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State of India's Digital Economy

SIDE

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AUTHORS

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GLOSSARY

AA	Account Aggregator
ABDM	Ayushman Bharat Digital Mission
ABHA	Ayushman Bharat Health Account
AB-HWC	Ayushman Bharat Health & Wellness Centre
AI	Artificial Intelligence
AIIMS	All India Institute of Medical Science
APB	Aadhaar Payments Bridge
APHRA	Australian Health Practitioner Regulation Agency
API	Application Programming Interface
AR/VR	Augmented Reality / Virtual Reality
ARPU	Average Revenue Per User.
BFSI	Banking, Financial Services and Insurance
BHIM	Bharat Interface for Money
CAG	Comptroller and Auditor General of India
CAGR	Compound Annual Growth Rate
CCTNS	Crime and Criminal Tracking Network and Systems
CDC	Centers for Disease Control and Prevention
CHIP	Connect, Harness, Innovate and Protect
CIC	Currency in Circulation
CIDR	Central Identities Data Repository
CMIE	Centre for Monitoring Indian Economy
Co-WIN	Covid Vaccine Intelligence Network
CPI	Consumer Price Index
CSC	Common Services Centre
DBT	Direct Benefit Transfer
DDL	Digital Development Level
DeFi	Decentralised Finance
DEPA	Data Empowerment and Protection Architecture
DGSes	Digitised Government Services
DIGIT	Digital Infrastructure for Governance, Impact and Transformation
DILRMP-MIS	Digital India Land Records Modernisation Programme
DISHHA	Digital Infrastructure for Sustainable and Healthy Habitats
DIVOC	Digital Infrastructure for Verifiable Open Credentialing
DoT	Department of Telecom
DPG	Digital Public Goods
DPI	Digital Public Infrastructure
DPIP	Digital Public Infrastructure and Platforms
DPP	Digital Public Platform
ECI	Election Commission of India
E-KYC	Electronic Know-Your-Customer
e-Taal	Electronic Transaction Aggregation and Analysis Layer

ETNO	European Telecommunications Network Operators' Association
EU	European Union
FIP	Financial Information Provider
FIU	Financial Information User
GB	GigaByte
GDP	Gross Domestic Product
GNI	Gross National Income
GPAI	Global Partnership on Artificial Intelligence
GPWSC	Gram Panchayat Water and Sanitation Committee
GSMA	Groupe Speciale Mobile Association
GTMI	World Bank GovTech Maturity Index
HFR	Health Facility Registry
HPD	Healthcare Providers Directory
HPI-I	Healthcare Provider Identifier- Individual
HPI-O	Healthcare Provider Identifier- Organisation
HPR	Health Professionals Registry
Hz	Hertz
IAMAI	Internet and Mobile Association of India
ICMR	Indian Council of Medical Research
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
iFIX	India Fiscal Information Exchange Platform
IHI	Individual Health Identifier
IIDEA	International Institute for Democracy and Electoral Assistance
IIHS	Indian Institute for Human Settlements
IIIT-B	International Institute of Information Technology, Bangalore
IMPS	Immediate Payments Service
INR	Indian National Rupee
INR	Indian Rupee
IRDAI	Insurance Regulatory and Development Authority
IT	Information Technology
ITeS	Information Technology Enabled Services
ITU	International Telecommunication Union
IXP	Internet Exchange Point
JAM	Jan Dhan-Aadhaar-Mobile
LDC	Least Developed Countries
LLDC	Land Locked Developing Countries
MAS	Monetary Authority of Singapore
MB	MegaByte
Mbps	Megabits Per Second
MDR	Merchant Discount Rate
MeitY	Ministry of Electronics and Information Technology
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MIS	Management Information Systems

MMP	Mission Mode Project
MoHFW	Ministry of Health and Family Welfare
MoHUA	Ministry of Housing and Urban Affairs
MOPNG	Ministry of Petroleum and Natural Gas
MOSIP	Modular Open-Source Identity Platform
MoU	Memorandum of Understanding
MSME	Micro, Small and Medium Enterprises
NBFCs	Non-Banking Finance Companies
NCRB	National Crime Records Bureau
NCSI	National Cybersecurity Index
NeGP	National e-Governance Plan
NeSDA	National e-Governance Service Delivery Assessment
NFHS	National Family Health Survey
NIC	National Informatics Centre
NLP	Natural Language Processing
NM-ICPS	National Mission on Interdisciplinary Cyber-Physical Systems
NPCI	National Payments Corporation of India
NSAP	National Social Assistance Programme
NUDM	National Urban Digital Mission
OBPAS	Online Building Plan Approval System
OCEN	Open Credit Enablement Network
OECD	Organisation for Economic Cooperation and Development
OFC	Optical Fibre Cable
OPD	Out Patient Department
OTT	Over the Top
P2P	Peer-To-Peer
PDS	Public Distribution System
PFRDA	Pension Fund Regulatory and Development Authority
PMGKAY	*Pradhan Mantri Garib Kalyan Anna Yojana*
PPP	Purchasing Power Parity
PwC	PricewaterhouseCoopers
RAISE	Responsible AI for Social Environment
RBI	Reserve Bank of India
RBIH	RBI Innovation Hub
ReBIT	Reserve Bank Information Technology Private Limited
RRBs	Regional Rural Banks
SDC	State Data Centre
SEBI	Securities and Exchange Board of India
SGFinDex	Singapore Financial Data Exchange
SIDs	Small Island Developing States
SIM	Subscriber Identity Module
SLL	Special and Local Laws
SNDGG	Smart Nation and Digital Government Group
SWAN	State Wide Area Networks

TRAI	Telecom Regulatory Authority of India
TSPs	Technical Service Providers
UAE	United Arab Emirates
UDISE+	Unified District Information System for Education Plus
UHI	Unified Health Interface
UIDAI	Unique Identification Authority of India
UK	United Kingdom
ULBs	Urban Local Bodies
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UPI	Unified Payments Interface
UPYOG	Urban Platform for deliverY of Online Governance
USA	United States of America
USD	United States Dollar
UT	Union Territory
Wi-Fi	Wireless Fidelity

From a laggard to a leader

It is striking that many Indians carry their Covid vaccination digital certificate on their smartphone, while Americans have no such option and must carry a hand-filled physical card (see Figure 1). Since the start of the industrial revolution in the 1750s, the benefits of technological progress have reached Indians with decades of delays. The steam engine came to India 81 years after it was invented. By the time electricity arrived, it had been in use for 78 years. Passenger cars took 71 years; computers 22 years, and smart phones 4 to 7 years.[1] Co-WIN, an app for making online appointments to get vaccinated and store certificates digitally, beat history. The Co-Win success stands out because India is still a relatively poor country – India's per capita income is 3.5 per cent that of the United States.[2]

Figure 1: India has a digital app to register and store vaccination records, while the US has opted for a paper-based system

