

Research Article

From Vision to Reality: How Digital Public Infrastructure is Shaping Service Delivery

Tushar Dhiman¹ & Pankaj Madan²

¹Research Scholar, Faculty of Management Studies, Gurukula Kangri (Deemed to be University) Haridwar, Uttarakhand

²Professor, Faculty of Management Studies, Gurukula Kangri (Deemed to be University) Haridwar, Uttarakhand

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*Corresponding author: Tushar Dhiman (tushardhiman.gkv@gmail.com)

Abstract: This research paper is a conceptual and policy-oriented analysis that underscores the transformative potential of Digital Public Infrastructure in enhancing service delivery across various sectors. By providing the foundational capabilities for data exchange, payments, and digital identification, DPI bridges physical infrastructure with sector-specific applications, such as social protection, e-commerce, and health services. The paper emphasizes how DPI has emerged as a critical enabler of resilience and inclusivity, especially highlighted throughout the COVID-19 outbreak, where countries with pre-existing DPI systems tripled the number of beneficiaries with social assistance compared to those without. Drawing on case studies from nations like India, Brazil, and Singapore, the paper explores successful implementations of DPI, as the Pix payment platform in Brazil and the Aadhaar system in India, and Singapore's Singpass digital ID. These examples demonstrate DPI's potential to enhance accessibility, financial inclusion, and efficiency while reducing corruption and improving governance. Furthermore, the research highlights challenges, including outdated legal frameworks, limited access to digital IDs, and digital exclusion among marginalized groups. The paper underscores the necessity of a whole-of-country approach for successful DPI implementation, involving public-private partnerships, interoperability standards, and robust governance mechanisms. It advocates for leveraging global momentum, as reflected in the G-20 consensus on DPI, to establish frameworks for international cooperation. DPI's role in fostering inclusive growth, empowering women, and enabling cross-sector innovation is presented as a pathway to achieving Sustainable Development Goals. This conceptual paper lays the groundwork for understanding DPI's significance, addressing barriers, and guiding policymakers toward creating equitable and resilient digital ecosystems that drive socioeconomic development worldwide.

Keywords: Digital Public Infrastructure, Service Delivery, Financial Inclusion, Governance and Public-Private Partnerships.

INTRODUCTION

Digital Public Infrastructure is an emerging concept that plays a crucial role in enhancing service delivery across various sectors. It serves as the foundational layer that connects physical infrastructure, such as broadband and data centers, with sector-specific applications, including social security and online shopping. The significance of Digital Public Infrastructure has been underscored by its rapid development and adoption throughout the COVID-19 outbreak, which highlighted the resilience of nations that had established Components of Digital Public Infrastructure prior to the crisis. Research indicates that these nations were able to reach Emergency financial transfers benefit three times as many recipients compared to those without such infrastructure in place. In nations such as Thailand and India, Digital Public Infrastructure has transformed the way citizens access services. For instance, India's remote workers can now Request social benefits and loans directly through their mobile phones, receiving payments into their bank accounts. Similarly, farmers in Thailand benefit from fertilizer subsidies through a system linked to their identification (ID). Singapore exemplifies the potential of Digital Public Infrastructure, where residents can conduct a wide range of

transactions online, from registering births to filing taxes, all facilitated by innovative digital solutions. Despite the advantages, the development of Digital Public Infrastructure is not without challenges. Many developing countries face significant gaps in their DPI systems, including outdated legal frameworks and resistance to change. A thorough examination and revision of the legislation might be necessary to overcome these obstacles. Furthermore, a whole-of-country approach, involving public-private partnerships, is essential for successful DPI implementation. This requires coordination among various stakeholders to create a unified vision for digital transformation. Platforms for data exchange, digital payments, and digital identity are the most prevalent forms of digital public infrastructure. However, as of 2021, a staggering 850 million individuals did not have formal identification of any kind, and 5 billion resided in nations without electronic identification that could facilitate secure online access to services. This highlights the urgent need for countries to invest in and develop robust Digital Public Infrastructure systems to ensure that all citizens can benefit from digital services. As the world continues to evolve digitally, the importance of Digital Public Infrastructure in fostering inclusive growth and enhancing service delivery

across sectors cannot be overstated.

- The new term used to describe the core set of skills that forms the basis of developing digital services at the level of society is called digital public infrastructure. DPI is a medium to facilitate the transition between the sector applications (such as social safety and e-commerce) and the physical infrastructure (such as broadband and data centers). The most common type of DPI would be the platforms and systems of digital payments, data exchange, and identification (ID).
- During the COVID-19 epidemic, DPI gained popularity. In general, the nations had DPI components in place prior to the pandemic shown greater resilience. According to research from The Digitalizing Government-to-Person Payments program of the World Bank, these nations sent emergency cash transfers to three times as many recipients. Government services, business, healthcare, education, and other functions might continue to run online in nations with strong DPI.
- In 2021, 850 million individuals worldwide lacked formal identification of any kind. Five billion people reside in nations without digital IDs that provide safe internet access to services provided by the public and commercial sectors.
- Although Merely 96 economies have completely made their technology infrastructure and legal frameworks functioning, electronic signatures are a significant origin of confidence in the internet-based economy. Economies with high and upper middle incomes make up two-thirds. Similarly, just 89 economies- three-quarters of which are high- and upper-middle-income economies- have a working platform for exchanging data.
- In low- and middle-income nations, just 57% of people made or received a digital payment, whereas just 37% used a retailer, despite the fact that the proportion of adults with a formal bank account increased to 71% in 2021 from 63% in 2017. The quick growth various quick or instantaneous payment methods, which have been introduced or declaring in around 100 jurisdictions is a major possibility.

LITERATURE REVIEW:

The pivotal role of Digital Public Infrastructure (DPI) and digital transformation in enhancing public service delivery globally. DPI comprises the foundational platforms such as digital identification systems, payment mechanisms, and data exchange frameworks that enable scalable and inclusive digital public services. The body of literature highlights that in countries where DPI is robustly implemented, the benefits during emergencies were significantly amplified, with three times more beneficiaries reached due to the ability to continue services through online channels (Marskell et al., 2024). A recurring theme throughout the literature is the transformative effect of digitalization on traditional public services. Finger and Montero (2023) delve into how digital interfaces challenge the delivery of infrastructure-dependent services like transportation, energy, and communication, prompting discussions about regulating these interfaces as public services. The integration of digital platforms not only

increases operational efficiency but also enhances accessibility, transparency, and citizen engagement key factors for accountable governance (Askariani & Amiruddin, 2023; Latupeirissa et al., 2024). Several studies, including those by Das (2024) and Sadykova & Galy (2024), stress the importance of technological readiness, strategic leadership, and digital governance frameworks in creating smart sustainable cities and fostering citizen satisfaction. OECD (2022; 2023) underscores the necessity of a user-centric approach to digital transformation, calling for internal organizational changes that place citizen needs above technological imperatives. This citizen-first perspective is echoed in the findings of Wang and Ma (2022), who show that mobile digital interfaces enhance citizen satisfaction by reducing administrative burdens and facilitating service evaluations. Furthermore, artificial intelligence (AI) is increasingly being integrated with DPI to personalize services and localize content, as noted by Nagar and Eaves (2024). The mutual enhancement of AI and DPI indicates the growing complexity and interdependence of digital technologies in public administration. Similarly, innovations such as cloud computing, big data analytics, and automation are driving productivity and accountability in the public sector (Ikwuanusi et al., 2024). At the same time, the literature does not shy away from acknowledging the challenges that accompany digital transformation. These include issues related to digital divides, infrastructure limitations, data security, and resistance to change. For instance, Setyawan (2024) points out the constraints of limited infrastructure and public digital literacy, particularly in developing nations. In the context of India, Rajendran (2024) discusses the Aadhaar system's success in improving service delivery efficiency and transparency but also critiques the system for potential exclusions and data privacy risks. In the European Union, Gherghin (2025) draws attention to variations in digital readiness across member states and the importance of institutional and socio-political cohesion in enhancing digital governance. She emphasizes interoperability, digital skills, and inclusive governance as critical areas for policy intervention. The Indonesian case, studied by Syamsiar (2023), provides a positive outlook, showing notable improvements in service quality and responsiveness through digitalization, although not without challenges. A systematic review by Prihatmanto et al. (2024) reinforces the importance of smart government architectures, IT integration, and stakeholder engagement for overcoming data security concerns and ensuring smooth implementation. Meanwhile, Luna et al. (2024) explore how digital public value is realized through the individual and collective benefits of transparent and accountable digital services.

