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C.K. MATHEW, SURENDRA NATH TRIPATHI
C. SHEELA REDDY & A.P. SINGH

Viksit Bharat @2047

Governance Transformed

C. K. MATHEW, SURENDRA NATH TRIPATHI, C. SHEELA
REDDY, A. P. SINGH, EDITORS

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Chapter 8. Digital Public Infrastructure as Digital Public Good

Alkesh Kumar Sharma³³

Introduction: Digital Transformation—Catalysing Economic Development

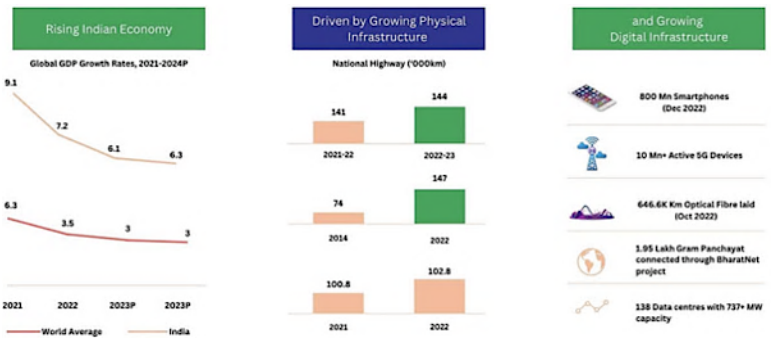
India's digital transformation journey has been a cornerstone of its economic development plan. The government's investment in digital infrastructure and governance reforms has yielded substantial savings, estimated at 1.1% of GDP (Gross Domestic Product) by March 2021 (Zhabska et al., 2023). Such progress not only enhances productivity but also augments potential growth, with studies by the United Nations Development Programme suggesting a 1 to 1.4 percentage point increase in GDP growth by 2030 (considering only two channels: financial inclusion and lower leakages from social programmes) in low- and middle-income countries due to digital public infrastructure (DPI) initiatives (Zhabska et al., 2023).

Notably, mature DPIs (like Aadhaar, UPI, GSTIN) with successful mass adoption and larger economic impact, and budding DPIs (like CoWIN, DigiLocker, DIKSHA) with successful proofs of concept and readiness for mass adoption, are forecasted to propel India towards its US\$8 trillion digital

³³ Shri Alkesh Kumar Sharma is Former Secretary in the Ministry of Electronics and Information Technology in the Government of India

economy goal, potentially contributing 2.9% to 4.2% of GDP by 2030 (ET Government, 2024; NASSCOM and Arthur D Little, 2024, p. 52).

Figure 1: Growth in India's Economy



Source: Report on India's digital public infrastructure by NASSCOM and Arthur D Little (2024).

India's journey toward a digital-first economy has been nothing short of transformative. It all began in 2006 with the ambitious National e-Governance Plan (NeGP). This was not just about digitising paperwork; it was about reimagining how citizens interacted with their government, making services more accessible, transparent, and efficient. Imagine a student accessing academic records online, a patient retrieving medical history electronically, or a citizen filing taxes from the comfort of her home—this was the promise of NeGP. By focusing on 31 Mission Mode Projects across key sectors, NeGP laid a solid foundation for a digitally empowered India.

This initial spark ignited a chain reaction of innovation. The Aadhaar project, a monumental undertaking to provide a unique digital identity to every resident, revolutionised access to services and benefits. This single identification number became a gateway to subsidies, pensions, banking services, and more. By linking Aadhaar with Jan Dhan bank accounts and mobile

numbers (the “JAM (Jan Dhan–Aaadhar–Mobile” Trinity), the government streamlined the delivery of social welfare programmes, reducing fraud and ensuring that benefits reached the intended recipients directly and efficiently. This proved particularly crucial during the pandemic, enabling swift and targeted disbursement of financial aid to those most in need.

Subsequently, the Digital India programme painted a bold vision of a digitally empowered society and knowledge economy. This was about more than just internet access; it was about digital literacy, skill development, and ensuring that every citizen, regardless of location or background, could participate in the digital age. Digital India aimed to bridge the digital divide, empower rural communities, and foster a culture of innovation and entrepreneurship. At the heart of this transformation was the strategic management of data. Logical data management, characterised by a systematic, structured approach to handling information, played a pivotal role in enabling governments and businesses to make informed decisions. It ensured that data was not only accessible but also meaningful, regardless of its source or format. Nationwide initiatives such as Aadhaar and CoWIN have benefited greatly from a logical data management approach. After all, national records and identities are systems that need to extract and unify information from myriad sources, regardless of formats and data types.

But with great digital power comes great responsibility. The rapid digitisation of services and the vast amounts of data generated have raised concerns about privacy and security. Recognising the need to safeguard citizens’ information, India enacted the Digital Personal Data Protection Act 2023. This landmark legislation goes beyond mere compliance with global standards. It empowers individuals with greater control over their personal data, mandates transparency in data collection and processing, and holds organisations accountable for data breaches. This not only builds trust in the digital ecosystem but also fosters a culture of responsible data practices—a cornerstone of any sustainable digital infrastructure.

India's digital ambitions do not stop at its borders, nor are they restricted to only the present day. The nation recognises the transformative potential of artificial intelligence (AI) and is actively engaged in the global AI arena. Through initiatives like the India AI Mission, a comprehensive programme to build a robust AI ecosystem, India is not merely keeping pace with global trends but actively shaping them. The India AI Mission, with its substantial investment of over ₹10,000 crores, is focused on developing practical AI solutions for critical sectors like healthcare, agriculture, education, and governance.

Beyond its national initiatives, India is also playing a significant role on the international stage. As a leading member of the Global Partnership on Artificial Intelligence (GPAI), India is collaborating with other nations to guide the responsible development and use of AI. GPAI focuses on four key themes: Responsible AI, Data Governance, Future of Work, and Innovation and Commercialisation. By investing in AI research, development, and deployment both domestically and internationally, India is paving the way for a future where AI-powered DPIs are not just a theoretical concept but a practical reality, driving tangible improvements in efficiency, inclusivity, and overall quality of life. This remarkable journey has paved the way for India's unique approach to Digital Public Infrastructure (DPI). These DPIs are more than just tools; they are transformative platforms built on trust, innovation, and inclusivity. By empowering individuals, businesses, and the government, they are propelling India towards a digital future filled with opportunity. While challenges remain, the progress made so far is undeniable, and the potential for further impact is immense. India's DPIs could be a testament to what can be achieved through thoughtful planning, collaboration, and a commitment to technological advancement for the benefit of all.

Lessons from the Pandemic: Reinforcing the Imperative of Digital Infrastructure

The COVID-19 pandemic was a crucible for governments worldwide, exposing the limitations of traditional systems in the face of unprecedented challenges. Suddenly, the challenges were not just about healthcare; they spanned every aspect of life, from tracing the virus's spread to adapting education systems for a virtual world. The crisis, however, became a catalyst, opening a “window of opportunity” (Kingdon, 1984) for emerging technologies to prove their worth and reshape public services in ways previously unimaginable (Li et al., 2022). In India, this opportunity was not missed. The nation's robust digital infrastructure, built on years of strategic investment, rose to the challenge. Aadhaar, the cornerstone of this infrastructure, became a lifeline for millions facing economic hardship due to the pandemic. The government leveraged Aadhaar to swiftly and accurately deliver financial aid to those who needed it most, showcasing the power of digital identity in times of crisis. Meanwhile, the Unified Payments Interface (UPI) became the backbone of contactless transactions, keeping the economy moving while promoting social distancing. Education, too, found its digital footing. DIKSHA, the Digital Infrastructure for Knowledge Sharing, became a beacon for remote learning. Its modular design was not limited to primary education; it extended to skilling initiatives and even hosted COVID-19 training modules for healthcare workers, facilitating the completion of over 1.7 million training sessions between April and June 2020 (Zhabska et al., 2023).

The Public Financial Management System (PFMS) emerged as a critical player in India's pandemic response. This integrated platform, already in place for managing government funds, proved invaluable for distributing aid under the Pradhan Mantri Garib Kalyan Yojana (PMGKY), a massive relief package

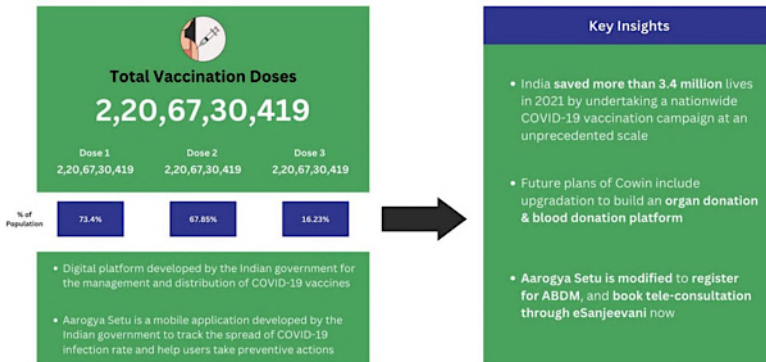
launched in March 2020 (Table 1). Thanks to its ability to seamlessly connect with existing beneficiary databases and leverage digital banking systems, PFMS facilitated the rapid transfer of funds to nearly 500 million individuals within a mere two weeks (Jain et al., 2021). This unprecedented speed and scale of aid delivery underscored the power of digital infrastructure to streamline and accelerate support during a crisis, ensuring that those most affected received timely assistance (Griffin et al., 2023).

Table 1: Coverage of Households Under the PMGKY Scheme (% Share of All Households) Source: Zhabska et al. (2023).

	All	Rural	Urban	Poor	Non-Poor
Food Only	40	38	43	42	39
Cash Only	6	7	4	6	6
Food and Cash	34	40	22	40	32
Atleast one benefit (Food & Cash)	80	85	69	87	76

Perhaps the most visible symbols of India’s digital prowess during the pandemic were the Aarogya Setu app and the CoWIN platform. These home-grown solutions became instrumental in the fight against COVID-19. Aarogya Setu, with its contact tracing capabilities, helped track the virus’s spread, while CoWIN orchestrated a nationwide vaccination campaign of unprecedented scale (Figure 2). By integrating existing digital platforms like DigiLocker and eVIN (Electronic Vaccine Intelligence Network), CoWIN managed everything from vaccine appointments and inventory tracking to adverse event monitoring, proving that technology could be a powerful ally in public health.

Figure 2: Impact of CoWIN, Aarogya Setu, and Rapid Vaccination Drive. Source: Report on India's digital infrastructure by NASSCOM and Arthur D Little (2024).