Co-WIN vaccination certificate in India

CDC certified vaccination card in the USA
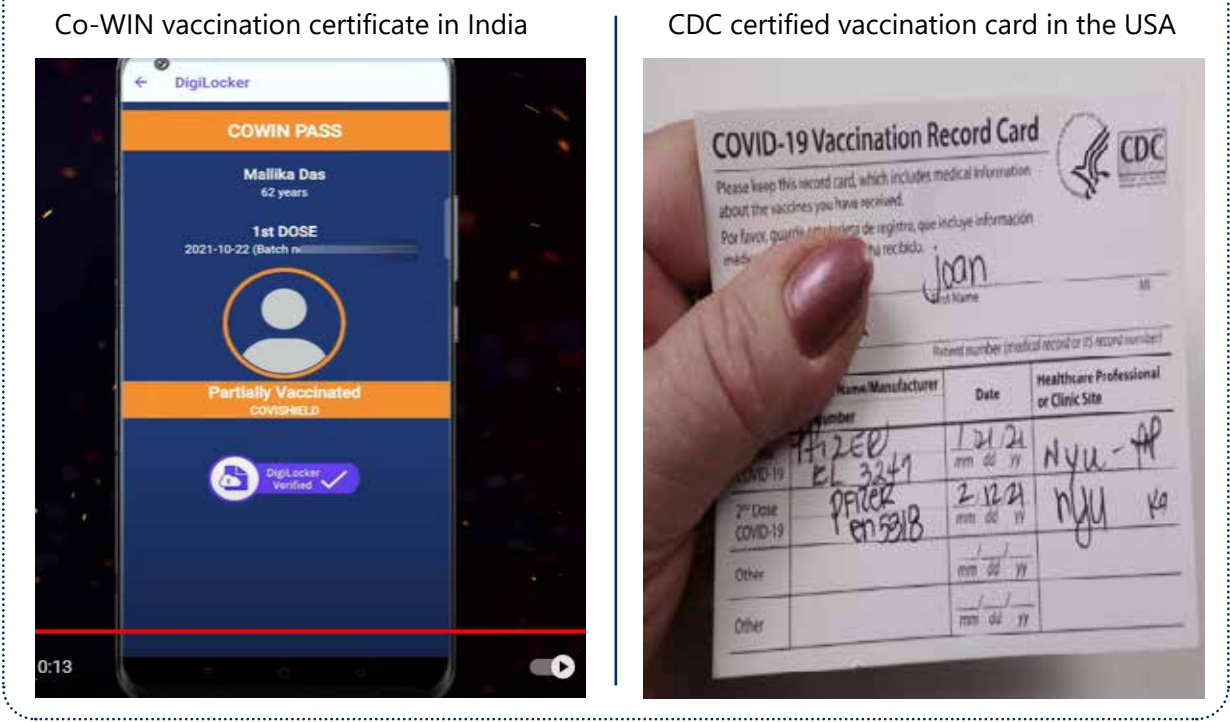
Source: IPCIDE Team

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[1] Retrieved on January 13, 2023, from https://thelogicalindian.com/exclusive/indian-railways-timeline/ (steam engine invented in 1764 and Indian railways established in 1845) ; https://www.statista.com/topics/5193/electricity-in-india/#topicOverview (electricity used commercially for lightbulbs in 1882 and India started using regional/state based management systems in the 1960s); https://htschool.hindustantimes.com/editorsdesk/knowledge-vine/the-first-ever-car-manufactured-in-india-a-journey-down-memory-lane (commercially available cars in 1886 in Germany while first ambassador introduced in 1957); https://history.computer.org/pubs/2012-12-rajaraman-india-computing-history.pdf (first commercially produced computers were UNIVAC in USA in 1951, it is unclear when the first computers were commercially spread across in India but according to the report , the ballpark of 22 years seems appropriate since 1951); https://economictimes.indiatimes.com/tech/hardware/first-android-phone-in-india-launched-today/articleshow/4689118.cms?from=mdr (first smartphone introduced in 1992 but started to spread commercially in 2002 - the first smartphone for India was introduced in 2009 by HTC).

[2] India is not the only developing country that is closing the gap with developed countries when it comes to the digital revolution. Several low-and-middle-income countries, including Brazil, China, Indonesia, Kenya, Vietnam, have built digital infrastructure that are as good or better than what one finds in the developed world.

The Co-WIN success story isn't an isolated one. More and more government services are being provided and accessed on digital platforms. With a large population of 1.4 billion, 1.3 billion telecom subscribers, 900 internet subscribers and nearly 500 million smartphone users, few countries in the world are experimenting with digital solutions that can match India's scale. The country's digital journey started in 2009 with Aadhaar, which is the world's largest biometric digital identity system. It provides the foundation on which India's digital ecosystem is being built. A range of digital goods, infrastructure, platforms and services are available within this ecosystem.[3] Many of which have added more than a 100 million plus users already (see Figure 2). Many components of India's digital ecosystem are owned and managed through public-private partnerships or are fully private.

What has set the Indian model apart is its championing of the development and deployment of digital public infrastructure and several digital public platforms (DPIPs). A prominent example being the *India Stack*: the trinity of Aadhaar, Unified Payments Interface (UPI) and the Data Empowerment and Protection Architecture (DEPA) set up to "unlock the economic primitives of identity, data, and payments at population scale and to establish a level playing field for members of a digital ecosystem". The Bharat Interface for Money (BHIM), a public sector mobile payment platform that was created as a reference app for UPI, directly competes with private players like PhonePe and Google Pay. There are numerous other DPIPs in operation, including health, commerce, urban governance, etc. (see Figure 3).

Figure 2: India has digital public infrastructure and platforms (DPIPs) along with an array of privately operated platforms (Number of users in million)

Category	Users (million)
Account Aggregators (Finance)	3
e-Sanjeevani (halth platform)	92
Online learning platforms	93
BHIM (payment platform)	209
DIGIT (e-gov)	250
Food delivery platforms	268
UPI (Payment interface)	300 — Public/PPP
ABHA (health ID)	322
Smartphone users	493
Social media platforms	497
E-commerce platforms	644 — Private
Active internet users	692
Internet subscribers	851
Co-Win (vaccination)	1,040
Telecom subscribers	1,250
Aadhar (foundational)	1,360
Population	1,400

Source: Compiled by IPCIDE Team

Note: Blue bars are statistics for public or public-private partnership platforms, yellow are for private platforms, and grey are basic access related data for the digital economy.

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[3] See "Aadhaar: platform or infrastructure? Developing a taxonomy for India's digital public eco-system," to understand the distinction between digital public goods (DPGs), digital public infrastructures (DPIs), digital public platforms (DPPs) and digital generalised services (DGS); Mishra, D., Kedia, M., Kanwar, S., & Das, B. (2023). Aadhaar: Platform or Infrastructure? Developing A Taxonomy for India's Digital Public Ecosystem. ICRIER-Prosus Centre for Internet and Digital Economy. Retrieved on February 8, 2023, from https://icrier.org/pdf/IPCIDE-Policy_Brief_3.pdf

Figure 3: India's digital public ecosystem in selected sectors

	Finance	Health	Commerce
DGS	**Digitised** Government Services	**Digitised** Government Services	**Digitised** Government Services
DPPs	BHIM	Co-WIN · eSanjeevani	GeM
DPIs	UPI	Health Professionals Registry · Health Facility Registry · Ayushman Bharat Health Account · Unified Health Interface	ONDC
DPGs	Several **DPGs**	beckn	beckn
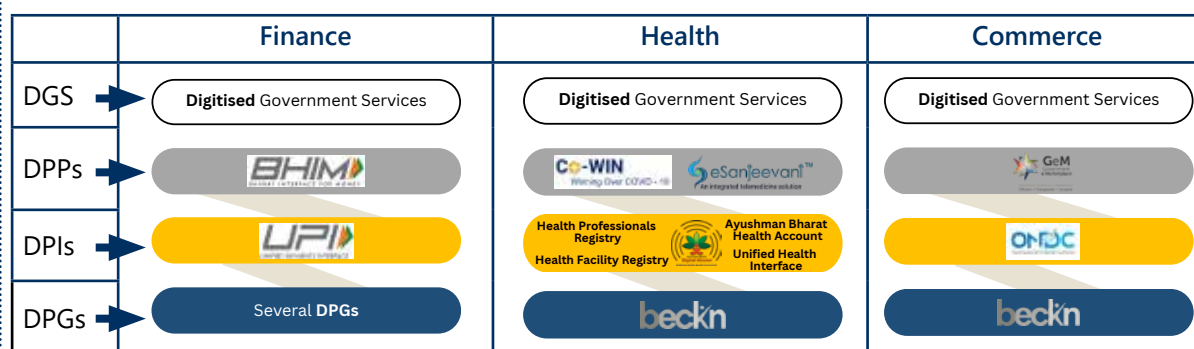
Source: IPCIDE Policy Brief 3 (2023)

Note: DGS - Digitised Government Services; DPPs - Digital Public Platforms; DPIs - Digital Public Infrastructure; DPGs - Digital Public Goods

An unchartered trail of benefits and risks

India's digital success is the coming together of technologies and applications from home and abroad. Predictably, the US has seen more private initiatives. The Big Tech companies and the Silicon Valley dominate the digital space there. China is at the other extreme, where the line between public and private is blurred. India is evolving differently: public and private companies, domestic and foreign players coexist. So far India's experiment has got off to a good start, with several DPIPs demonstrating the potential to beat the growth and reach of Aadhaar (see Figure 4).

