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Leveraging Digital Public Infrastructure as Enabler for Attaining Sustainable Development Goals

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Abstract

To achieve Sustainable Development Goals developed by United Nations within stipulate time period, various delivery intervention alternatives are being assessed on regular basis. Digital Public Infrastructure is such an alternative which can be termed as roads and railways (physical infrastructure) for achieving SDGs. It covers digital technology or systems which are open, secure and interoperable. It can only be possible with contribution of all stakeholders. In this study DPI's contribution is studied. Various DPI are contributing and other technologies also have potential to become effective DPI. Their contribution in fulfillment of SDGs is discussed. DPI, associated SDGs and DPI impact on them are highlighted in detail. Challenges in successful implementation along with principles, governance model and strategies to cope with these challenges are also discussed.

Keywords: SDGs, DPI, Governance Model, Strategies, Stakeholders.

Introduction

Sustainable development challenges like Socio-economic inequalities (like poverty, dignity, inequality, and large vulnerable population), Economic concerns (like Unemployment, especially in youths) and Environmental concerns (climate change, emissions, degradation like desertification, drought, land degradation, freshwater scarcity, and loss of biodiversity) needed to be addressed at the earliest. In 2015 in United Nations Summit 17 Sustainable Development Goals and 169 associated agendas were adopted to transform the lives of millions globally. These Goals are for inclusive development of people, peace, prosperity, planet and partnership. They are like a collective call for action. A rejuvenated global partnership is needed to implement the agenda (United Nations, 2015).

A fresh approach with unique outlook is needed to improve performance on the SDGs. With advancement of technology Digital Public Infrastructure (DPI) has

offered himself as a potential solution. Governments around the world are looking at it as a smart solution for developmental problems. Several reports from the United Nations Development Programme (UNDP) highlight the role DPIs can perform in accelerating the attainment of SDGs in Low and middle income countries (LMICs). Implementing open and inclusive DPI is can provide growth in economic, social and human development. Different DPIs are promising to attain various agendas by 2030. Like by adopting finance related DPI for payment and credit GDP growth can reach upto US\$ 19.2 trillion with improvement of 20-33% in economic growth. LMICs annual GDP can increase between 1-1.4 percent. Financial access through Digital payments can be provided to 530-730 million additional people i.e. increase of 12-16 percent. Credit access for MSMEs can increase between US\$ 16-19 million (i.e. increase by 7 percent). Leakage of US\$ 17 to 21 billion during fund transfer (Government to Public) can be saved through digital transfer of monetary benefits 2030. Access to justice can be improved bringing 23-35 billion more people under state dispute resolution mechanisms which is 28-42 percent of current accessibility. With alternative dispute resolution and efficient case management judicial service delivery time will reduce by at least 10 years and can save time (19-31 percent) which in turn will save around \$38-\$60 billion of money. On climate front through common monitoring, reporting and verification emissions can be brought down by at least 0.8 to 1.1 GtCO₂e by 2030. This is about 3–4% of current LMICs' emission reduction targets. Illegal deforestation can be checked with real time land monitoring DPIs and can save upto 11500-230000 hectares of forest cover. Agriculture yield and small farmer income can be increased by \$95 to \$170 per household annually and undernourishment of 55 to 115 million people can be prevented by 2030. (UNDP, 2013). But the question whether DPI will be able to contribute as expected in achieving SDGs will be answered in near future.

Understanding Digital Public Infrastructure (DPI)

DPI can be termed as "**railways of a digital economy**" and covers critical digital technology or systems which are necessities in 21st-century society. It is a set of open, secure and interoperable digital systems which are equally shared by all for public and/or for private services. These systems based on rules and regulations respect of human rights, build trust and fundamental freedoms for inclusive development. Without DPI digital transformation would pose threat of further division of society on the basis of digital haves and have not's. But through DPI a transparent, accountable and participative governance system can be formed which provide access to right technology to all and which can be applied to various problems, can be tailored to specific or general problems and can be reused, modified or further improved collectively. And all this for innovative, sustainable and large scale implementation for faster results. DPI can help in fast adaptation and solution in times

of crisis which is proved by various healthcare and financial DPI used during Covid-19 (UNDP, 2023) (Dang, Bootwalla, Lynders, & Reiners, 2024)

From the above explanation it can be concluded that DPI has four major characteristics:

- It is interoperable which means DPI is generation basic technologies adapted for solution of various problems in variety of fields with different objectives, different tools, and technology.
- It should follow open standards which mean it is available to all for use and further development for solving societal problems.
- It is operated at Society level and is not restricted by geography or demography.
- Robust enabling rules and favorable legal frameworks must be provided by government for growth and for preventing misuse at the same time.