The Global South and the Necessity of Digital Transformation

The digital revolution is more than just a technological shift—it is a global force with the potential to reshape economies and societies. For the Global South, this revolution offers an unprecedented chance to leapfrog traditional development barriers and forge a path toward a brighter future. However, as the recent United Nations Economic and Financial Committee meeting highlighted, the path to digital transformation is fraught with challenges. Representatives from developing nations voiced the urgent need to integrate digital tools into the fight against poverty, gender inequality, and climate change. The digital divide, they warned, threatens to widen existing inequalities and leave less connected nations further behind (UN Press, 2023).

Digital Public Infrastructure (DPI) emerges as a critical solution to these challenges. By providing essential digital services and platforms, DPIs can accelerate progress towards the Sustainable Development Goals (SDGs) (Figure 3). Through

initiatives like India Stack, which provides an open interface applicable across various countries, these nations can leapfrog traditional barriers. Moreover, by investing in digital public infrastructure, particularly through collaborative efforts like those emphasised during India's presidency of the Group of 20 (G20), these countries can unlock significant opportunities for inclusive growth and development (UN Press, 2023).

Figure 3: Performance of DPIs with Reference to SDGs

1 No Poverty	By establishing systems to identify vulnerable communities (informal workers, women) and roll out public services	1.27 billion residents are enrolled on Aadhaar, India's digital identity infrastructure
3 Good Health and Well-being	By introducing systems to enroll, schedule, and track doctor visits, medicines, and vaccinations to support existing health infrastructure	2 days to develop a COVID-19 tracking platform post disease outbreak on Sri Lanka's COVID-19 interface
10 Reduced Inequalities	By instituting systems to identify vulnerable populations with low financial literacy and enable fast, efficient, and accessible social transfers	40 million individuals made their first-ever financial transfer through Pix, Brazil's payment ecosystem
13 Climate Action	By instituting systems to manage carbon offsets and trading, forest preservation, weather information and monitoring , thus reducing response times to climate events	91% reduction in greenhouse gas emissions estimated in Namibia the first African country to implement a Carbon Trading DPI
2 Zero Hunger	By introducing open ecosystems and data exchanges , thus going beyond agriculture to support the management of market linkages, water and waste	3.5 million Ethiopian farmers benefited through data exchanges combining their information with non-personal datasets (soil, weather, market prices) to improve agricultural practices
4 Quality Education	By investing in learning management systems to support education delivery digitally and improve access to digital resources at larger scales	290 thousand e-content s in 30 languages available for teachers on Diksha, India's digital learning ecosystem , which has facilitated 5 billion learning sessions

Source: The DPI approach: A playbook (United Nations Development Programme, 2023).

Yet, as illustrated in Figure 4, the journey towards robust DPI development is not without its challenges.

While these challenges are not unique to the Global South, they often require tailored solutions that take into account the specific context and needs of developing nations. India's journey in digital transformation serves as a compelling blueprint for countries in the Global South. Prime Minister Narendra Modi's vision of "Sabka Saath Sabka Vikas" (leaving no one behind) has guided India's Digital India initiative. Despite initial challenges, particularly limited internet access in rural areas, India has made significant progress. Through initiatives

like BharatNet, which has woven a vast digital network across rural India, and the widespread adoption of affordable smartphones, the nation has made remarkable strides in bridging the digital divide. Furthermore, India enjoys some of the cheapest mobile data plans globally. The average cost of 1 GB of mobile data sits at a mere ₹13.98 (as of 2023) (Das, 2023). This affordability has been instrumental in propelling mobile internet adoption across the country. The result? Millions of Indians are now connected, empowered, and able to participate fully in the digital economy.

Figure 4: Challenges Associated with the Development/Deployment of DPIs

 Inadequate infrastructure Countries with inadequate infrastructure face challenges in providing reliable connectivity, high-speed internet access, and power supply for IT implementation. Globally, in 2018, there were 83 active mobile broadband subscriptions per 100 inhabitants, and the number was lower in developing countries and the least developed countries at 75 and 33, respectively.	 Digital governance and policy Creating frameworks for data governance, digital identity management, and open data initiatives can be complex tasks for countries. Out of 166 countries, 24 percent government organisations were classified as digitally advanced, delivering against transformation-focused digital initiatives.
 Affordability and digital inclusion High costs associated with IT hardware, software, and internet services can limit digital advancement. In Argentina, Colombia, Ghana, Guatemala, Paraguay, Peru and Rwanda, more than half the households limit their internet use due to its costs.	 Scalability and sustainability Digital technologies are responsible for 3.7 percent of global Green House Gas emissions. Implementing IT solutions at a national or large scale level requires careful planning for scalability and long-term sustainability.
 Digital skills gap Countries often face a shortage of skilled IT professionals who can drive technology initiatives and effectively manage IT systems. The percentage of the population with basic computer skills is 46 percent in developing countries and 65 percent in developed countries.	 Privacy and data protection As digital technologies collect and process vast amounts of personal data, ensuring privacy and data protection becomes crucial. Only 137 out of 194 countries had implemented legislation to secure data and privacy.
 Cybersecurity As countries embrace digital technologies, the risk of cyber threats increases. North America is the most impacted region, experiencing 33.5 percent of the total cyber issues reported, followed by Asia-Pacific at 23.5 percent, and Europe at 20 percent.	 Vendor lock-in and dependency Over-reliance on a single technology vendor or proprietary solutions can limit flexibility, competition, and hinder innovation. Over 80 percent enterprises expressed notable levels of apprehension regarding being locked to a single public cloud platform.
 Interoperability and standardisation The presence of restricted interoperability, such as a closed API, can act as a significant obstacle to entry into a market. In this scenario, a company would typically be required to provide users with a comprehensive range of services offered by the dominant player to effectively compete with their closed system.	 Integration of emerging technologies The adoption of emerging technologies, such as AI, blockchain, Internet of Things (IoT), and cloud computing presents both opportunities and challenges. Approximately 89 percent companies, are facing significant obstacles in integrating new technologies and solutions, which is impeding their efforts towards digital transformation.

Source: The DPI approach: A playbook (United Nations Development Programme, 2023).

To optimise the benefits of DPIs, countries could emulate India's multifaceted approach. This includes not only investing in robust digital public infrastructure but also promoting digital literacy, attracting private investments, ensuring affordability and accessibility of digital services, fostering R&D initiatives, and prioritising workforce upskilling. Such comprehensive efforts, intertwined with resilience and innovation, serve as a roadmap for nations in the Global South, showcasing the boundless possibilities of digital transformation in bridging societal gaps and uplifting communities.

Role of DPI and DPG in Digital Transformation

Definition and Conceptual Framework

At its core, DPI, as defined by the Centre for Digital Public Infrastructure, is a set of interoperable technology building blocks.³⁴ These blocks function under a framework of open standards and specifications. This open and transparent approach fosters innovation, inclusion, and competition at scale. Governments establish enabling rules to guide the development and utilisation of DPI.

The G20 Summit in Delhi (September 2023) further emphasised DPI as...a set of shared digital systems that should be secure and interoperable and can be built on open standards and specifications to deliver and provide equitable access to public and/or private services at societal scale and are governed by applicable legal frameworks and enabling rules to drive development, inclusion, innovation, trust, and competition and respect human rights and fundamental freedoms. The G20 acknowledges the evolving nature of DPI, recognising that specific country contexts might require tailored approaches and terminology. While a regular digitalisation effort may adhere to one or more of the following principles, it must fulfil all five in order to be considered DPI—interoperability, modularity and

³⁴ As defined by UNDP, these are reusable components—software code, platforms, and applications, which help scale basic digital services. They connect multiple digital services and enable large-scale interoperability. The GovStack Initiative reviews digital solutions to certify them as building-block compliant and develops technical specifications for building blocks. The multiple digital systems of a country's DPI can be connected via common protocols, standards, and applications to achieve unification and streamline access. Building blocks help to achieve this as they are reusable components, making services accessible on a decentralized, population-scale network.

extensibility, scalability, federation, and security and privacy (UNDP, 2023). India’s India Stack serves as a real-world example of DPI in action. This interoperable digital building block utilises open standards and specifications. Institutions and organisations leverage the India Stack to offer various services. The Stack’s three interconnected layers provide a digital identity for every Indian citizen and facilitate easy, cost-free, mobile-first digital transactions.

Defining Digital Public Goods

The UN Secretary-General’s Roadmap for Digital Cooperation defines Digital Public Goods (DPGs) as:

Open-source software, open data, open artificial intelligence models, open standards and open content that adhere to privacy and other applicable international and domestic laws, standards and best practices and do no harm. They should be aligned with achieving the United Nations’ 2030 Sustainable Development Goals (SDGs).

Table 2: Indicators that Determine the Qualification as a DPG

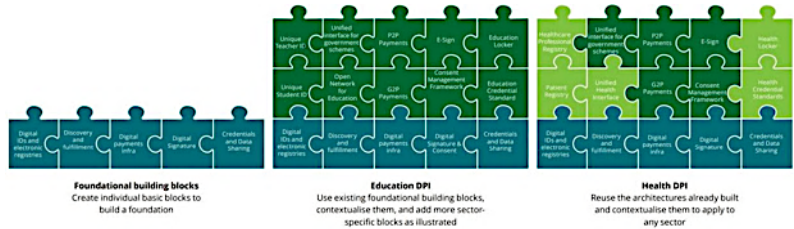
Indicators that Determine the Qualification as a DPG	
1. Relevance to Sustainable Development Goals	7. Adherence to Privacy and Applicable Laws
2. Use of Approved Open Licenses	8. Adherence to Standards & Best Practices
3. Clear Ownership	9. Do No Harm by Design
4. Platform Independence	9.a) Data Privacy & Security
5. Documentation	9.b) Inappropriate & Illegal Content
6. Mechanism for Extracting Data	9.c) Protection from Harassment

Source: UN Secretary-General’s Roadmap for Digital Cooperation.

The UN Secretary-General’s Roadmap for Digital Cooperation outlines nine indicators and requirements to determine if software, data, AI systems, or content collections qualify as

digital public goods. DPGs adhere to the principles of accessibility, affordability, and adaptability, serving as essential components in the development and deployment of DPI. There are two main approaches to constructing a Digital Public Infrastructure (DPI) layer. The first involves using or building proprietary components. This method, however, can be expensive due to high initial costs and ongoing maintenance fees. Additionally, it can lead to vendor lock-in, where dependence on a single supplier limits flexibility and potentially increases costs in the long run. This approach can hinder the long-term sustainability of the DPI layer.

Figure 5: Approach to Build DPIs



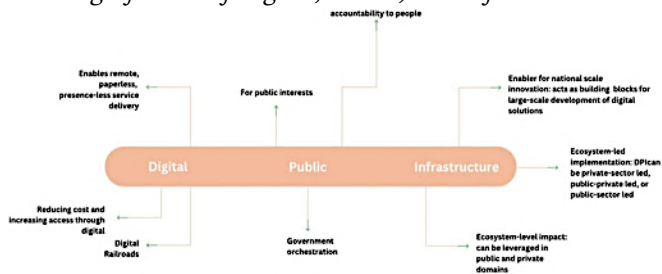
Source: *DPI playbook for nations* (Deloitte India, 2023).