Overall, the literature converges on the idea that digital transformation of public services is no longer optional but essential for efficient, transparent, and equitable governance. It requires strategic alignment of policies, inclusive technological frameworks, and citizen-focused service design to ensure that digital tools do not just automate services, but fundamentally redefine governance in the 21st century. The insights from various global and national case studies provide valuable lessons for

policymakers, technologists, and public administrators and sustainable governance.
aiming to harness digital tools for inclusive development

Table 1: Literature Review Table

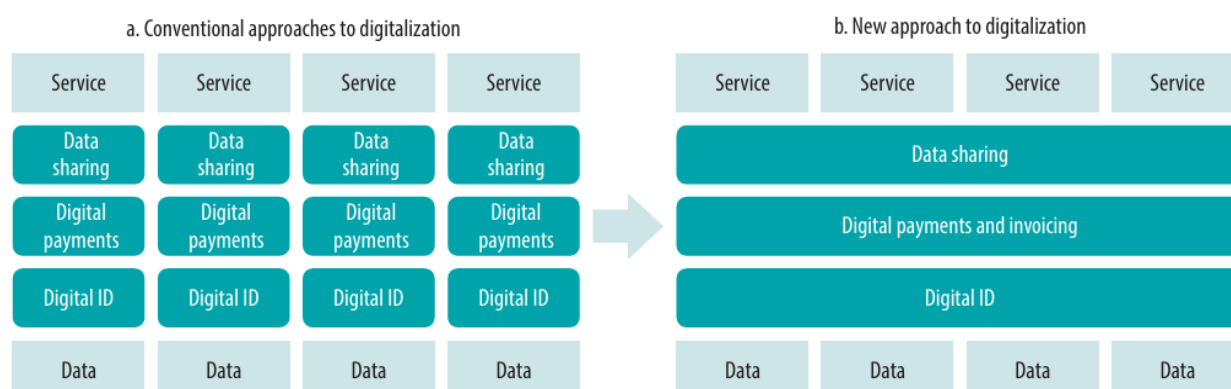
Author (Year)	Summary	Focus & Findings
Jonathan Marskell et al. (2024)	Digital Public Infrastructure offers capabilities toward the construction of digital services at the level of society. It has digital identification, payment platforms and systems and data-sharing. Unavailability of DPI makes it difficult to access governmental services, buy and sell their products and other online activities.	<ul style="list-style-type: none"> • Countries with DPI reached three times more beneficiaries during emergencies. • DPI enabled continued operation of services through online channels.
M. Finger & Juan Montero (2023)	In the present paper, the authors address the issues that have been created by the digitalization of the traditional physically perceived public services which are available to the society and which is mostly about the infrastructure public services in the transport, the energy, and the communications industries.	<ul style="list-style-type: none"> • Challenges of digitalizing traditional public services in infrastructure sectors. • Examination of whether digital interfaces should be regulated as public services.
Dillip Kumar Das (2024)	Developing the symbiosis between digital transformation, infrastructure, service delivery and governance to realize smart sustainable cities. The interdependencies are the key to the creation of intelligent and sustainable urban centers.	<ul style="list-style-type: none"> • Digital transformation drives innovation and efficiency in cities. • Interconnected elements create smart sustainable urban environments.
OECD (2022)	This paper provides the authors with the action-oriented principles that the policy makers and public servants will be advised to follow when designing and delivering the public services which are suitable to the digital era, and a set of practices that is chosen by diverse countries in relation to each principle.	<ul style="list-style-type: none"> • Digital government maturity requires comprehensive internal transformation. • User-centred approaches enhance public service delivery effectiveness.
Askariani Sahur & Amiruddin Amiruddin (2023)	This paper gives the authors the action-oriented principles that the policy makers and the public servants will be guided to adhere to in designing and delivering the public services that are appropriate to the digital era and a set of practices that will be selected by the various countries concerning each of the principles.	<ul style="list-style-type: none"> • Digital service delivery enhances efficiency and citizen engagement. • Challenges include digital gap and data security concerns.
Jonathan Jacob Paul Latupeirissa et al. (2024)	The evaluation established that digital transformation enhances efficiency, citizen engagement, government accountability in service delivery and emphasizes on technological readiness as a key driver in ensuring digital transformation of the local governments.	<ul style="list-style-type: none"> • Digital transformation enhances efficiency and citizen involvement. • Technological readiness is crucial for local government transformation.
Sarosh Nagar & David Eaves (2024)	This paper explores the interactions between artificial intelligence (AI) and digital public infrastructure (DPI), highlighting opportunities for mutual benefit, including AI-enhanced DPI functions and DPI-facilitated AI advancements, while also discussing integration challenges and policy implications.	<ul style="list-style-type: none"> • AI enhances DPI through personalization and language localization. • DPI improves AI systems with high-quality, consent-based data.
Agus Setyawan (2024)	This study examines the role of e-government in enhancing public service delivery, finding significant contributions	<ul style="list-style-type: none"> • E-government enhances public service efficiency and transparency.

	to process expediting, transparency, and reduced corruption, but also identifies obstacles such as limited infrastructure and digital divide, recommending infrastructure improvements and public digital literacy.	<ul style="list-style-type: none"> Challenges include digital infrastructure, resistance, and digital divide issues.
Kuralay Sadykova & Anne Galy (2024)	This study examines OECD countries' experiences in transforming public service delivery systems through digital technologies, highlighting successful strategies, challenges, and best practices in digital governance, with a focus on improving efficiency, transparency, and citizen satisfaction.	<ul style="list-style-type: none"> Digital transformation enhances public service delivery efficiency and citizen satisfaction. Strong leadership and strategies are crucial for successful digital governance.
Hannah Knox (2021)	It is upon these digital infrastructures that structural changes of the relations towards the social setting, what one can know as communicator in all that concerns communication, mobility, kinship, accessibility to all resources have been founded.	<ul style="list-style-type: none"> Digital infrastructures transform social relations and communication. Integration of digital technologies affects mobility and resource access.
Septian Aryatama et al. (2024)	This study examines global best practices in digital transformation of public services, identifying enablers and challenges to enhance governance efficiency, transparency, and citizen-centric service delivery, with implications for policymakers and practitioners worldwide.	<ul style="list-style-type: none"> Robust digital infrastructure and strong leadership are critical. Citizen engagement and data-driven decision-making enhance governance efficiency.
OECD (2023)	Governments must adopt a user-centric approach to digital transformation, prioritizing citizens' needs over technology, to harness benefits and mitigate threats, ensuring inclusive and equitable outcomes in public governance and digital tool implementation.	<ul style="list-style-type: none"> User-centric approach crucial for digital government transformation. Mature digital governments needed to address public governance challenges.
Sang-Chul Shin et al. (2019)	Digital government is being planned after e-government, and social creativity is planned to be solved through the opening and interaction on the basis of ICT by introducing interactive channels of public services.	<ul style="list-style-type: none"> 100% digitization of government services proposed for sustainable development. Digital government planned through interactive public service portals.
Claudia-Anamaria Gherghin (2025)	This article examines the EU's digitalization of public services, highlighting institutional, technological, and socio-political aspects, and proposes policy recommendations to improve interoperability, digital skills, and inclusive governance amidst challenges like corruption and digital literacy gaps.	<ul style="list-style-type: none"> Digital readiness varies significantly across EU member states. Collaborative governance enhances public trust in digital transformation.
Pavankumar Rajendran (2024)	This study examines the impact of India's Aadhaar program on public service delivery, finding enhanced efficiency and transparency, but also concerns over privacy, data security, and exclusion of marginalized groups, highlighting the need for robust legal frameworks and inclusive policies.	<ul style="list-style-type: none"> Aadhaar enhances efficiency and transparency of public services. Concerns include privacy, data security, and marginalization issues.
Syamsiar Syamsiar (2023)	Digitalization has significantly improved the effectiveness of public services in Indonesia, enhancing efficiency and accessibility.	<ul style="list-style-type: none"> Digitalization improves quality and responsiveness of public services in Indonesia. Study highlights challenges and opportunities in implementing digital solutions.