Figure 4: A horse race among Indian DPIPs: Will they all reach the finish line?
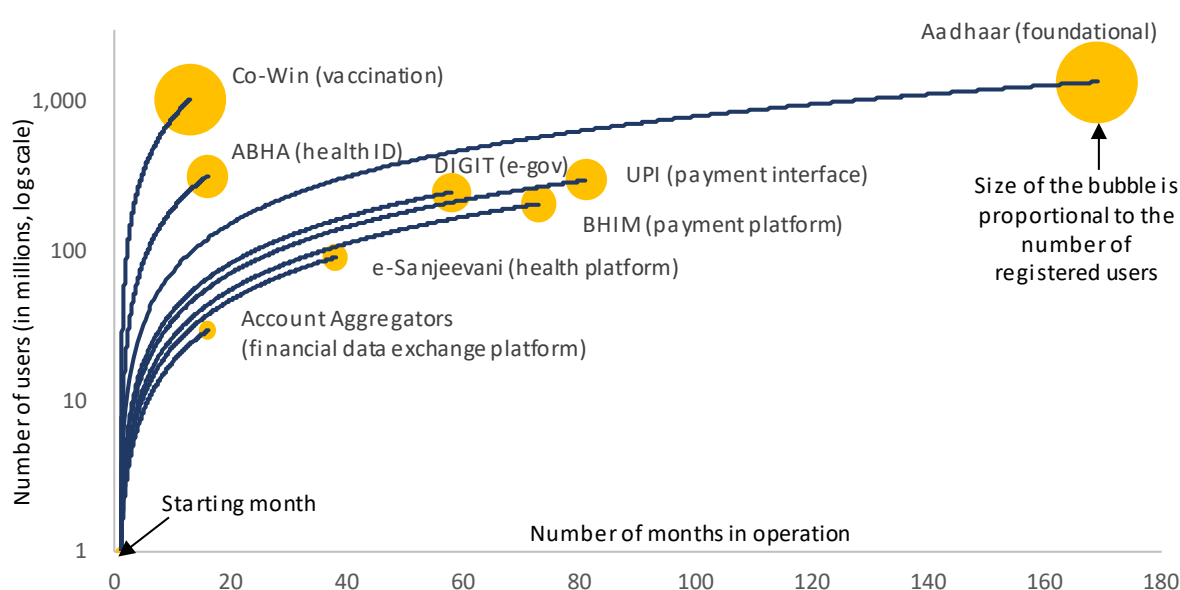
Source: IPCIDE Team

DPIPs hold the potential to bend the arc of India's development. DPIPs are largely being built in areas where either the markets have failed to provide services, e.g., credit to micro, small and medium enterprises (MSMEs), or there are government failures, e.g., transfer of cash benefits to underprivileged households. If effectively implemented, DPIPs could positively impact India's development outcomes in three ways. First, they could make the development process more inclusive by taking the gains of digital technologies to poor households and those in geographically remote areas. Second, by lowering the cost of transactions, they could make markets and governments more efficient. Finally, DPIPs could make the development process more innovative by allowing private sector and government agencies to build new products and services. This report provides several examples of the contribution of DPIPs in making India's development process more inclusive, efficient and innovative.

Despite these obvious advantages, DPIPs also pose three types of inter-related risks. First, given that they are often built on each other, if an individual gets left out of a foundational DPIP, the risk is that they would get excluded from an entire ecosystem. Universal connectivity and access to digital technologies are the starting point to leverage DPIPs. Those without access to these run the risk of **exclusion**. Such exclusions can in turn exacerbate pre-existing gender, regional or income divides. Second, in the absence of good governance and regulation, DPIPs could grow to become digital monopolies, and thus, carry the risk of **concentration**. Finally, given the volume of data passing through DPIPs, they have become a natural target for criminals and hostile entities, which poses risks related to **cybersecurity and privacy**.

Understanding the State of India's Digital Economy (SIDE)

The fast-paced growth in adoption of digital applications etc. seen in India does not get captured in the literature where performance is benchmarked against other countries. The widely cited ICT Development Index (IDI), prepared by the International Telecommunication Union, ranked India 134 out of 176 countries, ahead of Myanmar and behind Lesotho.[4] The United Nation's e-Government Readiness Index ranks India at the 88th position out of 193 countries (2020). The latest Network Readiness Index developed by the Portulans Institute places India at the 61st position among 131 countries (2022).

The **State of India's Digital Economy (SIDE) Report** measures and analyses India's digital transformation using data, information and evidence that are specifically relevant to the Indian context. In this, the report departs from the norm for global studies. While global indicators go for breadth rather than depth by choosing the indicators that are easily available across a large number of countries, the SIDE report focuses chiefly on those indicators that matter for understanding India's digital economy. It then finds the same data for comparator countries. The report also provides sub-national comparisons.

This is a two-part report. The first part benchmarks the progress of India's digital economy relative to the G20 countries. It also compares the performance across Indian states. The second part is a study of the rapid rise of DPIPs in India. It discusses the benefits they offer and the risks they are susceptible to.

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[4] Part of the problem is that some of the global indices are dated. For example, the latest ITU index is from 2017.

Framework of the Report

The report traces the digital transformation through its four interrelated stages: Connect, Harness, Innovate and Protect, or the CHIP framework. The progress is examined for three types of agents: people, businesses and government. The 'connect' pillar benchmarks the level and change in the internet connectivity of individuals, businesses and government agencies. The 'harness' pillar measures how India is using the internet to generate growth, create jobs and improve governance. The third pillar, 'innovate,' explores the engagement of Indian households, businesses and government agencies with emerging technologies. The final pillar examines the level of 'protection' Indians enjoy in the digital space vis-à-vis the rest of the world and across different states.

Main Findings – Part I

Despite being a lower-middle income country compared to its G20 peers, India's performance is significantly superior on the "innovation" pillar. The next strongest suit is harness, where Indians are adopting digital services at a quick pace. There are mixed results for the connect pillar. While India is set to become the world's most connected nation, at the same time the digital divides across geography, gender and income continue to remain unacceptably high. The weakest link in India's digital transition is the fourth pillar, protection against cybercrime and invasion of privacy. This requires urgent attention (see Figure 5). The government is working to address this through legislations such as the Digital Personal Data Protection Bill (2022) and new guidelines notified by CERT-In.

Connect: India's connectivity has grown by leaps and bounds in recent years, but unequally. India is the fastest growing and the second largest telecommunications market in the world. During the pandemic lockdowns, businesses adopted internet connectivity at faster pace in India, closing the gap on this front with other countries. The report shows sharp increase in connectivity in public sector institutions, especially those in charge of law and order and land records.

The digital divides, however, persist. In 2021, only 37 per cent of the rural population were active internet users compared to 69 per cent in urban areas. And with less than one out of three women in rural India using the internet, the gender divide is at an unacceptably high level. Across Indian states too, digital divides are large and these gaps are not closing. One reason for inequality in access is the infrastructural gap.