An alternative approach focuses on leveraging Digital Public Goods (DPGs) or open-source solutions. These readily available resources encompass software, protocols, standards, and specifications. By utilising these resources to build the DPI layer, several challenges are addressed. Security concerns are mitigated as open-source solutions are often rigorously vetted by the community. Scalability is enhanced due to the inherent flexibility of open-source tools. Furthermore, this approach promotes cost-effectiveness by reducing dependence on expensive proprietary solutions and vendor licencing fees. Ultimately, leveraging DPGs and open-source solutions fosters the long-term sustainability of the DPI layer by minimising reliance on external factors and vendors (Deloitte India, 2023).

Unbundling DPI: Digital, Public, Infrastructure

The “digital” component of DPI encapsulates the technological aspect of this infrastructure, emphasising the digitisation of services and systems to enable seamless access and interaction in the digital realm. By harnessing digital innovations such as cloud computing, artificial intelligence, and blockchain, DPI transforms traditional service delivery models into agile, user-centric platforms capable of addressing diverse needs. The digital nature of DPI ensures that services are accessible anytime, anywhere, empowering individuals and organisations to engage in a digitally connected ecosystem.

Figure 6: Significance of Digital, Public, and Infrastructure



Source: *The DPI approach: A playbook* (UNDP, 2023).

Public

When we talk about Digital Public Infrastructure (DPI), we are not just talking about any digital system. Take Google and Facebook, for example. They are undeniably part of our daily lives, connecting us with information, friends, and family. But are they truly “public”? Defining “public” in the context of DPI is tricky. It is not enough for a platform to be widely used or technologically advanced—it needs to serve the public good. Google, with its vast search engine and wealth of information, provides access to knowledge and empowers individuals to learn and explore. Yet, concerns about data privacy and targeted advertising raise questions about whose interests are truly being

served. Similarly, Facebook connects billions of people worldwide, fostering community and enabling global conversations. But the issues of misinformation and its opaque algorithms have led to criticism and calls for greater transparency. So, while these platforms do provide undeniable benefits, their status as true DPIs is up for debate. Therefore, perhaps DPIs should be those platforms that are created truly and solely for the good of the public, without other interests coming into play.

Public value creation is not just about measuring the benefits to society; it is about how those benefits are achieved. Who controls the platform? Who sets the rules? Who ensures that the system works for everyone, not just the platform's owners or advertisers? Traditionally, we have framed the debate as a battle between the public and private sectors (Mazzucato and Ryan-Collins, 2022). But the reality is far more nuanced. Public value is not created in a vacuum; it is a collaborative effort (Mazzucato, 2016). Governments, businesses, and civil society organisations all play a role in shaping the digital landscape. To truly maximise public value, we need to move beyond a competitive mindset and embrace a collaborative one. This means bringing together diverse perspectives, expertise, and resources to design, implement, and manage DPIs that serve the common good (Mazzucato and Kattel, 2019).

While the debate over what makes digital infrastructure truly “public” continues, two main approaches have emerged (Buhr, 2003; Frischmann, 2012). One focuses on the technical attributes of DPI, emphasising things like open standards and reusable components. This perspective sees DPI as a system to drive innovation, efficiency, and scalability. The other takes a more functional view, focusing on the societal purposes DPI serves, like empowering citizens, entrepreneurs, and consumers to fully participate in the digital age. This view prioritises the social and economic value that DPI can create, along with its potential to enhance human capabilities and protect fundamental rights. However, both approaches have a blind

spot. They tend to overlook the crucial role of governance and the state in maximising public value. It is not just about the technology itself; it is about how it is managed and whom it serves. To truly harness the potential of DPI, we need clear governance structures and an active role from the state to ensure that the infrastructure benefits everyone, not just a select few.

Figure 7: Framework to Understand Publicness in DPI

	Framings for publicness	Implicit normative values	Mechanisms for value creation
Attributes	Be interoperable through open standards	Dynamic efficiency and scale	Open and interoperable standards prevent lock-in, and thus improve and increase and shape competition
	Be built using reusable building blocks	Dynamic efficiency and scale	The more digital infrastructure can be reusable, the higher network effects and combinatorial innovation
	Be built using open-source licenses (or be unlicensed and in the public domain)	Efficiency and scale	Digital infrastructure with open-source licenses or in the public domain generates positive externalities through adoptability, adaptability and prevention of lock-in
Functions	Foster community and social relationships	Social value	DPI resources in the context of social infrastructure can foster inter- and intra-communal relationships
	Foster economic activity	Economic value	DPI can improve financial inclusion and mobilise the potentialities of economic agents
	Guarantee essential capabilities	Capabilities and human rights	DPI can create the capabilities for individuals, businesses and agents of society to participate and thrive in all dimensions of their lives
	Guarantee better quality of life	Essential Needs and Human Rights	DPI can guarantee the essential needs for human life, enhancing the overall well-being and happiness of the population, including considerations such as healthcare, education, and cultural enrichment.

Source: Eaves et al. (2024).

This is where the conversation gets interesting. It is not just about building the digital equivalent of roads and bridges; it is about creating a digital landscape that reflects our values, priorities, and aspirations as a society. It is about using technology to empower individuals, strengthen communities, and create a more equitable and sustainable future for all.

Infrastructure

Digital Public Infrastructure (DPI) builds upon the legacy of traditional infrastructure systems like transportation networks, electrical grids, and telecommunications. These established systems have played a pivotal role in economic, social, and political progress by enabling the creation and delivery of a vast array of public and private goods.

Brett Frischmann defines infrastructure as “shared means to many ends” (Frischmann, 2012). This provides a valuable starting point for understanding DPI. This concept goes beyond just physical infrastructure like roads and bridges; it encompasses the entire ecosystem of shared resources, including social, institutional, and—crucially—digital elements. Furthermore, it highlights two key aspects of infrastructure: (a) the communal use of infrastructure (“shared means”) and (b) its diverse range of potential applications (“to many ends”).

Frischmann proposes three criteria for infrastructure:

1. **Non-rivalrous Consumption:** The resource can be consumed by multiple users without diminishing its availability for others, within a reasonable demand range. For example, roads are non-rivalrous up to a point, but with excessive traffic, congestion can limit everyone’s ability to use them effectively. Similarly, digital infrastructure with limited storage or processing power becomes non-rivalrous only to a certain extent.
2. **Input for Downstream Activities:** Infrastructure serves as a “means” in economic terms, acting as an input for various productive activities.
3. **Versatility:** Infrastructure has a general purpose, meaning it can be used for a broad range of goods and services, including private, public, and social goods.

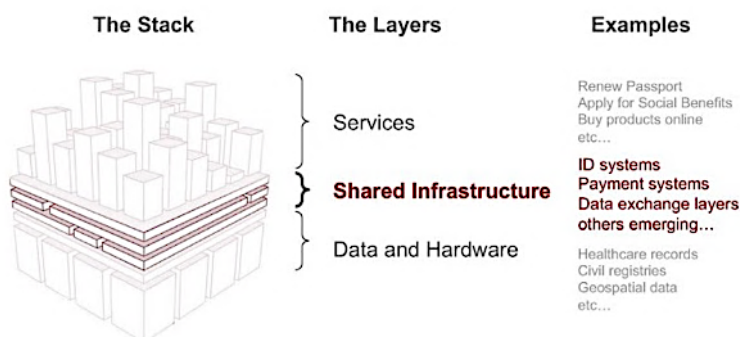
When discussing digital infrastructure, there are diverse perceptions. Some associate it solely with physical components like internet cables and data centres while others include

software and protocols like those enabling internet connectivity. The internet exemplifies digital infrastructure's transformative power, offering universal access for a multitude of activities ranging from communication to commerce. While the governance of this infrastructure is both contested and evolving, there is a broad consensus that both the pipes and protocols of the internet are a form of infrastructure. Understanding infrastructure as a digital stack, where each layer builds upon and interacts with others, is crucial.

Figure 8: The Digital Stack and Its Layers

Source: Eaves et al. (2024).

Essentially, this concept illustrates that each layer within the



stack is intricately linked to those above and below it, with upper layers capitalising on the resources generated by lower layers. The infrastructure layer has the shared resources that connect the data and hardware layers to the diverse services and applications that emerge at the top. This layer ensures seamless data flow and efficient hardware utilisation for public services. For example, a core component of the DPI stack might be a national digital identity system. This system (infrastructure layer) acts as a shared resource, allowing citizens to securely access various public services (upper layers) like healthcare portals, online tax filing, or social security benefits—all built upon the foundation provided by the digital identity system. By

functioning as a layered stack, DPI facilitates the development of a wide range of public services that cater to the needs of all citizens. Each layer builds upon the previous one, fostering innovation and expanding the possibilities for digital public services.

Design Principles of DPI

Digital Public Infrastructure (DPI) can take on various forms, but all successful implementations share a core set of design principles. These principles ensure that DPI fosters trust, safety, inclusivity, and accessibility for all citizens.

Technology Design

DPI adopts an infrastructure-like approach, serving as a foundational layer to support a diverse array of digital services and applications. Within this approach, the following principles play a key role:

1. **Foundational:** DPI operates on the principle that it should serve as a foundational layer upon which a multitude of digital services can be built and accessed by anyone without permission. This foundational aspect enables the creation of interoperable building blocks, comprising software code, platforms, and applications that offer basic digital services at scale and can be reused across various contexts and use cases. These building blocks are designed to be autonomous, generic, and interoperable, allowing for continuous improvement while being utilised as part of broader solutions.
2. **Interoperability:** A fundamental characteristic of DPI is interoperability, enabling different digital systems and software to effectively communicate, exchange data, and utilise shared information. Interoperability fosters seamless integration and collaboration among diverse digital platforms, enhancing the overall efficiency and accessibility

of DPI.

3. **Scalability:** DPI prioritises scalability, ensuring that digital systems can efficiently handle high volumes of transactions and interactions without compromising performance, reliability, or security. Scalability is essential for accommodating extensive usage and the evolving needs of users over time.

Governance

Effective governance is the linchpin that holds the entire Digital Public Infrastructure (DPI) ecosystem together. It is the framework of rules, policies, and practices that ensure these powerful digital systems are used responsibly, ethically, and for the greater good. Without strong governance, even the most well-intentioned DPI can go astray, exacerbating existing inequalities or falling prey to misuse.

The stakes are high. Consider India's Aadhaar system. While a marvel of technological innovation, its use has raised concerns about privacy, exclusion, and the potential for misuse. In Kenya, similar issues have arisen, with instances where identification errors have prevented migrants and refugees from receiving social security benefits. This highlights the need for vigilant oversight and proactive measures to protect the rights and interests of all citizens.