Dolores E. Luna et al. (2024)	Creating public value through digital service delivery is primarily perceived by citizens through individual benefits and broader societal impacts.	<ul style="list-style-type: none"> • Citizens perceive public value through individual benefits of digital services. • Value connects to transparency, accountability, and societal impacts.
Ary Setijadi Prihatmanto et al. (2024)	This systematic review examines smart government frameworks and architectures, identifying key components and challenges in transforming public services through innovative technologies, highlighting the importance of IT integration, interoperability, and stakeholder engagement to improve service delivery and address data security and infrastructure limitations.	<ul style="list-style-type: none"> • Importance of integrating advanced information technology in public services. • Major challenges include data security and resistance to change.
Ugochukwu Francis Ikwanusi et al. (2024)	Digital transformation in public sector services enhances productivity and accountability through scalable software solutions, leveraging cloud computing, data analytics, and automation technologies to streamline operations, improve data management, and facilitate citizen engagement.	<ul style="list-style-type: none"> • Digital transformation enhances productivity and accountability in public services. • Scalable software solutions improve service delivery and citizen engagement.
Chengwei Wang & Liang Ma (2022)	According to Wang et. al., given in this paper, the researchers established that digital interfaces support the act of citizens who make evaluations and enhance citizen satisfaction when compared to channels which are offline and that digital interfaces presented through mobile applications contribute greatly in supporting the act of evaluation on part of citizens and enhance citizen satisfaction.	<ul style="list-style-type: none"> • Digital interfaces increase citizen evaluations and satisfaction. • Administrative burden is reduced through digitalization of public services.

What is Digital Public Infrastructure and its importance for nation?

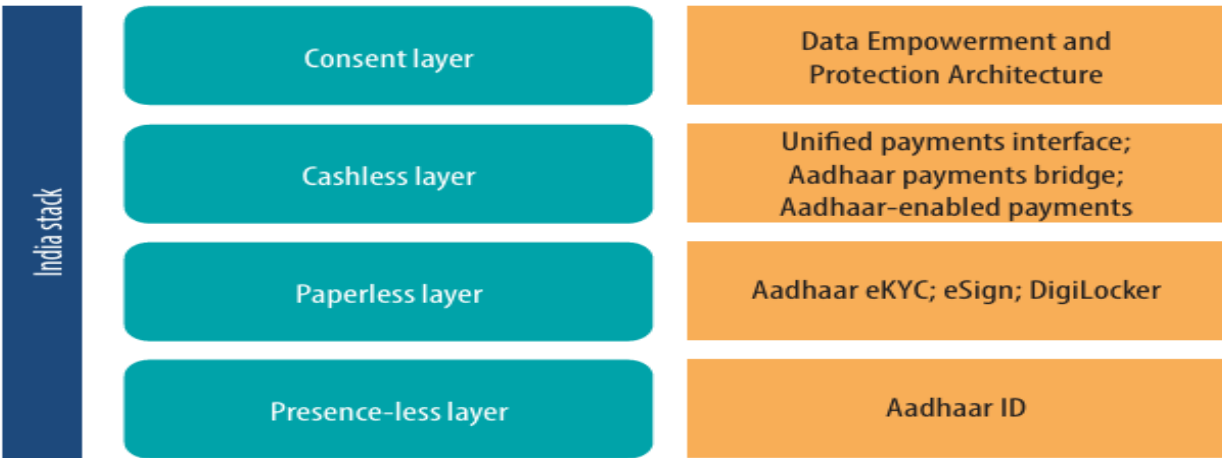
Digital Public Infrastructure refers to the fundamental features- like data exchange, payment processing, and identification- that serve as the foundation for creating revolutionary digital services on a societal level. Digital Public Infrastructure may be thought of as an intermediary layer in the digital environment in its most basic form (see figure 1). It supports applications in a variety of industries (such as solutions and information systems for various verticals, telemedicine, social protection, e-commerce, and remote learning) and sits on top of a physical layer that includes routers, servers, cloud computing, data centers, and gadgets. The emphasis on horizontal and reusable foundations represents a paradigm change from traditional digitization strategies that have frequently resulted in silos and fragmentation. The Aadhaar identity system in India, the Pix quick payment system in Brazil, and Consumer Data Rights in Australia the permitted exchange of private information are a few instances of DPI. DPI eliminates the requirement for the person who created the application to design the wheel because the majority of digital transactions revolve around the movement of money and information as well as trustworthy verification (Desai et al., 2023). DPI may also encourage competition, creativity, and increases in productivity and additional multiplier and democratizing impacts at the application layer as well as throughout industries when it is open and interoperable (Global Partnership for Financial Inclusion, 2023). The COVID-19 epidemic increased awareness of the value of DPI.



Source: World Bank

Figure 1: The concept of Digital Public Infrastructure

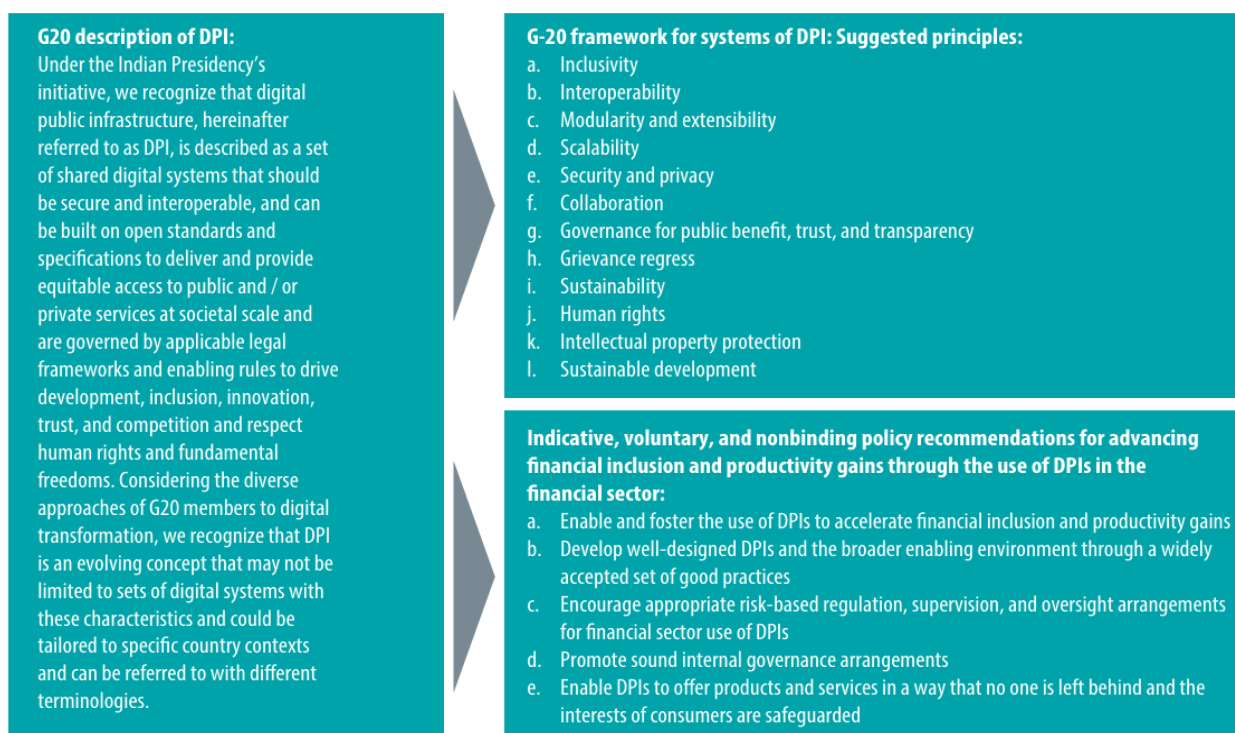
This capability increased the certainty that emergency cash transfers were going to the appropriate individual when a new initiative for unorganized laborers needed to be swiftly implemented through online registration. Additionally, when companies, government organizations, educational institutions, and medical facilities moved to digital and online platforms, nations with DPI were better prepared to adjust. Figure 2: The India stack the idea of DPI, however, has its origins in the past experiences of developed digital nations, even though the phrase is new. Even before the pandemic, cross-cutting resources for determining individuals and businesses, some of the most successful governments that are dynamic and digital, like the Republic of Korea, Brazil, Estonia, and Kenya attribute their prosperity to interoperable rapid payments and smooth and safe data exchange. These platforms also helped to create economic opportunities and make life easier. DPI is also being used by nations to mitigate and adapt to climate change, for example, by optimizing energy generation through peer-to-peer energy trading. Examples of how nations have combined DPI components with interoperability made possible by application programming interfaces (APIs) include Singapore's Digital Utilities and India's India Stack (see figure 2), which make the whole more than the sum of its parts and open the door to new goods and services. The word DPI first appeared in early 2022 (Metz et al. 2022). At the Foreign Affairs Ministry of Norway, Digital Public Goods Alliance, and Rockefeller Foundation, late 2021.