Figure 5: The heat map showing the State of India's Digital Economy (SIDE) in 2022

	People	Businesses	Government
Connect			
Harness			
Innovate			
Protect			
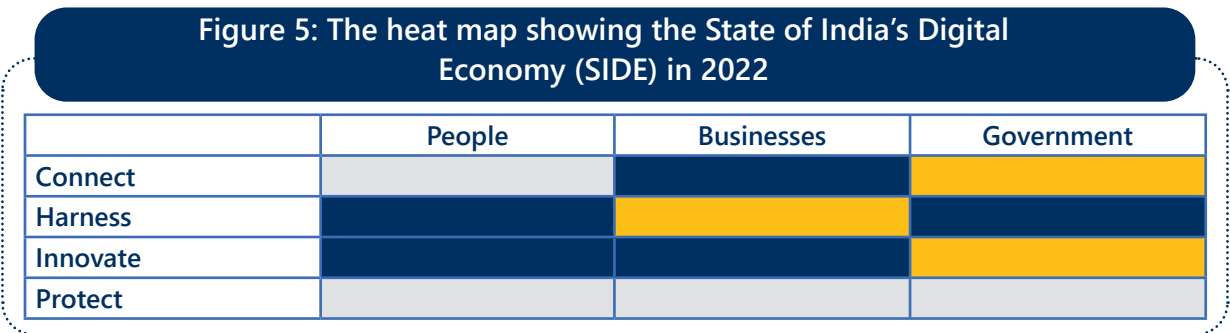
Source: IPCIDE Team

Note: Blue denotes above par, yellow denotes at par and grey represents sub-par performance. Assessment of the relative strength of each pillar is based on a considerable body of data and evidence that are presented in the sections of this report. Ultimately, this is not an objective assessment and involves some subjective interpretation of facts and their relative importance to India's digital transformation.

Government initiatives such as for the laying of fibre and strengthening state networks should help bridge this over time.

Harness: The report shows that once they connect to the internet, Indians are adept at harnessing its benefits. Households are using digital services, leading to a sharp rise in digital payments, e-commerce, online learning, food delivery, etc. Although revenue monetisation has lagged behind. The roll out of e-governance has seen remarkable growth, leading to measurable improvements in efficiency, service delivery and citizen engagement. For businesses, divides in internet connectivity have narrowed across firms by size. However, the gap has widened in the adoption of digital services. Lack of universal access to quality internet and low levels of digital literacy are the two main factors limiting the realisation of the internet's full potential.

Innovate: Of the four pillars in the CHIP framework, India is doing surprisingly well on "innovate". It currently ranks the highest in contribution to open-source Artificial Intelligence (AI) projects, ahead of developed nations like the US. Its AI publications are growing at 18 per cent, faster than the US, China, the EU and the UK. Venture capital investments in AI start-ups have also steadily increased. A higher percentage of IT workers in India possess AI skills than in any other G20 country. India has also been steadily pursuing the development and adoption of other emerging technologies like cloud computing, big data analytics, internet of things, augmented, mixed and extended reality, etc. India has the third highest number of unicorns in the world, having added 14 new unicorns in the first half of 2022. To maintain this momentum, India must invest more in enhancing its resource pool and building the technical capacity of its labour force across the range of emerging technologies.

Protect: India still has a lot of work to do in adequately protecting the digital economy from cyberthreats. Cybercrimes reported by Indian users is the highest among G20 countries. India had the fourth highest number of data breaches in 2022, followed by Russia, the US and France. Another worrying trend is the increasing number of attacks in the government sector and state-sponsored attacks. There is increasing sophistication in cybercrime, cyber espionage, compromising organisational networks and data systems. Without an exclusive cybersecurity law, Indians have to rely on anachronistic and sectoral regulations, making "protect" the weakest link in India's otherwise remarkable digital transformation.

Main Findings – Part II

This section delves into five DPIPs that are currently in operation in India, namely, *Aadhaar*, Unified Payment Interface (UPI), Ayushman Bharat Digital Mission (ABDM), Digital Infrastructure for Governance, Impact & Transformation (DIGIT), and the Account Aggregator (AA) Framework. Each case study presents an analysis of benefits and risks that have emerged from their implementation. Our analysis leads us to a seven-step DPI checklist that can potentially strengthen India's DPIP initiatives and their contribution to growth and development.

Aadhaar, the world's largest digital identity platform, has provided a massive boost to financial inclusion in India. The country has reached significantly high levels of bank account ownership, closing the gap between the rich and the poor and between men and

women. The Aadhaar Payments Bridge (APB) helped actualise the Direct Benefits Transfer (DBT) Scheme, plugging leakages in welfare delivery. According to government estimates, the scheme has led to an overall savings of INR 2 trillion. Aadhaar through e-KYC has also brought down costs of verification, leading to savings in costs for customer acquisition from INR 500 – 700 per person to INR 3. *Aadhaar*, however, is vulnerable to risks of exclusion, privacy and data security. Some of these risks have been highlighted previously in the 2019 State of Aadhaar report as well as the recent Comptroller and Auditor General (CAG) of India's 2022 report. Our report suggests that UIDAI share more data on authentication failures and explain the fool-proofing of its ecosystem for a better understanding of the perceived risks.

The Unified Payments Interface (UPI) is India's real-time interoperable payments system, which has seen unprecedented growth, especially for peer-to-peer (P2P) transactions. Over time, UPI has introduced features such as UPI123 and UPILite to make the ecosystem more inclusive, although gender divides continue to exist.[5] The policy choice to maintain the merchant discount rate (MDR) at zero is now being debated, as it has been found to hurt the economics of all stakeholders involved, and government subsidies are inadequate to cover the expenses incurred by ecosystem players.[6] One of the risks facing UPI is the concentration of market participants in the network, that has continued to persist. Pix, the digital payments network in Brazil, which has also seen phenomenal growth in two years of operation, is designed and governed differently and provides an alternate model to compare with and learn from.

The adoption of Ayushman Bharat Digital Mission (ABDM) has seen fragmented growth. As shown in the report, while the Co-Win platform saw phenomenal success, the registration of health IDs and linking of electronic health records has been relatively slow and regionally dispersed. The system currently is completely driven by public sector institutions unlike most other DPIs in India. E-Sanjeevani, the government's telehealth platform, is a rising star and stands out in terms of the share of female users, compared to many other private sector platforms. Australia's Digital Health Ecosystem designed and implemented differently, offers a good comparison.

The recently announced Urban Platform for deliverY of Online Governance (UPYOG), built using the Digital Infrastructure for Governance, Impact & Transformation (DIGIT) core, is designed to enhance the operational capacity of rural and urban local bodies and integrate municipalities and cantonments into a central system. The DIGIT core developed by the Egov Foundation has already been rolled out to provide domain specific applications for sanitation, health, public finance management, in addition to urban governance. The multichannel design feature of DIGIT enables inclusion, the modularity allows for innovation, data minimisation enables privacy and real-time transactional data allows for efficiency. Improvements in development outcomes are slowly becoming visible. However, several non-technical factors including inefficiencies in the government procurement process, identification of implementation partners, duplication of modules and low awareness, are challenges that have resulted in the relatively slow uptake of DIGIT.

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[5] UPI123 is for feature phones and UPILite is an on-device wallet for offline use.

[6] Merchant Discount Rate or MDR is the fee charged to a merchant for the processing of a digital payment.

Finally, the Account Aggregator Framework (AAs), built on the Data Empowerment and Protection Architecture (DEPA) is a new class of intermediaries that facilitate data sharing based on valid consent from individual users. The DigiSahamati Foundation or Sahamati is a not-for-profit collective of AAs established to promote adoption of the AA ecosystem. Currently, it formulates and promotes adoption of technical standards, publishes audit guidelines and interoperability standards for members, and monitors member compliance. The AA ecosystem is still in the early stages with evolving guidelines and industry practices. From the latest data available, 4.02 million bank accounts have been linked to AAs and the cumulative count of consent requests successfully fulfilled is 3.9 million. According to industry estimates, 50 per cent of the lending disbursed through AAs were to MSMEs and that the cost of loan processing has declined by 75 per cent from INR 440 to below INR 100. For the AA Framework to prosper, the lack of digital skills and literacy will need to be addressed. In a different institutional set up, SGFinDex from Singapore is operated by the government with users having full control over their financial information. The ideal model for financial information exchange depends on the needs of borrowers and how the ecosystem evolves over time. Cross-country assessments however help build an understanding of best practices.