So, what does good governance look like in the digital age? Effective governance of digital infrastructures requires setting appropriate guardrails to prevent misuse while ensuring that these systems contribute positively to public welfare. Here are key considerations for strong DPI governance:

1. **Alignment with Democratic Principles:** The governance framework should be aligned with democratic principles and incorporate institutionalised mechanisms for public involvement. In simpler terms, good governance implies that DPI is overseen by democratic institutions, with clear

guidelines and regulations.

2. **Inclusivity:** A core principle of DPI is ensuring user-friendly, widely available, and inclusive platforms and systems. This ensures that all citizens, irrespective of their digital literacy levels, can benefit from these services.
3. **Enabling Rules and Frameworks:** The implementation and operation of DPI are governed by enabling rules and frameworks encompassing policies, regulations, standards, and guidelines. These mechanisms govern various aspects of DPI, including usage, security, privacy, and ethics, ensuring adherence to established principles and promoting the responsible deployment of digital infrastructure.

Community Accountability

Public oversight is essential to guarantee that Digital Public Infrastructure (DPI) remains inclusive, interoperable, and serves the public good. Effective governance models for DPI prioritise a “whole-of-society” approach (Neto, 2024) by actively involving diverse stakeholders. This includes citizens, civil society organisations, national and local leaders, businesses, digital innovators, and government agencies. This collaborative approach fosters both accountability and transparency within DPI development and implementation. Governments responsible for DPI oversight must establish mechanisms—through ownership structures, regulations, policies, or laws—to enforce accountability and safeguard the public interest in digital infrastructure.

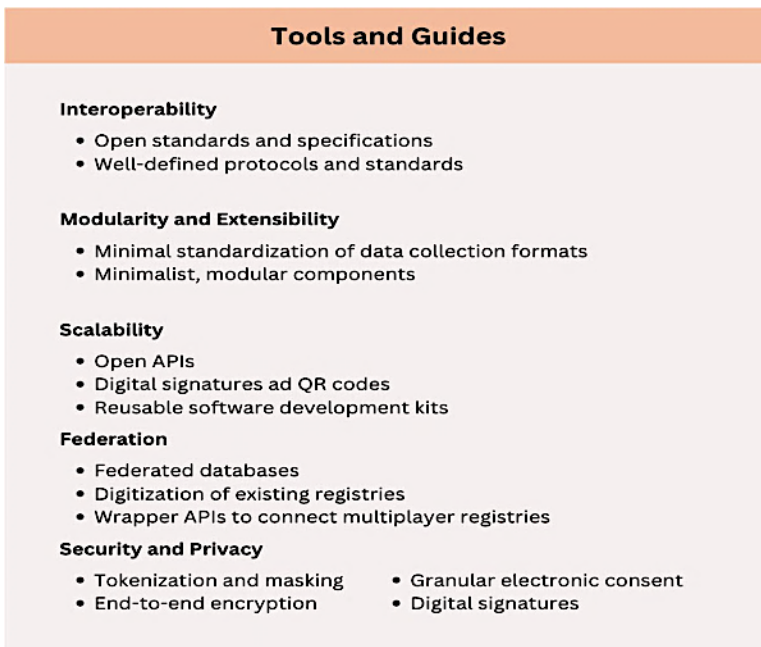
When technologies are designed and deployed through open consultations with both directly and indirectly impacted stakeholders, and with a focus on empowering vulnerable populations, the outcomes are demonstrably better. This approach ensures that the technology is:

1. **Context-Appropriate:** The technology aligns with the specific needs and circumstances of the community it serves.

2. **Locally Sustainable:** Local stakeholders gain the skills and knowledge to manage the technology effectively, ensuring its long-term viability.
3. **Empowering:** The technology promotes a more equitable distribution of power within the community.

By prioritising stakeholder engagement and focusing on inclusivity and empowerment, DPI governance can ensure that digital infrastructure serves the public good and does not exacerbate existing inequalities.

Figure 9: Tools for Operationalising the Design Principles of DPI.



Source: DPI playbook for nations (Deloitte India, 2023).

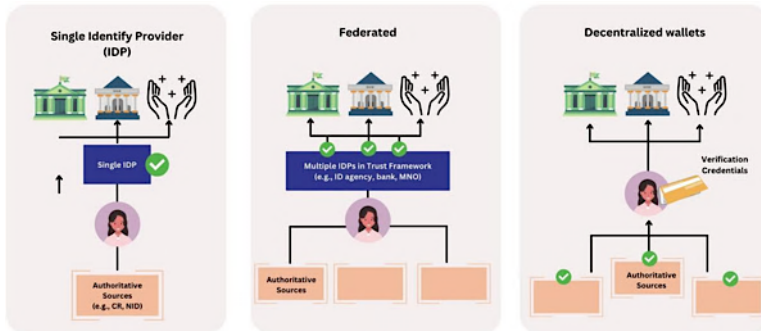
Foundational DPIs

For countries to achieve seamless, user-friendly, and secure digital interactions, they need a strong foundation of interconnected digital systems (The World Bank, 2022). These systems, working together, should promote secure authentication (both online and offline) of identities and data, enable rapid and secure payment flows, and facilitate responsible data exchange between different systems and databases. While the specific design and architecture of these systems will vary depending on each country's context, this section provides a brief overview of the core components—the Foundational DPIs—that underpin the essential functionalities and benefits of DPI.

Digital Identity

Digital identity serves as the cornerstone of DPI, enabling the validation of credentials and establishing trust in transactions (e.g., Aadhaar in India). In today's globalised and digital era, inclusive and user-friendly digital ID systems are essential for individuals to securely prove their identity both in-person and remotely. Such systems streamline processes like bank account opening, loan applications, and social protection programmes, while also enhancing the management of health and education records. India's Aadhaar system, which provides digital identity to over 1.3 billion people, exemplifies the deployment of identity systems at a population scale, ensuring widespread access and trust.

Figure 10: Different Digital Architecture.



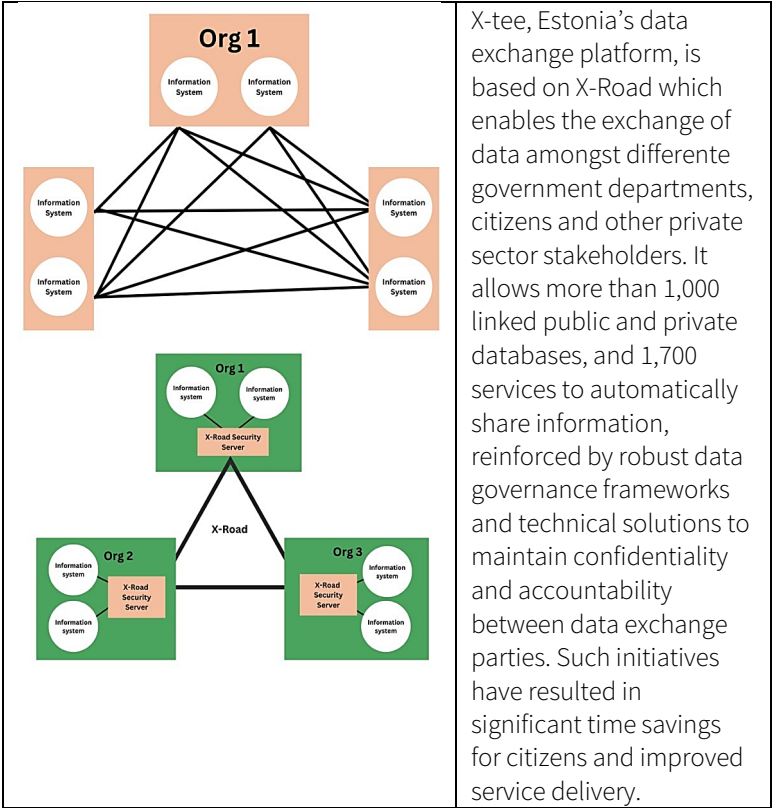
Source: The World Bank (2022).

Digital Payments

Digital payments are a critical component of Digital Public Infrastructure (DPI), facilitating seamless and secure transactions that empower individuals and businesses. By transitioning from paper cash to digital transactions, various benefits emerge, such as improved accessibility, convenience, and efficiency in making payments. One of the transformative impacts of digital payments is evident in the realm of remittances, where migrants can now send funds to their families instantly, overcoming barriers associated with traditional banking hours or geographical limitations. Furthermore, digital payments play a crucial role in government-to-person (G2P) payments, including social assistance programmes, wages, and pensions, enhancing financial inclusion and efficiency in disbursing funds. However, for digital payments to thrive within DPI, robust physical and financial infrastructures are necessary. This includes investments in IT and communications infrastructure, as well as specialised financial infrastructures like settlement services and clearinghouses. Fast payment systems that enable real-time transactions are also integral to supporting seamless financial transactions. While the adoption of digital payments has seen

significant progress, challenges remain, such as limited access to financial accounts and the need for enhanced account and payment instrument design. Ensuring readily available access points and expanding interoperable financial services are essential steps toward deepening financial inclusion and maximising the benefits of digital payments within DPI.

Box 1: Estonia’s X-tee Data Exchange Platform



Data Exchange

Trusted data exchange is a critical aspect of Digital Public Infrastructure (DPI) that facilitates efficient, secure, and

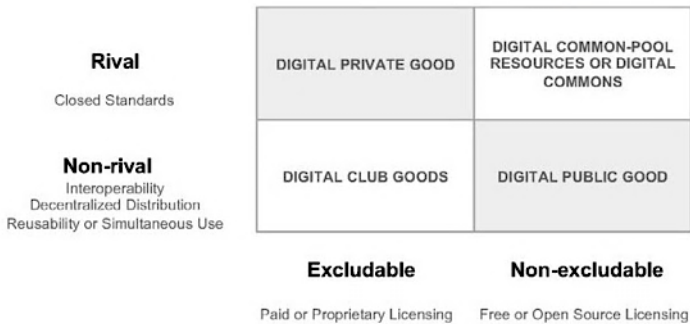
seamless interactions within digital ecosystems. It involves the secure sharing and federating of information among various databases, systems, and devices, both within organisations and across different entities. This data exchange layer enables governments, businesses, and individuals to exchange data and queries effectively, contributing to improved governance, better-informed policy-making, and inclusive decision-making processes. The technology behind trusted data exchange includes various elements such as Application Programming Interfaces (APIs), web services, service buses, cloud services, and wired connections. These components work together to ensure that different systems and services can interoperate and exchange data seamlessly. Effective data exchange is not just about technology; it also encompasses standards, processes, regulations, and institutional arrangements that promote interoperability while maintaining security and accountability.

DPI is dynamic in nature; more categories may evolve as technologies mature and become core systems, such as “Discovery and Fulfillment” and “Geospatial DPI.”