Source: The India Stack website (<https://indiastack.org>) served as the source.

Figure 2: The India Stack

The first international agreement on a definition of DPI and proposed guiding principles was agreed by the G-20 in August 2023 (see figure 3). The G-20 was led by the Indian Presidency's initiative digital economy ministers in negotiations for this accord, which was approved by the G-20 leaders. It establishes the foundation for future global collaboration and a shared understanding. Interestingly, the G-20 result acknowledges that data sharing, digital payments, and digital identification are fundamental DPIs, but it also understands that different nations will implement them in different ways and with different architectures. For instance, India views its Open Network for Digital Commerce (ONDC) as a DPI. On several sites, this a system of open communication links buyers and vendors, ranging from gig work to electronic commerce. Additionally, policy proposals on how DPI might support productivity increases and financial inclusion have been developed by the Global Partnership for Financial Inclusion. In the same global trend, the World Bank has established one of its five new global priorities as DPI. initiatives (in the area of deepening digitization), and the UN has launched its high-impact in branding DPI, in the promotion of development throughout its 17 Sustainable Development Goals. The word public in DPI does not mean government owned but the common good and the common benefit. The point is that, as far as nondiscriminatory access is provided pursuant to the regulations of the relevant governance, digital ID, digital payments, data sharing, and all the other essential features are equally important in the functioning and development of the economies and societies nowadays in the digital age as physical infrastructure, such as roads and railroads, in the previous centuries. Additionally, Poole, Toohey, and Harris (2014) state that, other than having infrastructure which is owned or directly financed by the sector itself, infrastructure should be considered as an investment done by the government, in which the government is deemed as mainly having the responsibility of determining whether infrastructure is delivered and how it should be given out in the best interest of the larger society. In this definition, the new concept of Digital Public Infrastructure may be included. As it turns out to be, the role of the private sector in production and utilization of Digital Public Infrastructure is significant. Among other applications, it can be utilized to design use cases and services that promote uptake, services and innovation to be developed on Digital Public Infrastructure, to manage Digital Public Infrastructure, and participate in a public-private partnership (and other joint efforts) to achieve scale.



Source: *Global Partnership for Financial Inclusion 2023; G20 India 2023.*

Figure 3: G-20 DPI outcomes in 2023

Access to IDs, e-signatures, data exchange, and digital payments still has significant gaps:

Despite being crucial for digital exchanges with companies, governments and other service providers, as well as the digital economy overall, digital IDs—government-recognized digital identity and authentication remain relatively inaccessible. Since having a secure online way to verify one's identity is essential for full participation in the digital economy, their absence presents a significant challenge. According to one estimate, digital identification has the ability to unleash economic value equal to 3–13 percent of GDP. (White et al. 2019). More significantly, a digital ID that enables safe online transactions, especially through a mobile device, can improve access to markets, services, formal employment (like gig work), and additional chances brought about by the digital economy for citizens, small business owners, farmers, and low-income households in remote and rural areas. For example, countries like Digital identification schemes have just been introduced in Brazil, Indonesia, and Rwanda with World Bank support due to its equalizing effect. Example 1 goes into additional detail about the situations of eFaas (Maldives), FranceConnect (France), and Fayda (Ethiopia).

Example 1: Digital ID examples include the Maldives' eFaas, FranceConnect, and Ethiopia's Fayda.

“Ethiopia's Fayda”

“Ethiopia's first digital ID system, Fayda, which translates to "value" or "utility" in a number of regional languages, was introduced as a trial in 2022. It aims to resolve the fragmentation and exclusion caused by local government-issued IDs (kebeles) that lack verification, security, and unique individual identification, which affects services like social transfers. Fayda is envisioned to support a more extensive digital public infrastructure, encompassing digital payments and data exchange. Constructed using the Modular Open-Source Identity Framework, much of its biometric and other component integration has been developed in-house. Users receive both a physical ID card and a downloadable digital ID via partner applications like those of mobile operators and banks. To date, fayda has more than 3 million registered users.”

“France's FranceConnect”

“From 2016, the ecosystem of federated digital IDs known as FranceConnect was launched, enables residents and citizens of France to access over 1,500 public services online using the digital ID provider of their choice from both the public and private sectors. The data sources and documents the user uses to log in determine how strong the digital ID is. Users can create an account or select an existing digital ID provider to authenticate themselves while accessing a service through a website or application. Their identity is confirmed based on information in pertinent government registries. Tax returns are among the higher-risk public services that can need a minimum strength of significant or elevated. Interoperability is made easier by adhering to. Since FranceConnect is a component of the Electronic Identification and Trust Services (eIDAS) regulatory framework, it may be used to access public services elsewhere in the EU using the OpenID Connect open standard. The FranceConnect link, which manages the transactions, must be maintained by the Interministerial Digital Directorate. An ecosystem of decentralized digital identification is being made by the administration of the European Union through the development of France Identité, a free digital ID application that is comparable to eFaas and Singpass and may meet eIDAS 2 regulations. Of all digital ID providers, FranceConnect serves 43 million customers and processes 330 million transactions

annually. Thirty million people authenticated at least once in 2022.”

“Maldives’ eFaas”

“The national identity card issued by the “Department of National Registration” serves as the foundation for eFaas, The National Center for Information Technology in the Maldives operates a digital ID service. Originally a single sign-on for government services, it has evolved into a smartphone application inspired by Singapore’s Singpass. eFaas allows citizens and residents to verify their identity in person with a digital ID card and QR code or online via single sign-on for over 450 services, using a personal ID number and selfie verification. It facilitates transactions with government and businesses without inter-island travel and also serves as a digital wallet for storing documents like driving licenses, family cards, and vaccination certificates. As of June 2023, the eFaas login had over 159,000 users, with 28,000 using the smartphone app. During the COVID-19 pandemic, user adoption quadrupled from 28,000 in 2019 to nearly 100,000 in 2021.”