A review of DPIs and their end objectives suggests that DPI conception and implementation, focuses on aspects that include both technical and non-technical components. Very often, there is disproportionate focus on the technical design, without enough emphasis on the non-technical components of implementation. Our seven-step checklist, helps to think of DPIs from a project implementation point of view that begins with (i) identification of the need and choice of DPI, followed by (ii) an institutional design and framework for governance, (iii) sources of financing; three key elements of implementation including (iv) partnerships, (v) mission mode delivery, (vi) strengthening of non-technical components and finally (vii) an impact assessment to establish DPI accountability and build trust.

CONNECT: A BRIGHT SPOT, BUT ALSO A WEAK LINK

A fast growing, mobile-based and data intensive digital economy

With rapid growth in mobile broadband subscriptions in the last decade, India is now the second-largest telecommunications market in the world with a subscriber base of over 1.17 billion (TRAI, 2022). Wireless internet subscriptions have more than tripled from 248 million in 2014 to over 820 million in September 2022 (TRAI, 2022), and could hit the one billion number as early as 2025.[7] India is not just the second largest mobile broadband market, but also the fastest growing one. Between 2014 and 2021, India registered an annual growth rate of 41 per cent, which implies that 3 out of 5 new customers in the global mobile broadband market came from India (see left panel, Figure 6)[8]. However, with 97 per cent of all broadband subscribers being mobile subscribers, India lags considerably when it comes to fixed broadband subscription (see right panel, Figure 6).

The average Indian subscriber generates 1.55 times the traffic of the G20 average (see left panel, Figure 7). The average monthly wireless data usage per subscriber almost doubled between 2018 and 2022.[10] A variety of reasons explain this meteoric rise, including cheaper data and cheaper devices.

Figure 6: India is the second largest and fastest growing telecommunications market in the world

Active Mobile Broadband Subscriptions (Growth rate in per cent, 2014-21)

India	40.8
Indonesia	19.2
South Africa	15.7
China	14.4
Turkey	11.7
Mexico	10.7
Japan	8.6
U.S.A	7.7
Russia	7.6
Canada	7.2
France	6.1
Germany	5.9
U.K.	4.4
Italy	4.2
Brazil	3.8
Australia	2.3
South Korea	1.8

Active Mobile Broadband Subscriptions (% of total broadband subscriptions, 2021)

South Africa	98
India	97
Indonesia	96
Japan	86
Brazil	83
Russia	82
Mexico	82
U.S.A	81
Turkey	79
Australia	78
Italy	75
China	74
U.K	73
South Korea	73
Germany	68
France	68
Canada	66

Source: ITU-D ICT Statistics (2021).

Note: Data for France are from 2020, the latest available in the ITU-D ICT Statistics Database

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[7] Retrieved on September 14, 2022, from https://indbiz.gov.in/india-to-have-nearly-1-billion-internet-users-by-2025-report/ and https://www.statista.com/statistics/255146/number-of-internet-users-in-india/.

[8] ITU-D ICT Statistics Database. Retrieved on September 14, 2022, from https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.

[9] Excluding the USA, the UK, Argentina and Saudi Arabia

[10] Average monthly wireless data usage per wireless data subscriber was 8.74 GB in December 2018 (TRAI, 2019) and 17.18 GB in September 2022 (TRAI, 2022).

High internet traffic also implies that internet users in India spend more time on the internet than the G20 average.[11] This is especially true for social media use. Internet users in India spend 36 per cent of their total internet time on social media against the G20 average of 32 per cent. However, it is aligned to trends in social media use in other developing countries, where social media is also used for work related activities (see Appendix 1A and 1B). In India, 28 per cent of internet users (between 16-64 years) use social media for work related activities.

Figure 7: Indians are amongst the most intensive mobile data users in the world, spending as much time on the internet as the average user in G20 countries

Average monthly mobile internet traffic per mobile broadband subscription (MB), 2021

Time spent on the internet, 2022

Source: ITU Digital Development Dashboard for internet traffic. Percent of population using the internet is from IAMAI-IMRB Internet in India Reports, OECD Digital toolkit, World Bank and Statista (2020/21)

Source: Digital 2022; Global Overview Report Hootsuite

A pandemic driven push has closed the digital divide among businesses

Businesses in India saw a sharp rise in connectivity between 2019 and 2021, much sharper than that for individuals. Businesses in India are now at par with other countries with respect to internet connectivity (see Figure 8). As lockdowns became the new normal, many firms that survived went online. This is especially true for small sized businesses where connectivity to the internet increased by 69 per cent in one year, from 2019 to 2020. While the growth for large businesses remained flat, connectivity in medium sized business also increased by 17 per

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[11] High video consumption and greater sharing of devices may partly explain why India's data traffic per subscription is higher than in countries like Brazil and South Africa that have higher time spent on the internet through mobile phones. High video consumption and greater sharing of devices may partly explain why India's data traffic per subscription is higher than countries like Brazil and South Africa, that have higher time spent on the internet through mobile phones (Sheth et al. 2023; Business Today 2020).

cent. This sharp rise almost closed any gaps in connectivity across firm size. This is also true for businesses across sectors (see Figure 9). In 2016, 33 per cent of the businesses in the services sector were connected to the internet compared to 22 per cent in the manufacturing sector. This gap has come down to 2 per cent today, with 90 per cent firms in the services sector and 88 per cent in the manufacturing sector, connected to the internet.

Figure 8: During the pandemic, growth in businesses connecting to the internet was significantly higher than that for individuals
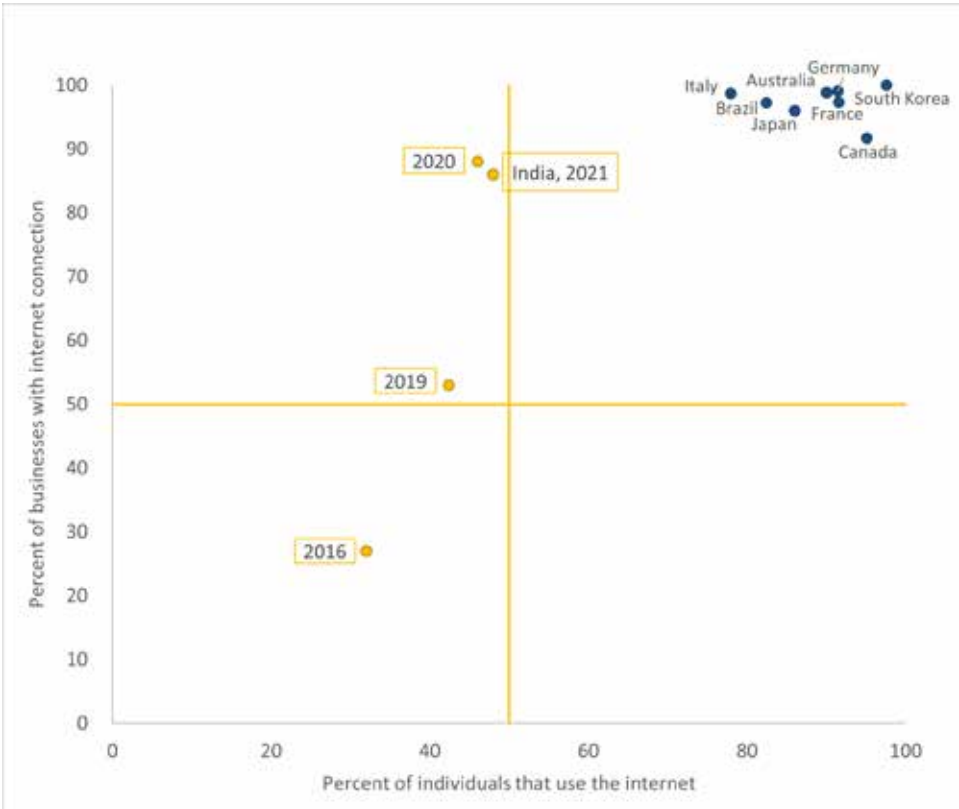
Source: IMRB Kantar ICUBE, OECD Digital Toolkit, Statista, World Bank for individual internet users' data. OECD Digital Toolkit and IMRB Kantar ITOPS 2021 for business internet access data.