Foundational DPIs as DPGs

In the realm of digital infrastructure, a significant transformation is underway as DPIs can be seen evolving into DPGs. An exemplary illustration of this evolution is India’s Aadhaar digital identity system, initially conceived as a DPI but now reimagined into the Modular Open-Source Identity Platform (MOSIP) as a robust DPG. MOSIP inherits the foundational capabilities of Aadhaar while embracing open-source principles, making it adaptable and customisable for various countries and contexts. This flexibility is evident in its adoption for national digital ID programmes like Ethiopia’s National ID and the Philippines’ ePhilID.

Figure 11: The Four Types of Economic Goods in the Digital Space



Source: Eaves et al. (2024).

Furthermore, examining DPIs and DPGs from an economic standpoint sheds light on their potential as public goods. Public goods are characterised by attributes like non-excludability and non-rivalry. In the digital realm, a good becomes a public good (an impure one) when it is universally accessible, built with interoperable standards, and uses open-source software. However, it is important to remember that open source alone is not a magic bullet. Factors like code quality, documentation, and governance models also play a crucial role in ensuring the long-term success and wider adoption of DPGs.

Benefits of Digital Public Infrastructure

Figure 12: Potential Benefits from the Usage of DPIs



Source: Clark and Marin (2023). DPI workshop: Why this matters.

Enhancing Service Delivery

Millions of individuals worldwide face challenges accessing their rights and essential services, while governments and businesses struggle with efficient service delivery and secure operations, especially in an increasingly digitalised environment. One of the key contributing factors to these challenges is the lack of inclusive, trusted, and digital systems for identity verification, data sharing, and payments.

For example, a significant portion of the global population lacks access to digital identification or bank accounts, leading to difficulties in accessing services and economic opportunities. Moreover, existing personal records and data are often insufficient or inaccurate, resulting in time-consuming and insecure methods for verifying identities and personal information. This situation is further exacerbated by poor data protection measures and a high incidence of identity theft, adding to operational costs due to reliance on in-person, cash-based processes. Digital Public Infrastructure (DPI) has emerged as a game-changer in addressing these challenges by empowering governments to deliver essential services efficiently and securely while reducing errors and fraud. A notable example is Estonia's X-Road digital infrastructure, which has enabled the government to provide 99% of public services online. This streamlined approach includes processes like tax filing in under five minutes and business registration in just three hours.

Similarly, in India, the adoption of Direct Benefit Transfer (DBT) mechanisms has led to significant improvements in service delivery and reduced leakages and corruption in social safety net programmes. It consolidates and controls data from multiple sources for 310 different government schemes managed by 53 ministries. Through DBT, government benefits are directly transferred to bank accounts, leveraging features linked to Aadhaar for secure and transparent transactions. The Government of India estimated that up to March 2021, the

government saved about 1.1% of GDP due to the DBT and other governance reforms. Most of the savings are attributed to the elimination of duplicate, non-existent, and ineligible beneficiaries.

Table 3: Estimated Savings from DBT and Related Reforms (up to March 2021).

Ministry/Department	Scheme	Savings (in billion Rs.)	Savings (in percent of GDP)
Department of Fertilizers	Fertilizer	100	0.05
Department of Rural Development	MGNREGS	335	0.17
Department of Rural Development	NSAP	5	0.00
Ministry of Women and Child Development	Others	15	0.01
Ministry of Petroleum and Natural Gas	PAHAL	729	0.37
Department of Food and Public Distribution	PDS	1016	0.52
Ministry of Minority Affairs	Scholarship scheme	14	0.01
Department of Social Justice and Empowerment	Scholarship scheme	3	0.00
Others	Others	12	0.01
Total		2230	1.14

Source: The World Bank (2022).

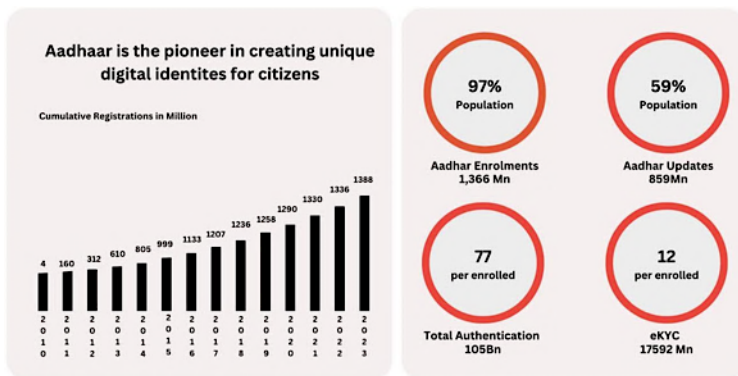
Ministry of Finance data indicates that 54% of DBT payments are now channelled through Aadhaar-linked accounts, ensuring greater accountability and efficiency in welfare distribution. DBT is also used for transfers of benefits in kind (e.g., the PDS); in this instance, Aadhaar authentication is used to access subsidised grains.

Promoting Inclusive Growth

DPI fosters sustainable and inclusive economic growth by democratising access to digital services and financial resources. In India, the adoption of DPI components, such as digital identity systems and payment platforms, has led to a significant increase in bank account ownership among adults, particularly women. According to recent data from the World Bank, the percentage of adults with bank accounts in India more than doubled, from 35% to 78%, within a little over 10 years after launching its digital identity system. Much of that growth occurred between 2014 and 2017 as a result of a government

programme that began in 2014 and provided unbanked adults with a financial account leveraging an official government identification document.

Figure 13: Trends in Aadhaar Penetration in India.



Source: *The DPI approach: A playbook* (UNDP, 2023).

Notably, women's account ownership grew even faster, soaring from 26% to an impressive 78% during the same period. This substantial increase in financial inclusion reflects the transformative impact of DPI on narrowing the gender gap and extending financial services to previously under-served populations.

Fostering Innovation and Entrepreneurship

DPI acts as a catalyst for innovation and entrepreneurship. Businesses of all sizes benefit from a level playing field where they can compete and reach new customers. Start-ups can leverage DPI to build innovative applications and launch thriving ventures. According to the Bill and Melinda Gates Foundation, DPI could unlock access to capital for 16 to 19 million micro and small businesses globally, propelling sustained growth.

Figure 14: Private Players and Start-Ups Creating Solutions for Unique Problems Using DPIs



Source: Report on India’s digital public infrastructure by NASSCOM and Arthur D Little (2024).

India’s robust DPI ecosystem, often referred to as “India Stack,” has fostered numerous successful businesses. Digital-only stockbrokers utilise the identity and payment layers of the India Stack to provide seamless onboarding experiences, attracting a new generation of investors. The potential for innovation multiplies as the number of DPIs increases. Imagine combining e-signatures, digital KYC (Know Your Customer), and secure document storage platforms like DigiLocker. This opens doors for new insurance companies to offer streamlined services without physical interaction with customers. Additionally, the Bhashini platform, a national language translation DPI, addresses communication barriers for India’s diverse population. This fosters greater access to digital tools for underserved communities.

Box 2: France's Health Data Hub

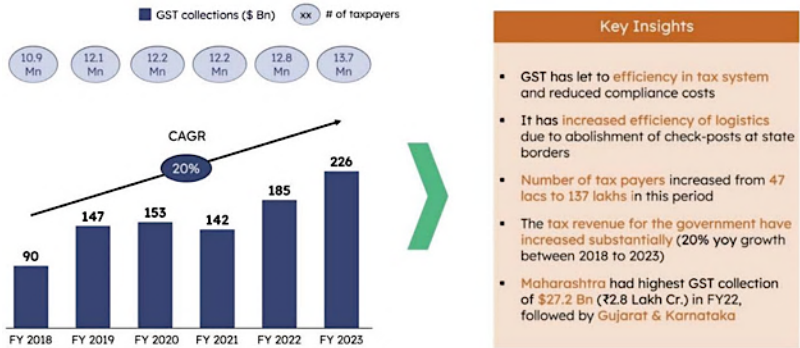
France's Health Data Hub exemplifies a Digital Public Infrastructure (DPI) in the health-care sector. This centralised platform consolidates administrative health data from diverse sources, including hospitals, insurance providers, and research institutions. With over 1,600 projects supported to date, the hub has proven its value in fostering health-care innovation and improvement. The Health Data Hub's strength lies in its commitment to interoperability, achieved through the use of international standards. This enables seamless integration with external databases, expanding the scope and potential applications of the data. While secure authorisation is required for certain sensitive datasets, a significant portion of the data, including information on medication usage and health insurance expenditures, is openly accessible through APIs (Application Programming Interfaces). This open access approach promotes transparency and encourages collaboration among researchers, health-care providers, and policymakers. Furthermore, the Health Data Hub actively supports a vibrant community of open-source developers who create tools for analysing and utilising the platform's data. This collaborative environment fosters innovation and ensures that the data is leveraged to its fullest potential.

Strengthening Governance and Accountability

In India, initiatives like Aadhaar and the Goods and Services Tax Network (GSTN) have revolutionised tax administration and compliance activities, enabling seamless registration, filing, and payment processes. Aadhaar's biometric authentication and PAN linkage have significantly reduced tax and financial fraud, while the GSTN has streamlined tax collection across states, reduced corruption, and improved transparency through open APIs and invoice-level data sharing. Furthermore, DPI facilitates real-time monitoring and public scrutiny of government initiatives, as demonstrated by the Biometric Attendance System, which enables citizens to track government employee

attendance and pension disbursements in real time, fostering accountability and trust in public institutions.

Figure 15: Impact of Deployment of GSTN on the Economy



Source: The DPI Approach – A Handbook, UNDP 2023

Box 3: mWater: An Open Source Software Platform

mWater, an open-source software platform, is a vital tool for tracking real-time water data, including crucial information on water quality, supply, and sanitation. As one of the most widely adopted platforms in its sector, with over 100,000 accounts in 184 countries, mWater is already making waves in water management.

By fostering data-driven decision-making, mWater acts as a Digital Public Infrastructure (DPI) that addresses various water and sanitation challenges. For example, in Haiti, over 60,000 water points have been mapped using mWater, promoting improved water governance and enabling targeted community- level interventions. To fully realise its potential as a DPI, mWater is enhancing interoperability by linking with other digital tools and technologies, allowing for seamless data sharing and collaboration. Additionally, mWater is focused on rapid scaling, ensuring its solutions can reach even more communities in need.

Challenges for DPI

Digital Divide and Accessibility

Despite the exponential growth in UPI-based payments, only 57% of individuals aged 15 and over have participated in digital transactions (PwC India, 2022). This discrepancy underscores the concentration of digital solution usage within specific demographic segments. According to data from the National Sample Survey in 2017–2018, only 38% of Indian households have at least one digitally literate member (Malotiya et al., 2023). The digital divide persists along gender, geographic, and income lines. For instance, digital literacy rates are over twice as high in urban areas (61%) compared to rural areas (25%) (Sabre India, 2024). Additionally, while 43.5% of urban men are proficient in internet usage, only 30.1% of urban women and 8.5% of rural women possess similar skills. The disparity is further exacerbated among older and lower-income individuals.