400 million individuals worldwide lack digitally verified identity documents, 220 million have no digital identity records, and an estimated 850 million people lack any formal identification. Vulnerable and disadvantaged groups, including women, young people, those with poor incomes, those living in rural regions, those with less education, and those not in the labor, are frequently impacted by these disparities. Closing this gap depends on achieving SDG goal 16.9, which calls for universal access to legal identification by 2030, including birth registration. Secure digital authentication methods and credentials for online services and transactions are inaccessible to more than 5 billion users, including 3.5 billion adults. Access to a variety of online services and transactions, the simplicity of future authentications, and the acquisition and use of digital credentials remain obstacles in the 75 economies with digital identity solutions, which are primarily high-income nations. Low-income and lower-middle-income nations similarly underuse e-signatures. A digital economy depends on e-signatures, which, when properly controlled, have the same legal standing as traditional signatures. This allows for remote contracts and increases trust in distant transactions. The technological infrastructure and regulatory frameworks for e-signatures, including certificate authorities and public key infrastructure, are only fully operationalized in 96 economies. Of them, 27 are upper-middle-income nations and 42 are high-income nations. The infrastructure and structures required are in place in another 28 economies, but they have not yet been put into use. Limited e-signature use cases, the expense and difficulty of building sustainable infrastructure, and a lack of supervisory ability to establish a competitive e-signature market are some of the main obstacles. For instance, whereas 35 economies have legislation, their technology infrastructure is still being developed.

Examples of data sharing include DigiLocker in India, APEX in Singapore, and UGHub in Uganda.

“India’s DigiLocker”

“The Indian government provides DigiLocker, a secure personal document wallet and 1 gigabyte of cloud storage, to all individuals who have registered with Aadhaar. It was introduced in 2015. Digital documents exchanged with DigiLocker have the same legal force as their physical counterparts and can be safely checked. Users have the option to request that papers be submitted on their behalf or upload scans of documents. Individual authorization is required for sharing, and users have the option to withdraw their permission for other parties to access their data. There are 1,684 document issuers, 187 requesters, 197 million users, and 6.3 billion issued documents as of September 2023. Significant adoption was prompted by the COVID-19 epidemic, with 23 million users in 2019.”

“Singapore’s APEX”

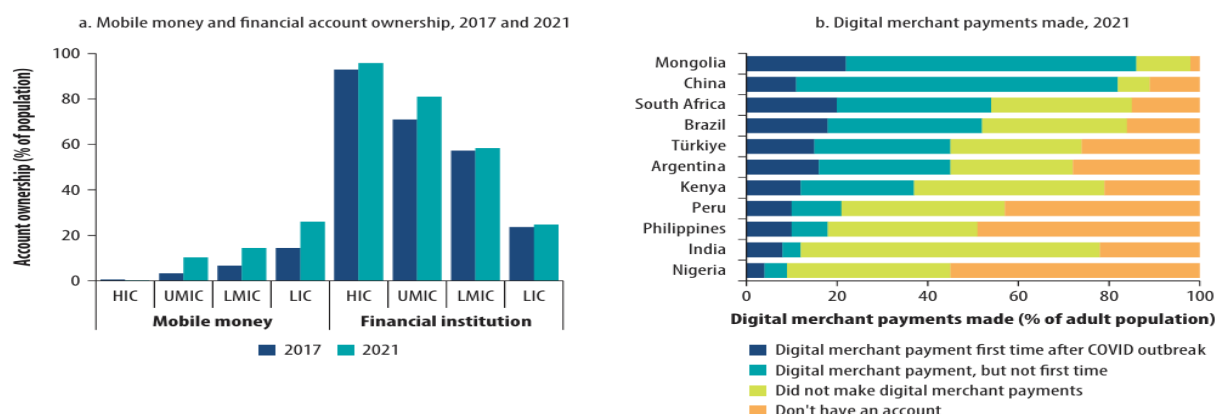
“Government agencies may publish and control access to their APIs as well as find other APIs with the help of APEX, a governmentwide application programming interface (API) management system (Cooper, Marskell, and Chan 2022). In contrast to the enterprise service bus model, which establishes a central infrastructure through which data may flow, APEX enables bilateral connections between databases and systems, potentially offering more scalability and flexibility. More than 45 agencies, or over half of all Singaporean government entities, are among the more than 2,000 APIs that APEX supports. With monthly peaks of over 300 million transactions on average, the volume of traffic has reached 100 million transactions. With its integration with the Singpass agreed data-sharing service, APEX serves as the foundation of Singapore's national digital ID (Singpass), enabling citizens, residents, and enterprises to authorize access to reliable information that the government has on them. By saving time, reducing expenses, and enhancing the quality of data provided to companies and government organizations, APEX makes services easier to access. According to estimates, Singpass can save up to S\$50 on each eKYC transaction made while creating a bank account.”

“Uganda’s UGHub”

“UGHub is a platform for systems and data integration that uses the open-source WSO2 technology stack and the enterprise service bus paradigm of a central infrastructure. After two years of operation, as of August 2023, 66 private organizations (such as banks and colleges) and 47 public organizations have linked to share personal and nonpersonal data more over 100 million times in a safe and easy way. With funding from the World Bank's Regional Communications Infrastructure Program, the National IT Authority created UGHub.”

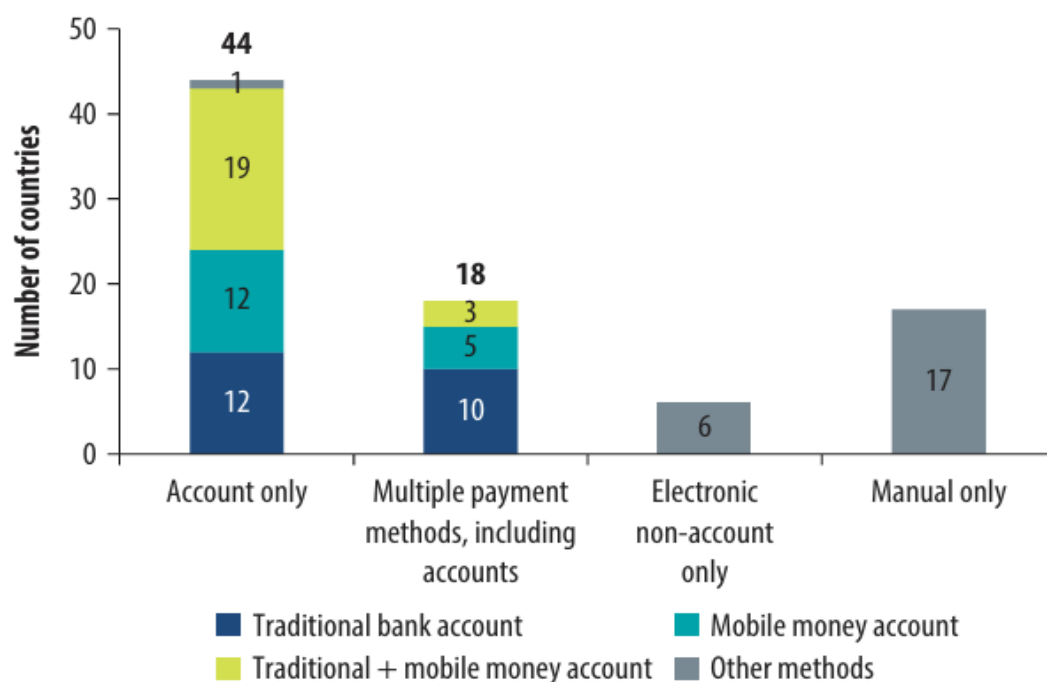
Digital technologies have been pivotal in promoting financial inclusion, particularly through mobile money accounts and payments in low- and middle-income countries. This "banking the unbanked" approach has transformed financial services, especially for those in rural areas lacking access to formal finance, significantly enhancing financial inclusion in these regions

(Demirgüç-Kunt et al. 2022). The global pandemic further accelerated this trend. World Bank Findex data from around 130 countries indicates that in 2021, more individuals in low-income countries had mobile money accounts than traditional financial institution accounts (26% vs. 25%). Additionally, from 2017 to 2021, mobile money account ownership grew faster than traditional financial institution accounts in both lower-middle-income and low-income countries.



Source: Demirgüç-Kunt et al. 2022.