Note: For India, firms outside the household with a fixed structure (electric meter connection and separate brick and mortar structure for the business) with any type of internet connection. For the remaining countries, businesses with 10 or more employees with a broadband connection (fixed or mobile).

Figure 9: Pandemic accelerated growth in business connectivity and narrowed the digital divide

Percentage of businesses with internet connection (all)

Percentage of businesses with internet connection (by size)
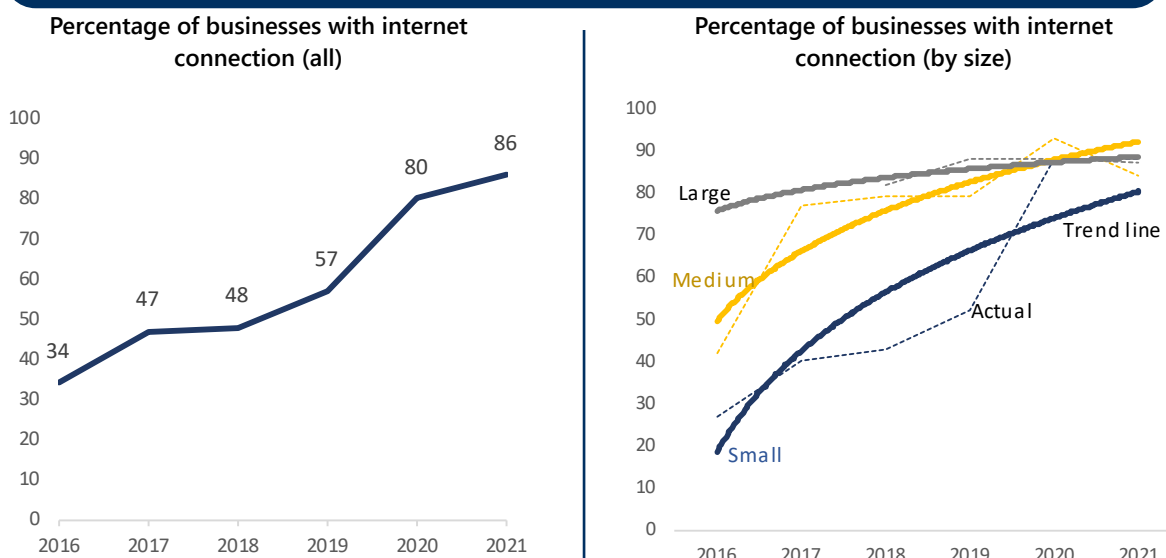
Source: IMRB Kantar ITOPS 2021. Sample consists only of firms outside the household with a fixed structure (electric meter connection and separate brick and mortar structure for the business).

Services include IT/ITES, travel, transport, logistics, education, BFSI, media and entertainment, healthcare and professional services

Connectivity varies across different government entities

In terms of connectivity in government entities, there is significant variation by sector and region. Internet access in government schools (Figure 10) and hospitals remains quite low and varies significantly by state. Other sectors such as police stations and sub-registrars' offices (that deal with land records) have relatively high access to internet across states. Their use of digital technologies varies slightly more but is still relatively widespread (see Appendix 19).

Figure 10: While schools have been slow to go online, connectivity is near universal for law-and-order agencies

Government schools (2022)

Government aided schools (2022)
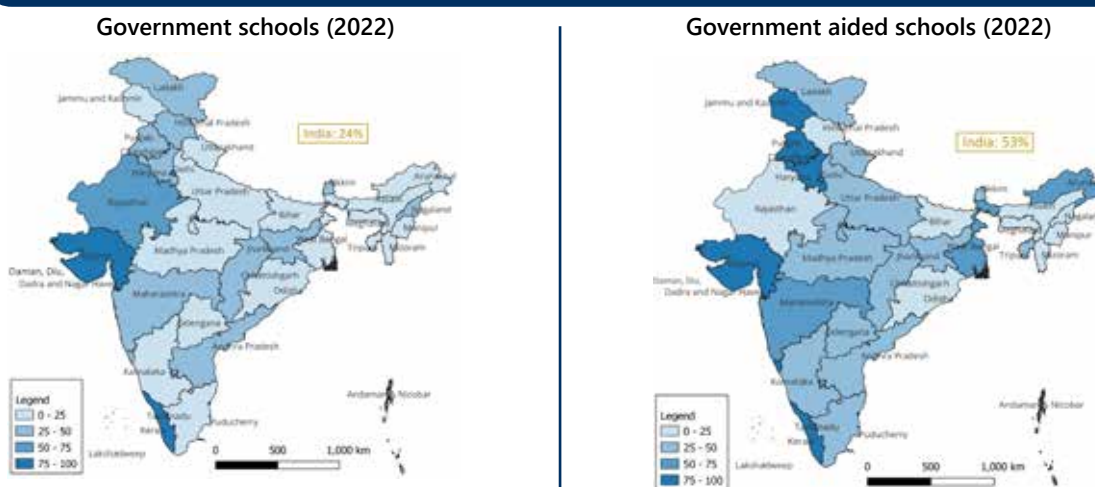
Source: UDISE+ 2020-21 Report.

Source: UDISE+ 2020-21 Report.

Figure 10: While schools have been slow to go online, connectivity is near universal for law-and-order agencies

Police Stations (2022)

India: 97%

Legend
- 0-50%
- 50-65%
- 65-80%
- 80-90%
- 90-100%

Sub-Registrar's Offices (2022)

India: 93%

Legend
- 0-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%
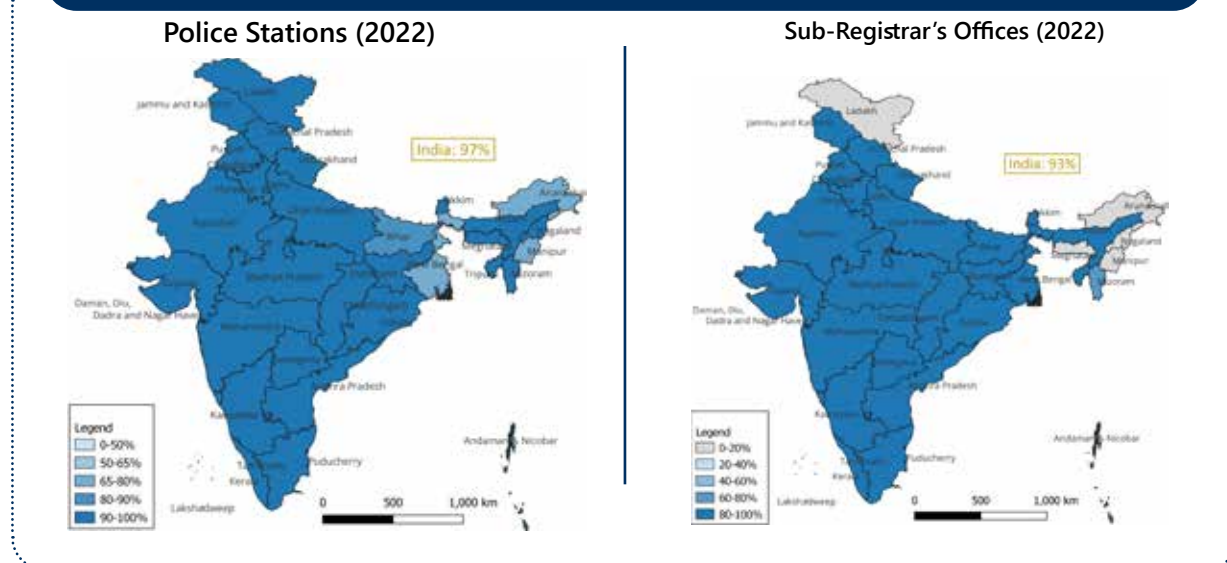
Source: CCTNS Pragati Dashboard, 2022

Source: Digital India Land Records Modernisation Programme (DILRMP-MIS 2.0) Database, 2022

Universality still distant and divides persist

India's digital transition albeit rapid, has been unequal. During the period 2016 to 2021, while India's per capita income increased from USD 1,714 to USD 2,257 (32 per cent),[12] internet penetration increased by 50 per cent from 32 to 48 per 100 population. When compared at purchasing power parity (PPP) levels, India has achieved higher growth in internet penetration despite lower increase in income levels (see left panel, Figure 11). Even among internet users, not everyone is a smartphone user, limiting the potential for digital dividends (see right panel, Figure 11). The common challenges include poor infrastructure, low affordability and inadequate literacy.