Data Privacy and Security Concerns

In 2021 alone, over 80 million Indian users were affected by data breaches (Business Today, 2021). These incidents, involving companies like Air India, Facebook, and Upstox, exposed sensitive personal information like phone numbers, bank details, and even Aadhaar data (Internet Freedom Foundation, 2021). The average cost of a data breach in India in 2021 amounted to US\$2.2 million, as estimated by IBM, highlighting the substantial financial implications of cyber risks. Such breaches not only erode trust but also discourage potential users from embracing digital solutions. Almost 50% of retail financial fraud arises from UPI. The ease of offering

financial services such as loans has also led to predatory lending to vulnerable people.

Funding and Sustainability

Governments play a crucial role in supporting Digital Public Infrastructure (DPI) projects throughout their lifecycle due to the substantial benefits they offer to residents and organisations across various sectors. However, despite this investment, scaling solutions beyond their own jurisdiction can be challenging for governments. They may encounter obstacles such as inflexible procurement processes, limited financial resources, wavering political will, and concerns regarding socio-political dynamics and data privacy risks. Adding to that, there are several challenges that hinder the sustainable implementation of DPIs, such as mentioned as follows:

- **High Initial Investment:** The development of robust DPI necessitates substantial upfront investments in infrastructure, technology, and human resources. This poses a considerable barrier for developing countries with limited financial resources.
- **Long-Term Maintenance Costs:** Ongoing financial commitments are essential for maintaining and upgrading DPI components. This includes addressing security vulnerabilities, adapting to technological advancements, and ensuring uninterrupted system functionality.
- **Uncertain Return on Investment (ROI):** Quantifying the ROI of DPI projects can be complex due to indirect benefits such as improved governance and economic growth. This uncertainty makes it challenging to secure long-term funding for DPI initiatives.

Figure 16: Potential Instruments for Financing DPIs

Financial Instrument	Merits	Challenges
Public budgets are sums of money allocated for public expenditure by a state entity	- backed by state policy - Steady flow and stable value - Subject to public security	- Influenced by changes in national priorities - Dependent on political buy-in
Grants are sums of money that are commitment based or philanthropic in nature	- Aligns DPI with welfare goals - Ideal for funding the R&D aspects of DPI - Often large amounts of money, with limited control over usage	- Unreliable for long-term financing as most grants are provided for a fixed period of the time with uncertain terms of renewal - Limited public accountability
Private Capital is a sum of money invested in an entity or infrastructure in exchange for ownership rights	- Possibility to raise more capital - Forges strategic partnerships with investors - Ideal for funding the R&D aspects of DPI	- Typically focused on short-term goals - Could create the micro-economic issue of principal-agent conflict
Debt is a sum of money borrowed for a fixed period of time, with accompanying interest payments	- Lowest risk for funder - Ownership rights remain with the entity/country	- Interest payments can cause fiscal burden - Restrictive terms of operation

Source: DPI playbook for nations (Deloitte India, 2023).

Figure 17: Merits and Challenges of Financial Instruments for DPIs

Non - Financial Instrument	Merits	Challenges
Capacity refers to the specific skills, insights or abilities that are supplied towards a goals/entity	Enable projects to benefit from the leadership of long term	Lack of monetary incentive makes it challenging to engage experts in the long-term
Shared resources refer to element to technology/DPG resource that are provided for mutual gains	Promote greater societal gains and richer innovation	Nature of partnership between private players and state uncertain
Volunteering refers to technical, pro-bono support provided by communities or collectives with subject matter expertise	- Promote contribution towards nation-building - Builds partnership and community value between technology developers and DPI thinkers	- Absence of funding relationship may generate conflict of interest - Lack of monetary incentive makes long-term engagement difficult

Source: DPI playbook for nations (Deloitte India, 2023).

Figure 18: Merits and Challenges of Non-financial Instruments for DPIs

INSTRUMENT	EXAMPLE
FINANCIAL	Public budgets  India's National Health Authority was allocated US\$41 million from the national budget in 2023-24 for the Ayushman Bharat Digital Mission . Within ten months of its nationwide launch, 20 government platforms and 32 private health applications were integrated and contributing to scaling the network.
	Grants  In response to a shift in geopolitical conditions in 2022, USAID contributed US\$25 million to further develop Ukraine's e-governance app, Dia . With support from the TAPAS project, Dia has been in development since 2019, and its first version was developed by EPAM, a private software firm. It has also seen varying contributions from UNDP Sweden, Swiss-funded EGAP, EU4Digital, and others over the years.
	Private capital  As of June 2023, 65 banks were shareholders of the NPCI, an umbrella organization that operates the Unified Payments Interface in India. There are currently 22 third-party applications developed by private sector firms for end-users to avail UPI for digital payments.
	Debt  The World Bank approved a US\$250 million loan to strengthen population and civil registration while increasing the usage of digital identification for service delivery in Indonesia.
NON-FINANCIAL	Capacity  The Pix Forum (for Brazil's digital payment system) comprises 200 participating institutions that serve as a permanent advisory committee, with representation from market players to Banco Central do Brasil, which is responsible for the management and operation of the payments ecosystem.
	Shared resources  GovTech , Singapore's implementing agency for its Smart Nation and Digital Government Office, is co-creating solutions with people by using their inputs at various stages of technology development. The Singapore government is estimated to spend US\$3.3 billion.
	Volunteering  In 2022, the Unique Identification Authority of India published a call for volunteers with expertise in technology and public administration to develop the Aadhaar ecosystem further. ISPT, a not-for-profit think tank also provides pro-bono support for service providers looking to make use of business opportunities provided by Aadhaar.

Source: *DPI playbook for nations (Deloitte India, 2023)*.

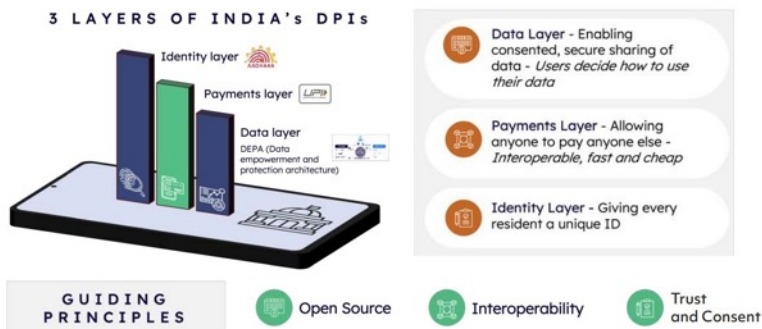
India's Digital Public Infrastructure

Central to India's digital transformative journey is the India Stack, a robust Digital Public Infrastructure aimed at empowering both citizens and businesses. This infrastructure is built on key components such as the Aadhaar digital ID system, Unified Payments Interface (UPI), Data Empowerment and Protection Architecture (DEPA), e-Sign, and DigiLocker. These interconnected layers allow seamless interactions between the public and private sectors, enabling them to develop services efficiently.

The India Stack has played a pivotal role in enhancing the delivery of public services and has brought about a significant transformation in the financial services domain. One of the key strengths of the India Stack is its ability to enable the creation of specialised sectoral frameworks.

Figure 19: India's DPI Layers

DPIs built layer by layer focusing on 3 core guiding principles



Source: *Report on India's digital public infrastructure by NASSCOM and Arthur D Little (2024)*.

India Stack represents a cohesive digital ecosystem that has not only streamlined processes but has also fostered a culture of

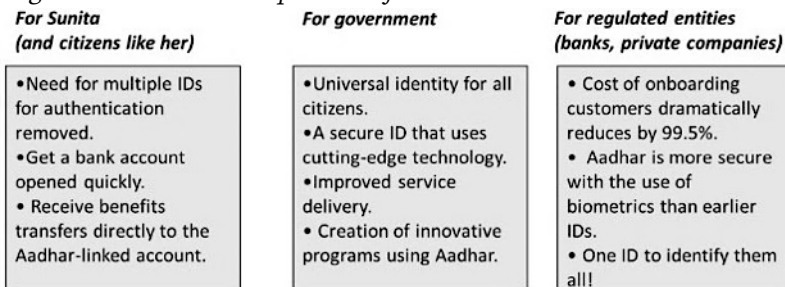
innovation and collaboration across different sectors, driving India's progress towards a more digitally inclusive future.

Aadhar: The Identity Layer

The Unique Identification Authority of India (UIDAI) was established with the objective of issuing a Unique Identification Number, known as Aadhaar, to all residents of India. This initiative, launched in 2009, has been a significant milestone in India's digital transformation. Aadhaar not only provides a digital ID but also allows online verification based on a combination of demographic and biometric data.

Prior to Aadhaar, obtaining formal identification documents like Proof of Identity (PoI) and Proof of Address (PoA) was a hurdle for many citizens, restricting access to essential financial products, mobile phone services, and government programmes. Traditionally, physical documents were the only verification method. Thankfully, Aadhaar now acts as a valid PoI and PoA across various sectors like banking, telecom, and government services.

Figure 20: The Value Proposition of Aadhaar



Source: eTrade for All. India's digital transformation could be a game-changer for economic development.

This unique biometric ID system empowers millions by simplifying access to government services and fostering

participation in private sector innovations. The versatility of Aadhaar extends beyond basic identification. Developers can leverage its functionalities to build secure identity workflows for various applications. For instance, a platform could restrict signup to women users only based on Aadhaar data, while another app could verify a user's address through e-authentication without revealing other personal details.

Box 4: The JAM Trinity

The widespread adoption of Aadhaar played a critical role in opening over 450 million bank accounts by 2022, many of them with a zero balance. This surge in financial inclusion was fuelled by Aadhaar's ability to streamline Know Your Customer (KYC) processes, making them faster and cheaper. Furthermore, Aadhaar facilitated the efficient transfer of more than US\$310 billion in direct benefit transfers to targeted recipients, minimising leakage and ensuring intended beneficiaries received the assistance.

This success story can be attributed in large part to a powerful collaboration known as the JAM trinity—Jan Dhan, Aadhaar, and Mobile. This innovative framework addressed the challenges of identification and delivery mechanisms for social welfare programmes built on DPI initiatives.