Figure 4: Mobile Money and Financial Account Ownership & Digital Merchant Payments



Between 2017 and 2021 (figure 4), the percentage of people in low- and middle-income countries who had formal financial accounts rose from 63% to 71%. Only 37% of these individuals made or received digital payments, and only 57% of them did so with merchants, according to Demirgüç-Kunt et al. (2022). Over 80% of Chinese and Mongolian individuals made payments through online retailers in 2021. Just 12% of Indian adults, on the other hand, paid online retailers, and two-thirds of them did so for the first time following COVID-19.

Source: World Bank 2022b.

Figure 5: Number of payment methods used during the COVID-19 response, by number of countries, as of May 2021

A promising development is the rapid rise of fast or real-time payment systems, now launched or announced in about 100 jurisdictions. These systems operate 24/7/365, providing instant funds availability, enhancing user trust and convenience, and encouraging innovation and competition from a range of suppliers, including nonbanks and banks. The importance of Digital Public Infrastructure (DPI) in facilitating governments' ability to provide social assistance in a timely and secure manner was highlighted by the COVID-19 pandemic. DPI made it possible for governments to make distant payments and reach an unprecedented number of new beneficiaries, bringing millions of people into the financial and social security systems for the first time. Two major obstacles to scaling up social assistance were delivering Government-to-Person (G2P) payments safely during the epidemic and modifying targeting and registration to include people who are not normally included in social assistance databases, such as urban informal laborers. By May 2021, (Figure 5) 80% of the nations under analysis had

implemented digital payments for at least one new or enlarged social assistance program, demonstrating the growing reliance on digital technologies to handle the latter concern. Several nations introduced digital payments for the first time, promoting a long-term shift to contemporary social assistance payments, even if many had some prior experience with them prior to the epidemic. More individuals may receive Government-to-Person (G2P) payments more quickly and securely when they are deposited digitally into accounts, whether they be traditional accounts like banks or microfinance institutions or mobile money. In addition to promoting financial inclusion and women's economic empowerment, this lessens corruption and leaks. 423 million women in low- and middle-income countries were among the approximately 865 million account owners (18%) who established their first financial institution account in order to get government funding, according to the Global Findex 2021. 15% of receivers got cash, while 65% received transfers digitally, with men and women using it equally. Digital payment methods and account opening are first steps toward financial inclusion. In 2021, 70% of recipients of government transfers in low- and middle-income nations made digital payments, compared to 50% in 2017. Payment methods included using mobile accounts for in-store transactions (54%), and the internet for bills or purchases (49%). Furthermore, 34% of respondents saved in mobile money accounts or official financial institutions, demonstrating advancements in expanding access to financial services. The move to digital payments during the epidemic resulted in a rise in account ownership. Account-based transfers were implemented for COVID-19 social assistance programs in at least 62 nations, several of which were doing so for the first time. These shifts, though, were frequently brief. To preserve and expand on these developments, consistent efforts are required to implement digital payments in all social assistance programs.

How to create a strong Digital Public Infrastructure:

A common comprehension of what is often required to build Digital Public Infrastructure operate at scale, in addition to the dangers and obstacles, is being fostered by an expanding corpus of experiences, data, and principles. However, the local environment will determine what works in a given nation.

Success Factors	Challenges and Risks
<ul style="list-style-type: none"> • Pay attention to use cases. It is doubtful that digital public infrastructure (DPI) would be widely adopted if it is built for its own sake. DPI should be designed with the goal of resolving practical issues that businesses, government organizations, and individuals encounter. • Give universal accessibility and inclusiveness top priority. In order for DPI to be effective for all segments of society, it must take into account a number of variables, such as accessibility awareness, proficiency, and faith in technology in relation to digital gadgets and infrastructure, as well as making sure that people with disabilities and other special needs can use it. • Increase public accountability and confidence. When all parties involved are certain that grievance resolution processes are in place, that DPI operates as intended, and that it serves their best interests, adoption may go more quickly. • A public-private cooperation and a nationwide strategy. The change in perspective necessitates cooperation and coordination among several stakeholders; a national strategy benefits from having a single vision. • Encourage compatibility. When several layers or components may cooperate to support exponential innovation, DPI's full potential is shown. This need can be met in part by implementing open application programming interfaces and shared standards. • Strengthen competence and culture in government. Incentives are necessary to encourage civil officials to think and act courageously and to take chances. It could also be necessary to make procurement and budgetary rules more appropriate. • The usage of DPI across borders. There is a chance for more International and regional cooperation to 	<ul style="list-style-type: none"> • Being shut out of services. Ineffective DPI design can put needless obstacles in the way of people's and businesses' access to services. Rethinking systems and procedures is necessary because digitizing bad habits will result in worse digital practices. • Security lapses and data protection. Public trust might be damaged and possibly dangerous outcomes can result from data leaks and misuse, not only of DPI but also of the apps that use it. These dangers can be decreased by ongoing investment in institutional, legal, and security postures to safeguard personal information. • Technology and vendor lock-in. Inadequate technology selection or acquisition can result in a reliance that hinders DPI adaptation and raises Over the medium and long periods, the total cost of ownership. Developing the ability to efficiently handle contracts and procurement, utilizing modular designs, and embracing open standards may all significantly lower the risk. • Legacy legal frameworks and inertia. There are several reasons why people could oppose the changes that DPI has the potential to implement. To alleviate this major backlog, rules and regulations may need to be thoroughly reviewed and reformed.

develop cross-border use standards as DPI becomes more popular worldwide. Secure data exchange, compatible quick payment systems, and reciprocal digital ID recognition are all examples of this collaboration. Remittances, cross-border service access, and cross-border data transfers are just a few of the international transactions that may be made less expensive and risky with such collaboration.	
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DISCUSSION:

The findings of this conceptual and policy-driven study underscore the pivotal role of Digital Public Infrastructure in transforming the landscape of public service delivery. As a foundational framework that integrates digital identity, payment systems, and data exchange, DPI offers a critical enabler for scalable, inclusive, and efficient service ecosystems. The COVID-19 pandemic served as an inflection point that not only exposed existing digital divides but also showcased the resilience of countries that had invested in DPI. Countries like India, Brazil, and Singapore were able to rapidly deploy social assistance and continue essential services through online platforms. This illustrates the transformative potential of DPI as both a crisis response mechanism and a long-term governance strategy. At the core of DPI's impact is its ability to bridge physical infrastructure with application-layer services. Platforms such as India's Aadhaar, Brazil's Pix, and Singapore's Singpass exemplify how robust digital identity and payment systems can facilitate seamless citizen engagement. These platforms not only enhance convenience but also embed transparency, reduce leakages in welfare programs, and improve overall governance. Aadhaar, in particular, enabled remote disbursement of benefits during the pandemic, directly into beneficiaries' bank accounts- a breakthrough in last-mile delivery. However, this transformation is not without its complexities. The study reveals significant disparities in DPI readiness across global regions. As of 2021, nearly 850 million people lacked any form of recognized identity, and over 5 billion had no access to secure digital credentials. This digital exclusion is most acute among marginalized populations rural residents, women, and low-income groups posing a substantial challenge to equitable service delivery. The policy implication here is clear: DPI cannot achieve its transformative potential without addressing issues of accessibility, digital literacy, and affordability. There is an urgent need for inclusive design principles that ensure DPI serves as a leveller rather than a divider. The discussion also brings to light the interplay between DPI and financial inclusion. The shift from traditional to digital payments has significantly broadened access to financial services in low- and middle-income countries. For example, the proliferation of mobile money accounts in Africa and Asia has brought millions into the formal financial system. The Global Findex data reveal that in some regions, mobile account ownership surpassed traditional bank account usage. DPI-enabled digital payments were not only instrumental in emergency cash transfers during the pandemic but also catalyzed long-term shifts toward a cashless, inclusive economy. Importantly, DPI is no longer an isolated national concern but a matter of international cooperation. The G-20 consensus on DPI in 2023 signals a

