH.** This includes the direct impact on the economy due to the exchange of data, indirect impacts due to the use of data (such as data users being able to develop better product and services), as well as induced impacts that include additional spending generated in the economy due to increased job creation or wage growth.

USD 3-4 Trillion represents the annual social and economic value to be unlocked through data sharing across different sectors across 49 emerging nations in 2030. It does not imply an annual GDP boost of 5-6% but rather indicates that the value generated from UDH would approximate 5-6% of their projected GDP in 2030. This estimation draws on the European Data Market Study 2021-23 by the European Commission, which assesses the impact of the Data Economy on the GDP of EU countries. Our calculation assumes that the impact on GDP (as a % of GDP) is influenced by a state's ability to drive digital transformation and data sharing at scale. Consequently, the potential value unlocked as a % of GDP will vary between emerging nations and EU nations.

To contextualize this data from EU to emerging nations, we have used the World Bank's GovTech Maturity Index (GTMI) as an adjustment factor. We assume that a higher GTMI score suggests a greater potential for a country to unlock value through data sharing. The World Bank GTMI index includes 48 indicators such as government cloud, interoperability framework, accessibility of government services online, open data, open government portal, and more. Considering the substantial state involvement required for the development of UDH, we selected the GTMI index as an adjustment factor. Given that UDH are typically state-led initiatives, the state's capacity for digital transformation is a crucial determinant of the value that can be created through UDH.

Appendix 4: Further Reading

DPI has been extensively studied by global organizations and experts who have significantly shaped the current understanding of the topic. We have drawn inspiration from publicly available literature to enrich this report with valuable insights. Below, we present a selection of these resources for your further reading.

- Co-develop (2023): What is Digital Public Infrastructure?
- Digital Public Goods Alliance (2023): DPI-DPG-BB Definitions
- Digital Impact Alliance (2023): Can We Future-Proof Digital Public Goods
- Digital Public Goods Alliance (2023): DPG Ecosystem 2023
- Gates Foundation (2023): What is a Digital Public Infrastructure?
- G20 New Delhi Leaders' Declaration (2023): G20 New Delhi Leaders' Declaration
- NITI Aayog (2023): Data Empowerment and Protection Architecture
- UNDP (2023): Accelerating the SDGs through Digital Public Infrastructure
- UNDP (2023): The Human and Economic Impact of Digital Public Infrastructure
- UNDP (2023): DPI Approach Playbook
- Omidyar Network India (2021): Estonia Case Study
- World Economic Forum (2021): Towards a Data Economy
- Omidyar Network India (2020): The Potential of Open Digital Ecosystems: Building India's Digital Highways
- ENTSO-E (2017): THEMA Report


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