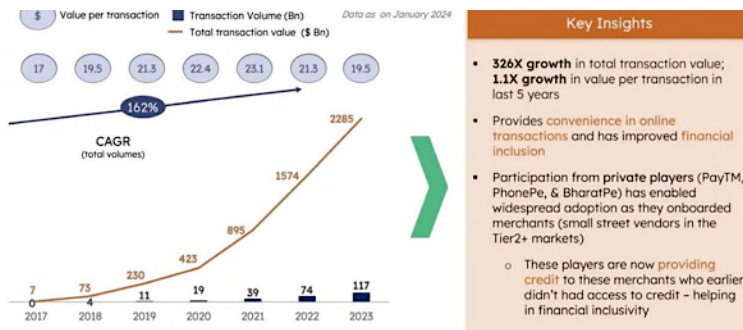
- Jan Dhan: The first pillar, Jan Dhan, is a financial inclusion initiative that broadens access to bank accounts and essential financial services for a wider population segment.
- Aadhaar: The second pillar, Aadhaar, provides a unique digital identification system. This enables efficient beneficiary identification and eliminates the risk of duplicate entries in social welfare programmes. Aadhaar plays a key role by linking bank accounts to unique ID numbers (Aadhaar Enabled Bank Accounts), forming the backbone for electronic channelling of government benefits.
- Mobile: The final pillar, Mobile, represents the vast network of over 960 million mobile phones in India. This robust network serves as a powerful platform for information exchange, particularly in rural areas. It also empowers households to utilise mobile apps for accessing their banking information and managing their finances conveniently.

Unified Payments Interface (UPI): The Payment Layer

Unified Payments Interface (UPI), introduced in 2016, is the most popular peer-to-merchant retail payment system in India. Developed collaboratively by the National Payments Corporation of India (NPCI) and various stakeholders, UPI democratised digital payments, transcending socio-economic barriers. It enabled inter-bank transactions through an instant process without requiring customers to enter recipient account details each time.

Unlike closed payment systems, UPI's open API architecture fostered innovation and interoperability, democratising access to digital transactions. Its mobile-first approach, coupled with the proliferation of smartphones and affordable internet, fuelled exponential growth in transaction volumes. In 2024, UPI processed a staggering 12.20 billion transactions worth ₹18.41 trillion, underlining its pivotal role in enhancing efficiency, financial inclusion, and formalisation of the economy.

Figure 21: Adoption Trends of UPI in India



Source: Report on India's digital public infrastructure by NASSCOM and Arthur D Little (2024).

Figure 22: The Value Proposition of UPI

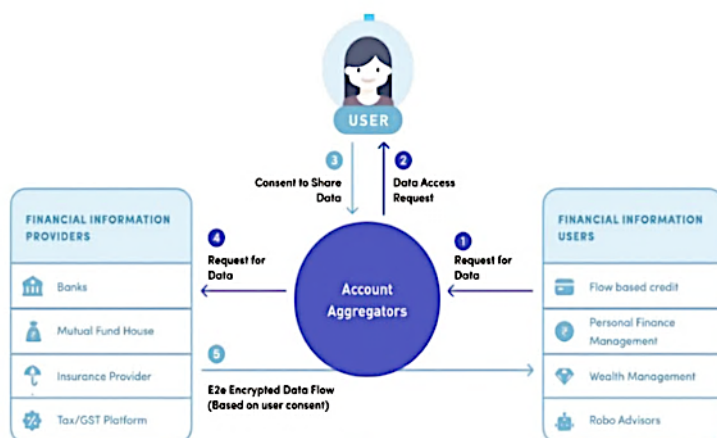
For Sunita (and citizens like her)	For government	For regulated entities (banks, private companies)
• Easy and no-cost system for any ticket size payment. • Innovative new financial products built on UPI. • Save time with interoperability between banks.	• Increased Financial inclusion. • Reduction in the informal economy. • Reduction of inefficiencies and corruption due to the usage of UPI over cash.	• Using UPI results in a reduction of business costs. • Opportunity to expand the business to new customers. • Create new businesses using the UPI ecosystem.

Source: eTrade for All. India’s digital transformation could be a game-changer for economic development.

Data Empowerment and Protection Architecture (DEPA): The Data Exchange Layer

India’s approach to data protection and empowerment diverges from conventional models, emphasising individual control over personal data. The Data Empowerment and Protection Architecture (DEPA) constitutes the third layer of India Stack, heralding a paradigm shift in data governance. DEPA introduces consent managers, known as Account Aggregators (AAs), tasked with facilitating secure and standardised data sharing across institutions. AAs empower individuals to control the flow of their data, catalysing innovation and trust in the digital ecosystem.

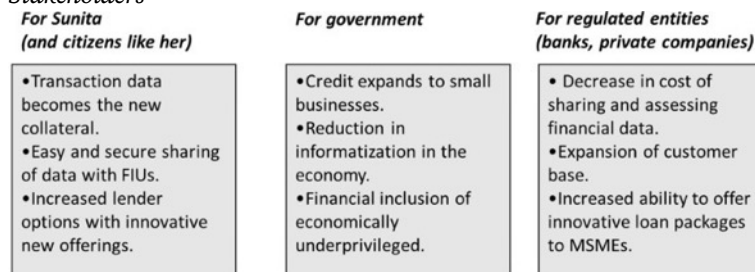
Figure 23: Structure of DEPA.



Source: NITI Aayog. (2020). *Data empowerment and protection architecture (DEPA)*.

With over 200 financial institutions integrated into the AA ecosystem, disbursing US\$750 million in FY2023, DEPA's impact on financial inclusion and credit accessibility is palpable. By democratising access to financial data and streamlining document sharing, DEPA paves the way for inclusive growth and innovation in India's digital economy.

Figure 24: Value Proposition of Account Aggregator for Different Stakeholders



Source: eTrade for All. *India's digital transformation could be a game-changer for economic development.*

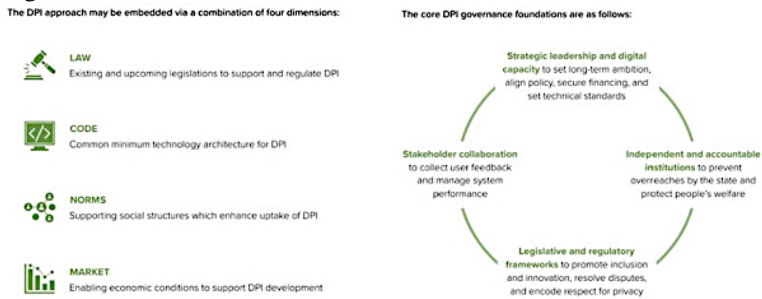
Figure 25: Overview of How DPGs and DPIs Have Been Deployed in India in Private and Public Sectors



Source: Report on India’s digital public infrastructure by NASSCOM and Arthur D Little (2024).

Governance Models for Digital Public Infrastructure

The potential of DPIs to transform societies is undeniable. However, to ensure this transformation benefits everyone and does not exacerbate existing inequalities, robust governance models are essential. These models act as a critical layer, ensuring all DPIs deliver on their promise and that the digital transformation is inclusive, respectful of rights, and protective of vulnerable populations.

Figure 26: Core DPI Governance Foundations

Source: *DPI playbook for nations* (Deloitte India, 2023).

Therefore, strong governance frameworks are needed to prevent DPIs from simply amplifying existing power structures and inequalities. These frameworks will guide the development, implementation, and use of DPIs to ensure they promote equitable access and participation in the digital world.

Government-Based Model

A compelling argument for a more proactive government role lies in fostering sovereignty—the ability to deliver public value and promote the common good. When governments outsource essential functions, they risk losing institutional memory and their long-term implementation capacity. Without state involvement in building DPIs, essential societal functions could become the exclusive domain of private corporations, potentially foreign-owned. This loss of control weakens a state's ability to safeguard the principles of the common good.

Figure 27: Principles of the Common Good



Source: Eaves et al. (2024).

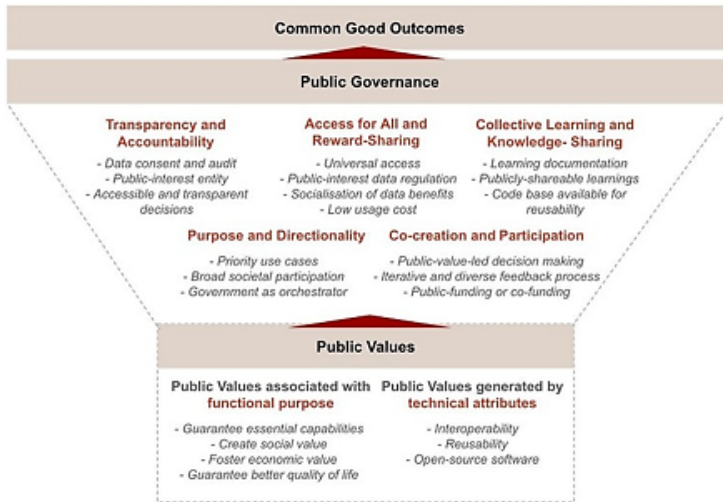
This vision does not advocate for complete government control of DPIs. However, maintaining a minimum level of internal capacity is crucial for effective regulation. Governments also play a critical role in setting the overall direction and fostering collaboration among diverse stakeholders (Eaves et al., 2024).

Eaves et al. (2024) emphasises that creating public value through DPIs is a collective endeavour. To achieve this, strong public governance structures are needed, focusing on five key pillars:

1. **Purpose and Directionality:** Setting ambitious goals for policies, public-private partnerships, and citizen engagement.
2. **Co-creation and Participation:** Establishing clear rules and mechanisms for diverse stakeholders to co-invest, collaborate, and coordinate effectively.
3. **Collective Learning and Knowledge-Sharing:** Encouraging institutional practices that promote shared learning and build long-term capabilities.
4. **Access for All and Reward-Sharing:** Ensuring equitable distribution of the benefits of DPIs (inclusive growth).
5. **Transparency and Accountability:** Building trust by demonstrating a commitment to transparency and

accountability through clear progress-tracking mechanisms.

Figure 28: Framework for Governing DPI for the Common Good.



Source: Eaves et al. (2024).

These pillars are interconnected. Maximising public value requires well-defined public values embedded within DPIs, translating these pillars into concrete governance practices and aligning them with clear societal goals (see Figure 28 for a visual representation).

A government-driven governance model, when implemented effectively, can ensure DPIs deliver on their promise. It necessitates a shift in perspective—from the state as a passive regulator to an active shaper of the digital landscape, working collaboratively with all stakeholders to create and share public value. This collaborative approach, guided by strong governance frameworks, will pave the way for an inclusive digital future that benefits all.

Community-Based Governance

As Digital Public Infrastructure (DPI) becomes increasingly integrated into everyday life, it is essential to consider governance models that place communities at the centre. This approach recognises DPIs as a common, shared resource managed by the citizens who rely on it. Imagine DPIs not as government-imposed systems, but rather as digital utilities co-created and governed by the people they serve.