growing recognition of DPI as global digital public goods. Cross-border interoperability of payment systems, mutual recognition of digital identities, and standardized data-sharing protocols are now on the global agenda. Such multilateral initiatives hold promise for reducing the cost of remittances, facilitating international trade, and enabling citizens to access services across borders especially vital in the context of migration, diaspora engagement, and global mobility. Yet, challenges persist. The research identifies several structural and operational risks, including outdated legal frameworks, cyber threats, and technology vendor lock-in. Many developing nations still operate under legacy regulations that fail to accommodate the dynamic needs of DPI ecosystems. Furthermore, issues of data privacy, security breaches, and surveillance fears can erode public trust in digital systems. The Ethiopian example of Fayda shows that even well-intentioned digital ID programs can face resistance if citizens lack confidence in data governance structures. Thus, building DPI also necessitates strengthening institutional capacity, regulatory clarity, and citizen engagement mechanisms. Another key takeaway is the need for a whole-of-country approach. DPI is not merely a technical or administrative tool; it is a socio-technical construct that requires coordinated action among government agencies, private sector innovators, civil society, and end-users. Public-private partnerships are essential for scaling DPI solutions, particularly in areas like cloud infrastructure, digital wallets, and mobile connectivity. Likewise, open standards and APIs, as seen in Singapore's APEX or India's DigiLocker, ensure that different layers of DPI can interoperate efficiently, allowing innovation to flourish. From a governance standpoint, DPI represents a paradigm shift. Unlike previous siloed approaches to digitization, DPI emphasizes reusability, scalability, and integration. This is evident in the modular architecture of platforms like India Stack, where identification, authentication, consent, and digital document exchange are layered to create a comprehensive digital ecosystem. Such architectures enable governments to rapidly innovate and respond to citizens' evolving needs without reinventing infrastructure for each new service. In terms of policy frameworks, the emphasis should be on embedding equity, resilience, and transparency into DPI design. Policies must ensure that DPI systems are inclusive by default accommodating persons with disabilities, the elderly, and those without digital devices. Equally, DPI must be resilient to future shocks whether pandemics, economic crises, or climate disasters. Investment in cybersecurity, ethical AI integration, and real-time monitoring systems can fortify DPI against these risks. Finally, transparency through open data protocols and grievance redressal mechanisms is essential to cultivate public trust and accountability. Looking ahead, DPI holds

the potential to act as a multiplier for achieving Sustainable Development Goals (SDGs). By enabling targeted social protection, digital education, remote healthcare, and efficient public utilities, DPI can accelerate progress on poverty reduction, gender equality, and climate resilience. For example, smart subsidies for agriculture or dynamic registration for health benefits can be built on DPI platforms. The convergence of DPI with emerging technologies like AI, IoT, and blockchain also opens new frontiers for personalized, predictive, and preventative public services. The discussion affirms that DPI is not a luxury but a necessity for modern governance. Its successful implementation, however, requires deliberate action rooted in ethical design, inclusive policy, cross-sector collaboration, and international solidarity. As digital transformation becomes the backbone of service delivery, DPI must be envisioned as the digital equivalent of roads, railways, and utilities an essential infrastructure for the 21st century.

CONCLUSION:

The importance of Digital Public Infrastructure (DPI) in the inclusive growth and improved service delivery in different sectors. With veritable adoption of the digital solution to the realities of the world, strong and available digital infrastructure is imperative especially in terms of realization of Sustainable Development Goals (SDGs) inclusive of the subject universal legal identification by 2030. In access to digital identity and financial services, especially rural populations, less educated people, and people not in the labor force, the gaps are critical, such as the necessity of eliminating these gaps. The COVID-19 pandemic has acted as a catalyst for the adoption of digital payments and services, revealing the stark contrast between countries with established DPI systems and those without. Countries that had invested in DPI were able to provide emergency assistance to significantly more beneficiaries, demonstrating the transformative potential of such infrastructure in times of crisis. Successful case studies from India, Brazil, and Singapore illustrate how effective DPI implementations, such as India's Aadhaar system and Brazil's Pix payment platform, can enhance accessibility, promote financial inclusion, and improve governance. However, the paper also identifies several challenges that must be addressed to fully realize the benefits of DPI. These include outdated legal frameworks, security risks, technology lock-in, and limited access to digital IDs for marginalized groups. The lack of secure digital authentication methods for over 5 billion users, particularly in low- and middle-income countries, poses a significant barrier to financial inclusion and equitable access to services. Therefore, it is essential for policymakers to prioritize the development of inclusive digital ecosystems that cater to the needs of all citizens, particularly the most vulnerable. To achieve this, the paper advocates for a whole-of-country approach that involves public-private partnerships and interoperability standards. Such collaboration can facilitate the sharing of best practices and resources, ultimately leading to more effective and sustainable DPI implementations. Global cooperation, as reflected in the G-20 consensus on DPI, is also crucial in fostering inclusive growth and supporting the SDGs. By

working together, countries can leverage their collective knowledge and experience to create equitable digital ecosystems that drive socioeconomic development worldwide.

In conclusion, the paper serves as a call to action for policymakers, urging them to recognize the importance of DPI in shaping the future of service delivery and financial inclusion. By addressing the existing disparities and challenges, and by fostering collaboration among various stakeholders, it is possible to build a digital infrastructure that not only enhances access to services but also promotes trust and security among users. The successful implementation of DPI can pave the way for a more inclusive and equitable digital economy, ultimately contributing to the broader goals of sustainable development and social equity. As we move forward, it is imperative that we prioritize the creation of accessible, inclusive, and resilient digital ecosystems that empower all individuals, regardless of their background or circumstances, to participate fully in the digital economy.

REFERENCES

1. Aker, J. C., Boumniel, R., McClellan, A., & Tierney, N. (2016). Payment mechanisms and antipoverty programs: Evidence from a mobile money cash transfer experiment in Niger. *Economic Development and Cultural Change*, 65(1), 1–37. <https://doi.org/10.1086/687578>
2. Baur-Yazbeck, S., Hobson, E. W., & Chirumba, M. (2021). The future of government-to-person (G2P) payments: 3 years of learning about G2P choice in Zambia. *CGAP Background Document, FinDev Gateway*. <https://www.findevgateway.org/paper/2021/04/future-government-person-g2p-payments-three-years-learning-about-g2p-choice-zambia>
3. Clark, J. M., Haseeb, M., Jalal, U. E. A., Siddiqi, B. M., & Vyborny, K. (2022). Using biometrics to deliver cash payments to women: Early results from an impact evaluation in Pakistan. *ID4D Evidence Note, World Bank Group*. <http://documents.worldbank.org/curated/en/099155004142238180/P1763410d1e1af00108e170e5754d04fed9>
4. Clark, J. M., Metz, A., & Casher, C. (2022). *ID4D Global Dataset—Volume 1 2021: Global ID coverage estimates*. Washington, DC: World Bank Group. <http://documents.worldbank.org/curated/en/099705012232226786/P176341032c1ef0b20adf10abad304425ef>
5. Cooper, A. K., Marskell, J. D., & Chan, C. H. (2022). *National digital identity and government data sharing in Singapore: A case study of Singpass and APEX*. Washington, DC: World Bank Group. <http://documents.worldbank.org/curated/en/099300010212228518/P171592079b3e50d70a1630d5663205bf94>
6. Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2022). *The Global Findex Database 2021: Financial inclusion, digital payments, and resilience*