Core Categories of DPI

DPIs are in varied form and can include large number of technologies but with consensus of major stakeholders three categories are accepted universally on the basis of their functions leaving scope for other emerging categories.

- **Digital identity:** It refers to secure system to verify one's identity through biometrics, electronic signatures or any other verifiable credentials.
- **Digital Payments:** It refers to online transfer of money with ease and immediately between people, businesses and governments. (Asopa & Choudhary, 2025)
- **Consent-based data sharing:** It refers to sharing of data with consent across various systems and sectors with surety of ethical use of personal data and protection against any misuse. (G20 South Africa, 2025)
- **Other emerging:** Technologies emerging currently used in specific problem or sectors which have the capability to emerge as DPI in future.

The Sustainable Development Goals (SDGs) and possible DPI Contribution

The 17 SDGs specifically include goals to end poverty (Goal 1), end hunger (Goal 2), ensure healthy lives (Goal 3), achieve quality education (Goal 4), achieve gender equality (Goal 5), ensure water and sanitation management (Goal 6), ensure access to modern energy (Goal 7), promote sustained economic growth and decent work (Goal 8), build resilient infrastructure and foster innovation (Goal 9), reduce inequality (Goal 10), make cities sustainable (Goal 11), ensure sustainable consumption and production patterns (Goal 12), combat climate change (Goal 13), conserve marine resources (Goal 14), promote sustainable use of terrestrial ecosystems (Goal 15), promote peaceful and inclusive societies (Goal 16), and

strengthen the means of implementation and revitalize the Global Partnership (Goal 17)(United Nations, 2015).

People, Planet, Prosperity, Peace and Partnership are the central point of all agendas. Following are the ways DPI can contribute to these five Ps and associated SDGs (United Nations, 2015):

Table 1: Five Ps, Associated SDGs and Possible DPI Contribution

Five Ps	SDGs	How DPI contribute
People	1-5, 10	DPI fundamentally addresses human dignity and equality through universal identity, financial inclusion, and access to healthcare and education. Systems like Aadhaar and M-Pesa have brought over a billion people into formal systems.
Planet	SDGs 6-7, 12-15	Digital infrastructure optimizes resource use, enables climate action, and promotes sustainable practices. Smart grids, precision agriculture, and climate monitoring systems create measurable environmental benefits.
Prosperity	SDGs 8-9, 11	DPI catalyzes economic growth by reducing transaction costs, enabling entrepreneurship, and creating innovation ecosystems. India's UPI processes 8 billion transactions monthly, demonstrating massive economic impact.
Peace	SDG 16	Transparent, automated systems reduce corruption and increase accountability. Direct benefit transfers have saved over \$50 billion annually by eliminating intermediaries.
Partnerships	SDG 17	Open-source DPI and interoperable standards enable knowledge sharing and South-South cooperation. Over 40 countries now implement shared DPI solutions, reducing costs by 70%.

Comprehensive mapping of Digital Public Infrastructure components to Sustainable Development Goals





Figure 1: DPI-SDG Relationship Network

Distinguishing Digital Public Infrastructure from Commercial Digital Infrastructure

Digital Public Infrastructure and Commercial Digital Infrastructure are not same just because they both have technological base. The fundamental difference lies in the core philosophy on which they are formed. DPI is based on open and inclusive growth of society designed as a public good but Commercial DI are operated on the core principles of business designed as private asset for profit motive or for generating greater returns for investors. Following are the important differences between DPI and Commercial DI:

Table 2: Comparison between DPI and Commercial DI

Basis	Digital Public Infrastructure (DPI)	Commercial Digital Infrastructure
Core Philosophy, objective and Governance Model	Open, inclusive, foundational layer for society Financial inclusion, digital inclusion, equity Public governance, multi-stakeholder approach	Proprietary, competitive advantage for business Market share, customer acquisition, revenue growth Private corporate governance
Economic and Network Model	Non-profit or minimal cost recovery Benefits increase for entire ecosystem Designed to prevent lock-in	Profit-maximizing Benefits accrue primarily to platform owner Often creates intentional lock-in
Innovation and Participation Approach	Enables permissionless innovation by third parties Open participation for builders/developers	Innovation controlled by platform owner Controlled through partnerships/ licensing
Accessibility and Data Rights	User-centric, consent-based, portable, Universal access prioritized,	Platform-centric, terms-of-service based, Access based on ability to pay
Scalability Goal and Revenue Source	Designed for population-scale adoption with Public funding, cross-subsidization	Based on market opportunity with User fees, subscriptions, advertising, data monetization
Regulatory Approach	Self-regulation through public accountability	External regulation by government

Interoperability	Mandatory, designed into architecture. For example Multiple competing apps using UPI in India	Optional, strategic business decision For example Amazon's closed marketplace ecosystem
Examples –	<ul style="list-style-type: none"> • Identity - India's Aadhaar (open API), Estonia's X-Road • Payments - UPI (India), PIX (Brazil), FedNow (USA) • Data Exchange - DEPA (Data Empowerment Protection Architecture), FHIR for healthcare • Credentialing- Digital vaccination certificates (public standard) 	<ul style="list-style-type: none"> • Identity-Facebook Login, Google Sign-In • Payments - Visa/Mastercard networks, PayPal • Data Exchange - Salesforce, Oracle databases, SAP systems • Credentialing- LinkedIn certifications, proprietary badges

Therefore it can be concluded that Digital Public Infrastructure acts like roads and highways - publicly provided, openly accessible foundational infrastructure that anyone can build upon. For example, UPI in India allows any bank or fintech to participate equally. Commercial Digital Infrastructure acts like private toll roads or shopping malls - owned by specific companies who control access, set rules, and capture value from usage. For example, the Visa/Mastercard payment network where they control standards and charge fees.

DPI as an Enabler across the SDGs

DPI in India popularly known for India Stack includes Aadhar (biometric identification), UPI (digital payments) and Digilocker (digital documents), DIKSHA (Digital Infrastructure for Knowledge Sharing) etc. which helped in improving SDGs through financial inclusion (Desai, Manoharan, Jayanth, & Zack, 2024), reach to educational resources, effective identification and providing essential services. Following is the current state of DPI in India:

Table 3: Major DPI initiatives in India and Impacted SDGs

Digital Public Infrastructure	Primary SDGs Impacted	Key Impacts
Aadhaar (Digital ID) (Dattani, 2020)	SDG 1, 8, 10, 16	Enables financial inclusion, reduces leakages in welfare delivery, facilitates access to government services for 1.3+ billion people
UPI (Unified Payments Interface) (Agarwal, Shukla, & Awasthi, 2024)	SDG 1, 8, 9, 10	Enables instant digital payments, reduces transaction costs, promotes financial inclusion, supports small businesses and informal economy

DigiLocker	SDG 4, 9, 16	Digital document storage, reduces paperwork, enables instant credential verification for education and employment
FASTag & DigiYatra	SDG 9, 11, 13	Automated toll collection reduces congestion, digital airport processing improves efficiency and reduces carbon footprint
eKYC (Electronic Know Your Customer)	SDG 1, 8, 10, 16	Quick customer verification, enables faster access to financial services, reduces fraud
National Digital Health Mission (NDHM)	SDG 3, 9, 10	Unified health records, telemedicine access, improved healthcare delivery in rural areas (Agrawal, Ota, & Ray, 2024)
Digital Agricultural Platforms(eNAM),	SDG 2, 8, 9, 12	Fair prices for farmers, market access, agricultural information, sustainable farming practices
Ration Card Digitization (ePos)	SDG 1, 2, 10	Direct benefit transfer for food security, reduces corruption, ensures targeted delivery
Digital Tax Systems	SDG 8, 10, 16, 17	Improved tax collection, reduced evasion, funds for public services