Local governance structures for common resources provide valuable insights. Examples include community forest rights, water governance initiatives, and even recent calls to govern the internet as a common. These models share core principles like accountability, transparency, autonomy, and decentralised decision-making. Technologies governed by such structures empower citizens, fostering participation as opposed to the top-down control often associated with security concerns. Similarly, a citizen-centric approach holds immense potential for DPIs. While DPIs often champion principles like open-source access and privacy-by-design, these alone may not prevent unintended harm or unequal outcomes. A critical missing piece is robust public accountability—not just for a DPI's impact, but also for its conceptualisation and design. Formalised mechanisms are essential to ensure public participation in defining a DPI's purpose and validating assumptions about its effectiveness in achieving stated goals. Additionally, accessible and well-defined accountability mechanisms must be in place to address potential violations. Legislation mandating a representative body to highlight such issues and ensure transparent disclosure and resolution is crucial. Without strong accountability structures, DPIs risk harming marginalised groups and weakening the citizen-state interface, ultimately undermining democratic principles (Seth et al., 2023).

The following could be the key elements for a community-based DPI governance framework as stated by Seth et al. (2023):

1. **Democratic Purpose Identification:** The purpose of a DPI should be established through a democratic consensus among citizens. This requires gathering needs and observations through established participatory mechanisms like community forums. Research studies and multi-stakeholder consultations can further refine these needs into concrete DPI proposals. This ensures that genuine citizen needs take precedence over misguided or profit-driven agendas.
2. **Participatory and Evaluative Design:** Once the purpose is clear, a participatory design process involving communities is crucial. Accessibility, fault diagnosis, process integration, grievance redressal mechanisms, transparency, and accountability should all be built into the design from the outset. Similar to the concept of privacy-by-design, principles of “accountability-by-design” and “power-based equality by design” should guide technology and process development. Extensive piloting in diverse settings, followed by rigorous monitoring, learning, and evaluation processes with publicly available reports, allows for further design refinement based on real-world experience.
3. **Federated Management:** Even with comprehensive design, unforeseen issues can arise during deployment. A federated management approach can empower local stakeholders to responsibly manage DPIs and address challenges while upholding accountability and power-based equality principles. Local governance institutions, starting with village-level bodies, can act as nodal points for identifying and addressing emerging issues. Citizen interest groups can also play a vital role in this process. However, this may not always be possible, keeping in mind administrative challenges and on-ground constraints.
4. **Regulatory Body:** Effective governance across all stages—conceptualisation, design, and ongoing management—necessitates a regulatory body. This body would oversee multi-level (local, state, central) coordination. Existing

frameworks like India's Right to Information (RTI) Act and Anti-Corruption (Lokayukta) Act provide a useful model, with ombudsmen and nodal officers facilitating implementation across various levels. A similar DPI regulatory body with representatives from government, domain experts, civil society organisations, and citizen representatives could oversee DPI operations at state and central levels. By embracing a community-centric governance model, DPIs can evolve from top-down directives to tools that empower citizens and foster a more inclusive digital landscape. This collaborative approach, built on strong accountability mechanisms, paves the way for a future where DPIs truly serve the needs of the people they were designed to empower.

Public-Private Partnerships Governance Model

The private sector, through both established companies and philanthropic infrastructure, can bring more than financial muscle to the table. They can contribute technological innovation, expertise, and strategic partnerships. More importantly, public-private partnerships (PPPs) allow them to unlock vital capital, making public projects more efficient and innovative (Bandura et al. (2024). Companies, as frontline operators, possess a deep understanding of consumer needs and market dynamics, with a keen eye for opportunities and challenges. They can play a critical role in the development and expansion of Digital Public Services to citizens. Through collaboration, PPPs leverage the private sector's market insights and financial resources alongside the government's policy priorities, creating optimal outcomes for everyone involved. Their expertise in managing complex projects and implementing cutting-edge technologies leads to the creation of more sustainable DPI systems. In low- and middle-income

countries (LMICs) particularly, where governments may struggle to keep pace with technological advancements, collaboration with private entities is essential.

Negotiating the Regulatory Landscape

Inconsistent and evolving regulations can pose significant challenges for DPI deployment. Data privacy, cross-border data flows, and digital transactions are subject to widely varying regulations across countries, creating roadblocks to implementation. This is an area where governments can collaborate effectively with private firms, considering their needs and facilitating smooth operations within the technology sector.

Financing Innovation and Tailoring Solutions

Digital transformation and DPI development require significant resources. Identifying new and innovative financing models, along with fostering new types of partnerships where each player contributes unique value, is crucial. PPPs can play a leading role in achieving this. These partnerships, including those utilising blended finance approaches, can attract diverse investors and bridge the financing gap, particularly in developing countries. Keeping in mind the local government's current and future needs, PPPs can localise development in a manner that benefits all stakeholders, making them more accessible.

International Cooperation

The growing recognition of Digital Public Infrastructure's (DPI) role in fostering inclusive digital economies is driving a wave of international cooperation. Unlocking DPI's full

potential requires a robust global governance model that fosters collaboration, knowledge sharing, and responsible development. Recent international cooperation efforts demonstrate the promising path towards achieving this goal.

In May 2023, the EU-India Trade and Technology Council recognised DPI's potential for fostering open and inclusive economies. This was followed by the Quad Leaders' Statement, which highlighted DPI's transformative power for sustainable development. Additionally, the support from the Shanghai Cooperation Organisation for India's proposal to assist member states with India Stack adoption reflects this global shift.

G20 Summit 2023

Under India's leadership, the 2023 G20 summit saw a landmark shift in the global conversation on digital transformation. For the first time, nations came together to forge a unified vision for Digital Public Infrastructure (DPI)—the digital backbone that underpins essential services like identity verification, payments, and data exchange. This was not just about technology; it was about building a more equitable and inclusive digital future for all. The G20 recognised that DPI is not a one-size-fits-all solution; it is a flexible framework that can be tailored to each country's unique needs and priorities. But to truly unlock its potential, nations need to share knowledge, collaborate, and learn from each other's successes and challenges. A key highlight of the summit was the launch of two groundbreaking initiatives championed by India. The Global Digital Public Infrastructure Repository (GDPIR) serves as a virtual library, providing a wealth of information, tools, and resources for countries looking to develop or enhance their DPI. With over 50 DPI examples from 16 countries already on display, the GDPIR is a testament to the diversity and potential of these systems. Equally significant was the creation of the Social Impact Fund (SIF), a multi-stakeholder initiative designed to provide much-

needed financial and technical assistance to countries in the Global South. This fund, with an initial commitment of US\$25 million from India, will help accelerate DPI implementation in regions where the digital divide remains a significant barrier to progress.

The impact of India's leadership at the G20 was far-reaching. For the first time, a global consensus on DPI was achieved, resulting in the adoption of a comprehensive framework and the establishment of the GDPIR. These outcomes represent a major step forward in international cooperation on digital governance. They also highlight the growing recognition of DPI's potential to drive inclusive growth, enhance service delivery, and empower individuals. An effective global DPI governance model requires the active participation of all stakeholders. The G20's engagement groups, particularly Civil20 (for civil society), Labour20 (for trade unions), and Think20 (for think tanks), provide a crucial platform for these organisations to raise concerns, advocate for human rights, and ensure that the digital agenda reflects the needs of all citizens. By amplifying diverse voices and perspectives, C20, L20, and T20 strengthen the legitimacy and inclusivity of the global DPI governance model. The international community is actively supporting DPI development in low- and middle-income countries (LMICs). India's One Future Alliance (OFA) exemplifies this commitment. This voluntary initiative aims to build capacity, provide technical assistance, and offer funding to support LMICs in implementing DPI solutions.

Way Forward

The path forward for India's Digital Public Infrastructure (DPI) is paved with both promise and challenges. To truly unlock its transformative potential, several key areas require careful consideration and strategic action.

Safeguarding the Digital Realm

The very nature of DPI, dealing with vast amounts of sensitive personal and financial data, makes it a prime target for malicious actors. As the G20 outcome document warns, inadequate safeguards can lead to devastating consequences, from data breaches and privacy violations to intellectual property theft. This necessitates a multi-pronged approach. Robust security measures must be embedded into the very fabric of DPI systems, utilising encryption, multi-factor authentication, and regular security audits. A strong legal framework, like India's Digital Personal Data Protection Act 2023, must be in place to protect individuals' rights and hold organisations accountable for data misuse. Additionally, continuous international collaboration and knowledge sharing are crucial to stay ahead of evolving threats.

Expanding Reach and Usability

While India's DPI has made significant strides in reaching millions, the journey towards true digital inclusion is far from over. Language barriers, lack of real-time data integration, and a focus primarily on government services are some of the roadblocks hindering wider adoption. To overcome these challenges, DPI initiatives must prioritise user-centric design. This means developing intuitive interfaces, offering support in multiple languages, and ensuring that DPIs are accessible even in areas with limited connectivity. Furthermore, integrating real-time data can unlock a wealth of possibilities, from personalised service delivery to predictive analytics that can inform policy decisions.

Maintaining the “Public” in DPI

The rise of UPI as a dominant player in India’s digital payments landscape is a testament to the power of open and interoperable systems. However, the increasing concentration of the UPI market in the hands of a few foreign-owned companies raises concerns about the long-term publicness of this critical infrastructure. To safeguard the inclusive nature of DPI, policymakers must foster a competitive landscape that encourages innovation and prevents monopolisation. This could involve measures such as promoting open APIs, encouraging the development of alternative payment solutions, and ensuring fair access to the UPI platform for all players, big and small.

Harnessing the Power of AI

Artificial intelligence (AI) has the potential to revolutionise DPI, making it more efficient, adaptive, and responsive to user needs. Imagine AI-powered chatbots providing instant customer support, predictive algorithms optimising service delivery, and data analytics tools uncovering hidden patterns and insights. India’s experimentation with Confidential Clean Rooms, which allow for secure data sharing and collaboration while preserving privacy, is a promising step in this direction. However, the integration of AI into DPI must be guided by ethical principles and robust safeguards to ensure fairness, transparency, and accountability.

A Roadmap for the Future

The rapid pace of technological change necessitates a proactive approach to DPI development. Robust frameworks for self-assessment and evaluation can help countries gauge their progress, identify areas for improvement, and make informed decisions about future investments. These frameworks should

not be limited to technical aspects but should also encompass governance, inclusivity, and the overall impact of DPI on society. By incorporating feedback from citizens, businesses, and other stakeholders, DPI initiatives can be continuously refined and adapted to meet evolving needs. India's journey towards a digitally empowered society is far from over. While challenges remain, the progress made so far is undeniable. The foundation has been laid for a vibrant digital ecosystem that can drive innovation, economic growth, and social progress. By prioritising security, inclusivity, openness, and responsible AI integration, India can continue to lead the way in harnessing the power of digital technology for the benefit of all its citizens. This is not just about building a digital infrastructure; it is about building a more equitable, inclusive, and prosperous future for all.

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