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[12] The World Bank. GDP per capita (current US $) – India. Retrieved on January 26th 2023, from https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=IN.

Figure 11: India's internet penetration is proportional to its per capita income but smartphone penetration is lower

Internet penetration and per capita income (2020/21)

Smartphone versus internet density (2020/21)
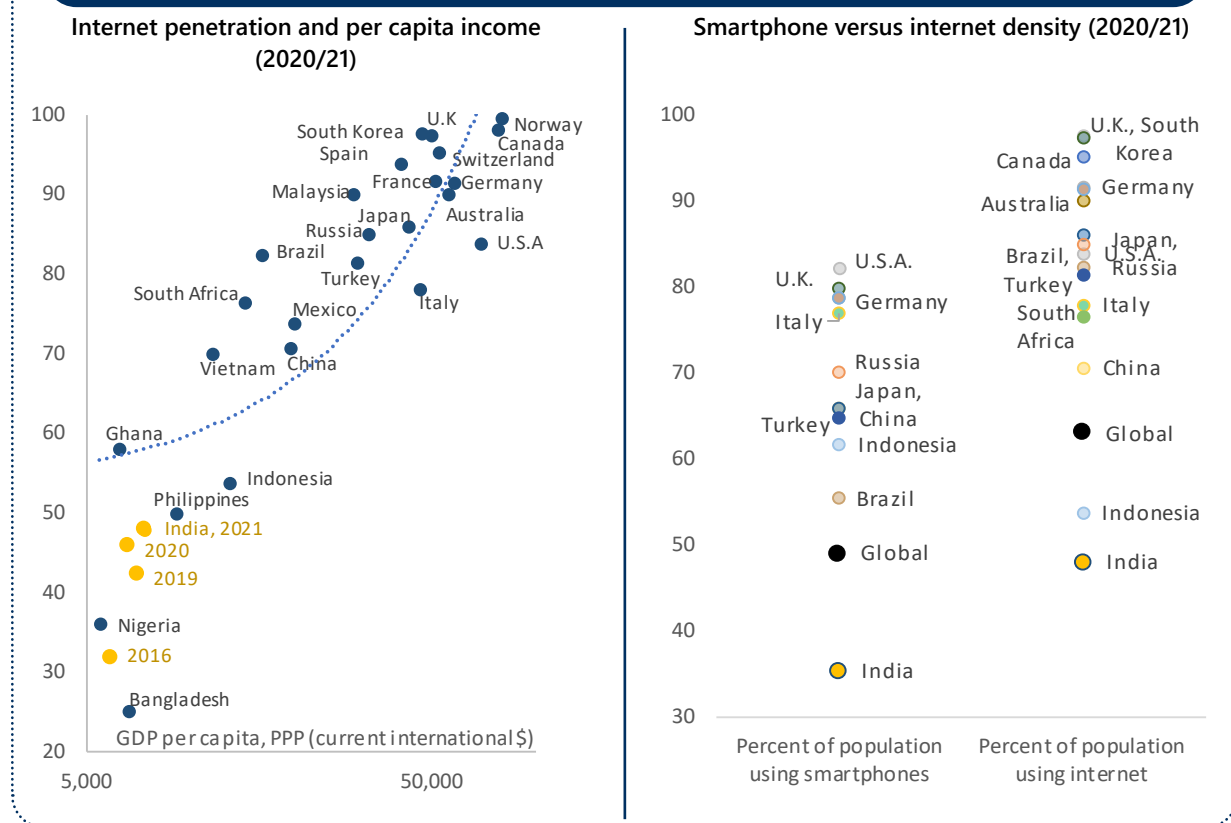
Source: Per cent of population using the internet values are the latest years available from OECD Digital toolkit, World Bank, Statista, and IAMAI-IMRB Internet in India Reports. GDP per capita values are from World Bank Databank.

Source: For smartphone data, NewZoo Global Market Report. For internet users' data, IMRB Kantar, OECD Digital Toolkit, Statista and World Bank. The OECD data is for population aged 16-74 years old.

Even among the current pool, penetration in rural areas is substantially low. According to the 2021 IAMAI-IMRB Internet in India report, only 37 per cent of the rural population were active internet users compared to 69 per cent in urban areas.[13] This amounts to the same number of users in both urban and rural areas, though the rural population in India is roughly twice that in urban areas (see Figure 12). This reflects the subscription gap of internet users in India. When compared internationally, the percentage of internet users in rural India is lower than that of Asia Pacific in general, but is aligned to the average in developing countries (see Figure 13).

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[13] Active internet user refers to those who have accessed internet in the last one month.

Figure 12: While rural internet users exceed the number of urban users, the rural-urban disparity in internet penetration remains persistently high

Number of active internet users

Internet density (subscribers per 100 people)
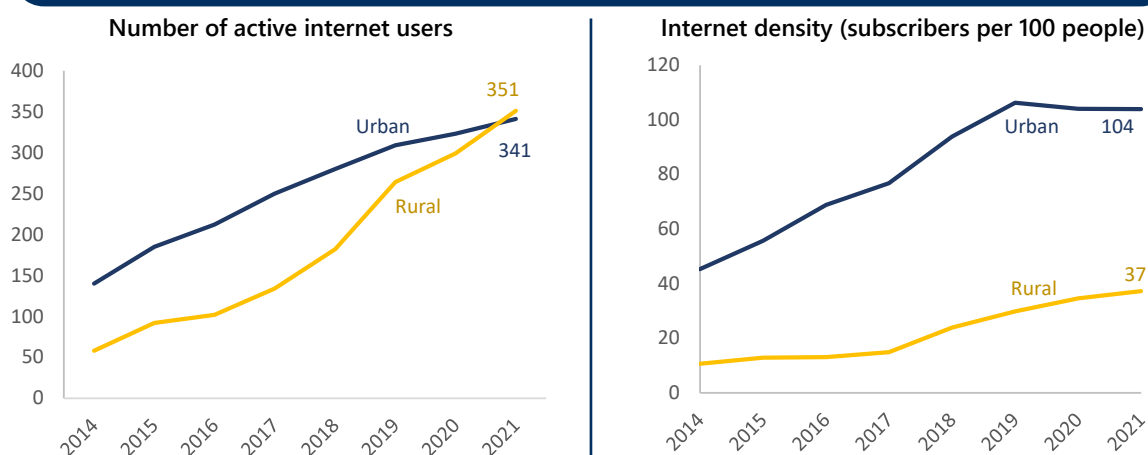
Source: Kantar IMRB-IAMAI ICUBE Internet in India 2021, and earlier ICUBE data received from Kantar

Note: Active internet users are those who have accessed/ used the internet in the past one month. Data is from June of every year..