Various DPI/potential DPI around the globe impacted different SDGs in different ways. Government Stack in Multiple countries for building reusable building blocks for digital government services, promotes interoperability and efficiency supporting SDG 9, 16 and 17. Government Tech Stack in Singapore provided smart city solutions, efficient public service delivery, digital health records and transparent governance (SDG 9, 11 and 16). MOSIP (Modular Open Source Identity Platform) in multiple countries (like Philippines, Morocco, Guinea) impacts SDG 1, 10 and 16. M-Pesa in Kenya, Pix (Instant Payment System) in Brazil and Mobile Money in Tanzania financially empowers unbanked populations, empowers women entrepreneurs, facilitate remittances, supports micro-businesses/transactions (SDG 1, 5, 8, 9, 10). eKYC (Electronic Know Your Customer) in multiple countries helps in quick customer verification, enables faster access to financial services and reduces fraud (SDG 1, 8, 10, 16). Estonia e-Residency & X-Road provides digital governance, e-services for citizens and businesses, transparent public services and international digital entrepreneurship (SDG 8, 9, 16, 17). Digital Land Registries in Rawanda, Georgia, Sweden and others securing property rights, reducing land disputes, empowering women with land ownership and transparent transactions are (SDG 1, 5, 10, 16). With use of Blockchain Land Registry in Ghana, Honduras and other countries property records become simmutable and secure which prevents land grabbing(SDG 1 and 16). Smart Electricity Grids established in EU, China, India reduced wastage and

carbon emission through efficient energy distribution and renewable energy integration. Digital Tax Systems improves tax collection which provides funds for public services (SDG 8, 10, 16, 17). Health Information System (DHIS2) improving health data management (disease surveillance/immunization tracking/informed healthcare decisions) in more than 70 countries (especially Africa and Asia). Open Data Platforms in UK, USA and EU (SDG 9, 16, 17), Mobile Learning Platforms in Kenya (M-Shule), Rwanda (SDG 4, 5, 10), Tele-Yemen e-government system (SDG 16, 17), Digital Agricultural Platforms (SDG 2, 8, 9, 12) National Broadband Plans in Australia (NBM), USA and EU (SDG 4, 8, 9, 10) are some other examples.