- in the age of COVID-19. Washington, DC: World Bank.
7. Desai, V., Klapper, L., & Natarjan, H. (2022, November 15). Does digitizing government payments increase financial access and usage? *Brookings Future Development* (blog). <https://www.brookings.edu/blog/future-development/2022/11/15/does-digitizing-government-payments-increase-financial-access-and-usage>
8. Desai, V., Marskell, J., Marin, G., & Varghese, M. (2023, March 15). How digital public infrastructure supports empowerment, inclusion, and resilience. *Digital Development* (blog). <https://blogs.worldbank.org/digital-development/how-digital-public-infrastructure-supports-empowerment-inclusion-and-resilience>
9. *Designing and delivering public services in the digital age* (Going Digital Toolkit Notes). (2022). Organisation for Economic Co-Operation and Development (OECD). <https://doi.org/10.1787/e056ef99-en>
10. Field, E., Pande, R., Rigol, N., Schaner, S., & Troyer Moore, C. (2021). On her own account: How strengthening women's financial control impacts labor supply and gender norms. *American Economic Review*, 111(7), 234–275.
11. Finger, M., & Montero, J. (2023). Digitalizing infrastructure, digital platforms and public services. *Competition and Regulation in Network Industries*, 24(1), 40–53. <https://doi.org/10.1177/17835917231156099>
12. G20 India. (2023). *Digital economy ministers' meeting—Outcome statement and chair's summary*. G20 India, Bengaluru. https://www.g20.org/content/dam/gtwenty/gtwenty_new/document/G20_Digital_Economy_Outcome_Document_and_Chair's_Summary_19082023.pdf
13. Gherghin, C.-A. (2025). Public Policies for the Digitalization of Public Services in the European Union: From Foundations to Contemporary Challenges. *Technium Social Sciences Journal*, 67, 528–539. <https://doi.org/10.47577/tssj.v67i1.12453>
14. Global Partnership for Financial Inclusion. (2023). *G20 policy recommendations for advancing financial inclusion and productivity gains through digital public infrastructure*. Washington, DC: Global Partnership for Financial Inclusion. https://www.g20.org/content/dam/gtwenty/gtwenty_new/document/G20_POLICY_RECOMMENDATION_S.pdf
15. Lara de Arruda, P., Lazarotto de Andrade, M., Falcao, T., Barbosa, D. T., & Morgandi, M. (2022). The payment system used by Auxilio Emergencial: Introduction of the digital social account and the banking of more than 100 million people in 9 months. *Technical Note* 2, World Bank. <http://hdl.handle.net/10986/36837>
16. Latupeirissa, J. J. P., Dewi, N. L. Y., Prayana, I. K. R., Srikanth, M. B., Ramadiansyah, S. A., & Pramana, I. B. G. A. Y. (2024). Transforming Public Service Delivery: A Comprehensive Review of Digitization Initiatives. *Sustainability*, 16(7), 2818. <https://doi.org/10.3390/su16072818>
17. Luna, D. E., Picazo-Vela, S., Buyannemekh, B., & Luna-Reyes, L. F. (2024). Creating public value through digital service delivery from a citizen's perspective. *Government Information Quarterly*, 41(2), 101928. <https://doi.org/10.1016/j.giq.2024.101928>
18. Metz, A., Marin, G., Marksell, J., Clark, J., & Karpinski, K. (2022). A digital stack for transforming service delivery: ID, payments, and data sharing. *ID4D/G2Px Practitioner's Note*, World Bank Group. <https://documents1.worldbank.org/curated/en/099755004072288910/pdf/P1715920edb5990d60b83e037f756213782.pdf>
19. Muralidharan, K., Niehaus, P., & Sukhtankar, S. (2016). Building state capacity: Evidence from biometric smartcards in India. *American Economic Review*, 106(10), 2895–2929.
20. Nagar, S., & Eaves, D. (2024). *Interactions Between Artificial Intelligence and Digital Public Infrastructure: Concepts, Benefits, and Challenges* (Version 1). arXiv. <https://doi.org/10.48550/ARXIV.2412.05761>
21. Nordic Institute for Interoperability Solutions. (2023). *X-Road world map*. Tallin: Nordic Institute for Interoperability Solutions. <https://x-road.global/xroad-world-map>
22. OECD (Organisation for Economic Co-operation and Development). (2022). Singapore's national digital identity—Singpass. *Observatory of Public Sector Innovation* (blog).
23. Poole, E., Toohey, C., & Harris, P. (2014). Public infrastructure: A framework for decision-making. *Reserve Bank of Australia (RBA) Annual Conference*, 97–135. Sydney: Reserve Bank of Australia. <https://www.rba.gov.au/publications/confs/2014/pdf/poole-toohey-harris.pdf>
24. Rockefeller Foundation, Digital Public Goods Alliance, & Norway Ministry of Foreign Affairs. (2021). *Co-Develop: Digital public infrastructure for an equitable recovery*. New York: Rockefeller Foundation. <https://www.rockefellerfoundation.org/wp-content/uploads/2021/08/Co-Develop-Digital-Public-Infrastructure-for-an-Equitable-Recovery-Full-Report.pdf>
25. Sadykova, K., & Galy, A. (2024). OECD COUNTRIES' EXPERIENCE IN TRANSFORMATION OF PUBLIC SERVICE DELIVERY SYSTEMS. «Вестник Атырауского университета имени Халела Досмұхамедова», 195–208. <https://doi.org/10.47649/vau.24.v75.i4.17>
26. Sahur, A., & Amiruddin, A. (2023). Analysis of the Success of Implementing Digital Service Delivery in the Indonesian Public Sector: A Case Study on the Use of Online Public Service Applications. *International Journal Paper Public Review*, 4(3), 1–9. <https://doi.org/10.47667/ijppr.v4i3.242>
27. Setijadi Prihatmanto, A., Andrian, R., Danar Sunindyo, W., & Sutriadi, R. (2024). Transforming Public Services: A Systematic Review of Smart

- Government Frameworks, Architectures, and Implementation Challenges. *IEEE Access*, 12, 135799–135810. <https://doi.org/10.1109/access.2024.3450907>
28. Setyawan, A. C. (2024). Enhancing Public Service Delivery through Digital Transformation: A Study on the Role of E-Government in Modern Public Administration. *Global International Journal of Innovative Research*, 2(10), 2439–2453. <https://doi.org/10.59613/global.v2i10.340>
29. Shin, S.-C., & Rakhmatullayev, Z. M. (2019). Digital Transformation of the Public Service Delivery System in Uzbekistan. *2019 21st International Conference on Advanced Communication Technology (ICACT)*, 703–709. <https://doi.org/10.23919/icact.2019.8702014>
30. Syamsiar, S. (2023). The Role of Digitalization in Enhancing Public Service Effectiveness in Indonesia. *Jurnal Ilmiah Ilmu Administrasi Publik*, 13(1), 465. <https://doi.org/10.26858/jiap.v13i1.51026>
31. Traversing the infrastructures of digital life. (2021). In H. Knox, *Digital Anthropology* (2nd ed., pp. 178–196). Routledge. <https://doi.org/10.4324/9781003087885-13>
32. Ugochukwu Francis Ikwuanusi, Okeoma Onunka, Samuel Jesupelumi Owoade, & Abel Uzoka. (2024). Digital transformation in public sector services: Enhancing productivity and accountability through scalable software solutions. *International Journal of Applied Research in Social Sciences*, 6(11), 2744–2774. <https://doi.org/10.51594/ijarss.v6i11.1724>
33. Vainsalu, H. (2017, December 12). How do Estonians save annually 820 years of work without much effort? *e-Estonia* (blog). <https://e-estonia.com/how-save-annually-820-years-of-work>
34. White, O., Madgavkar, A., Manyika, J., Mahajan, D., Bughin, J., McCarthy, M., & Sperling, O. (2019). *Digital identification: A key to inclusive growth*. New York: McKinsey Global Institute. <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/digital-identification-a-key-to-inclusive-growth>
35. World Bank. (2018). *Private sector economic impacts from identification systems*. Washington, DC: World Bank.
36. World Bank. (2022a). *ID4D federated ecosystems for digital ID*. Washington, DC: World Bank Group. <http://documents.worldbank.org/curated/en/099745012232218303/P17159208cf1d501a0af6f001e4852997fc>
37. World Bank. (2022b). *The role of digital in the COVID-19 social assistance response*. Washington, DC: World Bank. <http://hdl.handle.net/10986/38104>
38. World Bank. (2023). *Deep dive into the ecosystem for the delivery of social assistance payments: Türkiye case study*. Washington, DC: World Bank.
39. World Bank. (Forthcoming). *Mozambique SP COVID-19 response survey*. Washington, DC: World Bank.