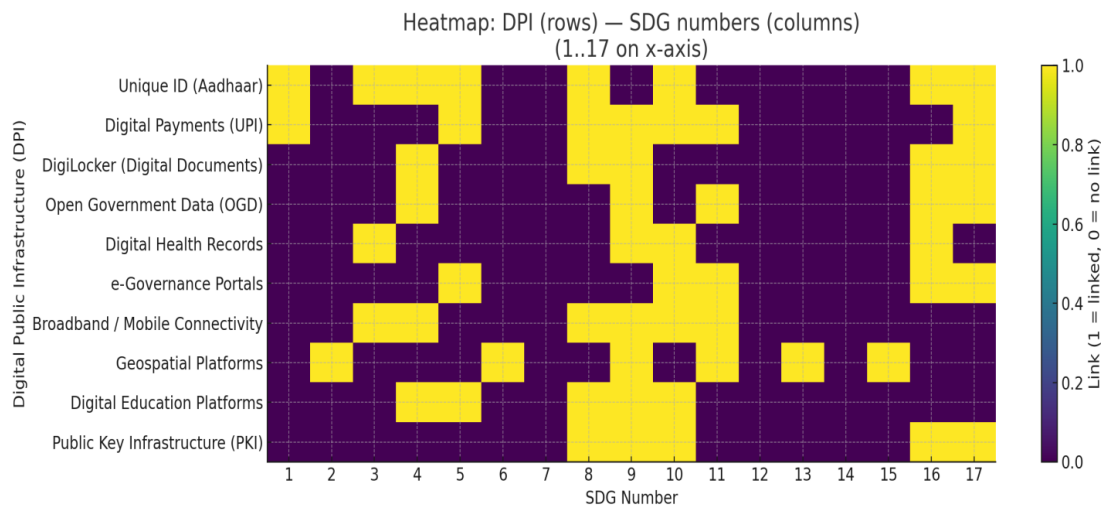


Figure 2: Major DPI and SDG

Major Challenges in implementing DPI

DPI poses some challenges unique to its implementation. Exclusion and inequality means excluding some groups who were unable to access these DPIs for whatever reasons. For example when digital identity become base for welfare benefits then it will become barrier for those who are excluded from digital identification as happened with migrants and refugees in Kenya (Mazzucato, Eaves, & Vasconcellos, 2024), with 850 million people who were not able to access public services and mobility and with 1.4 billion people who remain unbanked globally (UNDP, 2023). Another challenge is use of algorithms based artificial intelligence. Prejudiced algorithms will provide unfair outcomes (Mazzucato, Eaves, & Vasconcellos, 2024). Quick implementation of DPI sometimes results in over dependence of countries on few technologies or vendors some other challenges. This results in situations like limited mobility, over dependence or high cost in shifting from one technology to another (UNDP, 2013). An arrangement of funds becomes a bit challenging for this purpose as stated in (UNDP, 2023)(shortfall of around US\$ 4 trillion). Interoperability issues are also an important challenge in DPI implementation (UNDP, 2023).

Strategies and Governing Principles for Mitigating Risk in DPI Implementation

• Governance and Public Value Maximization

To govern DPI for the common good and to maximize public value, the state must proactively arrange DPI development and adhere to five essential pillars and mitigation strategies (Mazzucato, Eaves, & Vasconcellos, 2024) (Ingram, McArthur, & Vora, 2022):

- Purpose and Directionality: The direction of the infrastructure must be explicitly set and prioritized, moving away from a skeptical view of technology toward a purposeful one.
- Co-creation and Participation: Define rules and mechanisms for co-investment, collaboration, and coordination involving diverse actors (government, private sector, civil society). Institutional mechanisms must be created for collaboration *ex-ante* (in early conceptualization stages) to mitigate distrust.
- Collective Learning and Knowledge-Sharing: Encourage collective intelligence by institutionalizing learning processes. The orchestrators must find ways to promote knowledge-sharing, often achieved through incentivizing open-source software and communities of code.
- Access for All and Reward-Sharing: Guarantee universal access, which unequivocally implies ensuring access through analogue means for those without universal internet access (e.g., through "phygital public infrastructure"). Ensure value extracted from data is shared with the public, using tools like data sovereignty clauses in procurement.
- Transparency and Accountability: Ensure clear accountability mechanisms despite decentralized architectures. Provide citizens and companies the ability to consent or audit how and when their data is used, for example, through open-source data-sharing infrastructure.

For building technical ecosystem governments need to develop skill for using and developing DPI. Environment must be provided for development of open sources. Technology and data transfer must be facilitated (G20 India; UNDP, 2023).

Principles for Responsible Implementation of DPI

As DPI supports open for all digital infrastructures it brings some perils with it also. Issues like unethical use of digital infrastructure, security of personal data, privacy and human rights should also be addressed simultaneously. Core principle categories identified for responsible implementation of DPIs are Right Centered Principles, Technical excellence Principles, Governance Principles and Adaptive Principles. Right Centered Principles ensures availability of DPI to all without bias. It backs used of data under DPI after consent and for specified purposes. Technical

Excellence Principles emphasize that DPI must be designed in a manner which provide security and entry for all without barrier. Its application must be diverse and in different fields. As technology development requires resources therefore DPI developed must be scalable and sustainable so benefits must exceed its cost. Governance Principles states that DPI must be implement in transparent manner and without any hidden and ulterior motives. Accountability is also important when technology is open to all for use as well as further development. It must be flexible enough to operate under different legal and regulatory framework of multi-stakeholder governance. It should be purposeful and of public value. Adaptability of DPI is also must for improvement and continuous learning.

Conclusion

Digital Public Infrastructure (DPI) can help achieve sustainable development goals fast and wide. Advantages are to achieve the targets earlier than they are achieved in traditional way. Pace and scale provided by DPI is necessary as most of the goals are basic to the survival of humans with dignity. DPI is also favorable for environment as it will limit the repetition of effort and use of resources by working together. Digital public infrastructure accelerates economic growth, equality, reduce harmful emissions faster and can significantly improve access to judicial services. Expectations are that DPI can achieve SDGs atleast 5 to 10 years earlier that what is expected. But common good principle must be implemented to minimize problems associated with DPI and to avoid existing bias in getting into new infrastructure.

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