Source: TRAI Performance Indicator Reports (2021)

Note: This includes all internet subscribers including wired (narrowband and broadband) and wireless over the phone. These numbers do not necessarily depict share of population with internet – some individuals can have multiple subscriptions. According to the 2021 IMRB Kantar report, 69 per cent of the urban population and 37 per cent of the rural population has used the internet in the past three months.

Figure 13: Global comparison of rural internet users

Per cent of rural population using the internet (regions by income levels) (2020)

Per cent of rural population using the internet (regions by geography) (2020)
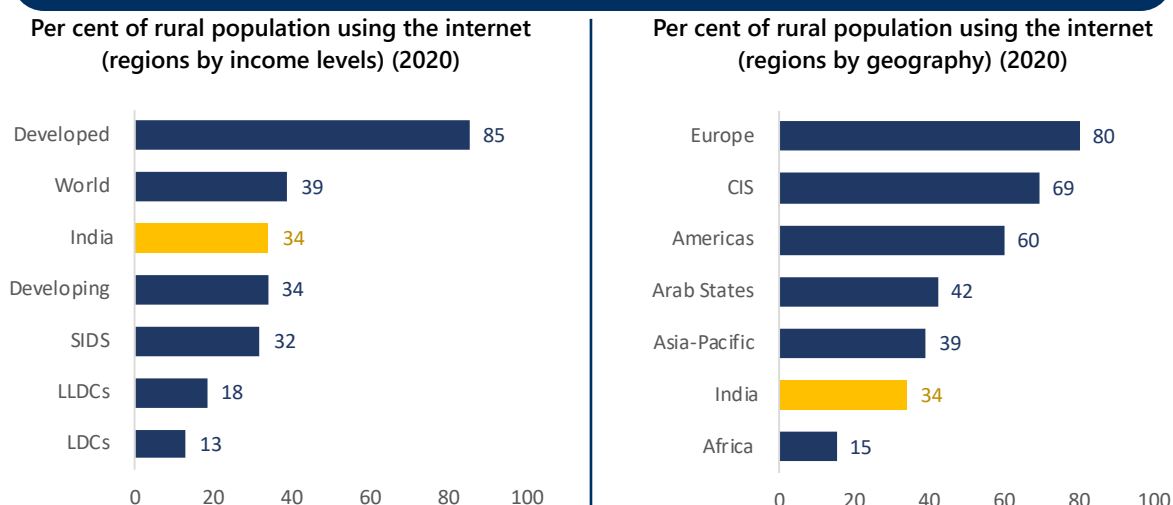
Source: ITU World Telecommunication/ICT Indicators database (November 2022) and IMRB Kantar 2020 ICUBE report (for India)

SIDS: Small Island Developing States. LLDC: Land Locked Developing Countries. LDC: Least Developed Countries.

Digital Divide in Gender is Unacceptably High

A global comparison of internet use by women finds that the percentage of female internet users in India is below the lower-middle income regions and the Asia-Pacific average (see Figure 14). At the rural level, despite low levels of penetration, gender divides exist. According to IMRB, only 29 per cent of women in rural areas use the internet, as compared to 40 per cent of men in rural areas use the internet. Besides, while access to mobile phones has improved for women from 46 per cent in 2015 (NFHS 4) to 54 per cent in 2021 (NFHS 5), the gender gap in mobile phone use has increased. This is in sharp contrast to the trend among G20 countries, many of whom have successfully closed the gender gap (see Figure 15). However, we also find that gender gaps in digital skills is lower than the rural-urban gap. Besides existing divides in income and literacy, cultural norms also play a role in determining female access to the internet. As an example, see Appendix 2 for a cross-country comparison of gender discrimination scores and parity in social media use.

Figure 14: Internet use amongst women in India is significantly lower than is observed in most regions of the world

Percent of women using the internet (regions by income level) (2022)

Region	Percent
High-income	89
Upper-middle-income	72
SIDS	60
World	57
Lower-middle-income	42
India**	40
India*	33
LLDCs	27
LDCs	23
Low-income	16

Percent of women using the internet (regions by geography) (2022)

Region	Percent
Europe	82
Americas	79
CIS	78
World	57
Arab States	56
Asia-Pacific	54
India**	40
India*	33
Africa	27
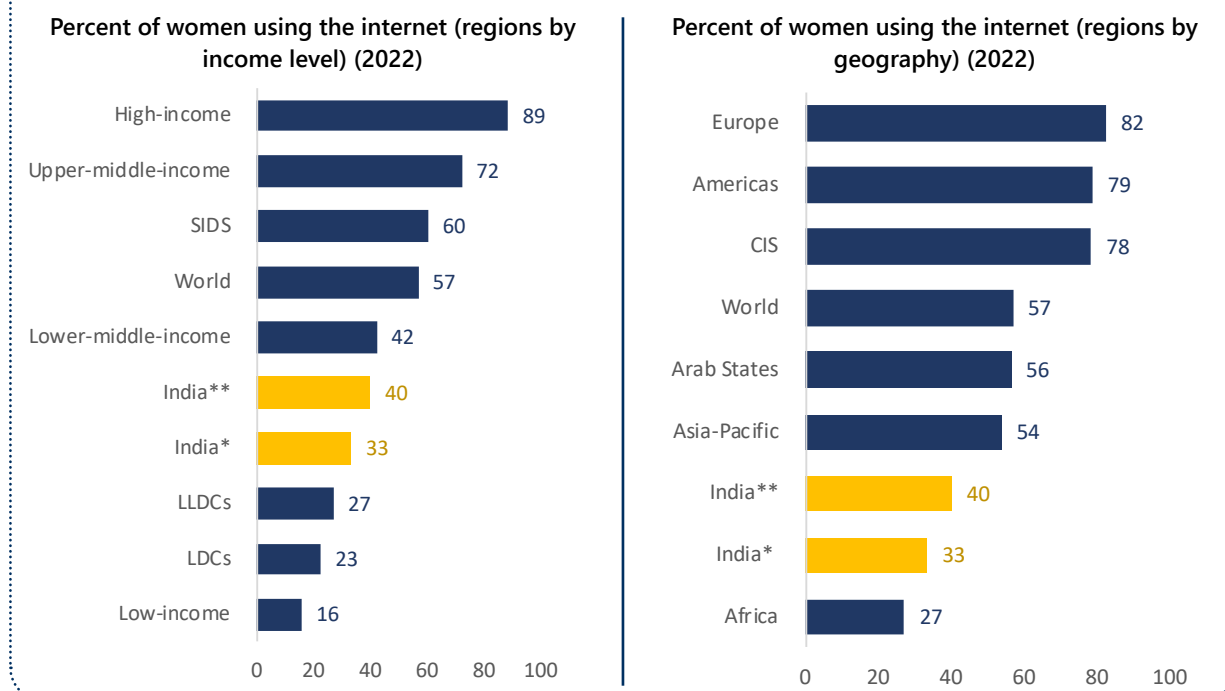
Source: ITU World Telecommunication/ICT Indicators database (November 2022), and NFHS (2019-2021) and IMRB (2020) for India.

SIDS: Small Island Developing States. LLDC: Land Locked Developing Countries. LDC: Least Developed Countries.

* NFHS 2019-2021 (ever used). ** IMRB 2020 (used in last 3 months). The IMRB data appears to show a different picture from the NFHS data because the former uses 'active' users (used in the last three months), while the latter uses 'ever used'. In the NHFS data, in rural areas, men are about twice as likely as rural women to have ever used the internet. But in the IMRB data, men make up only about 56 per cent of active internet users. So, the gender balance is greater in the IMRB data. This would imply that a good number of men have had access (have ever used) but do not use it regularly (are not active users) – while many women have never had the chance to access at all. IMRB active users: <15 years: 31%, 15-34 years: 64%, 34+ years: 37%, Urban female active users is 63% and rural female is 29% active users.

Figure 15: India has the lowest gender parity in access to mobile ownership among G20 countries; this disparity has worsened in recent years

Gender Gap Score in Mobile Ownership

● 2014 ● 2021
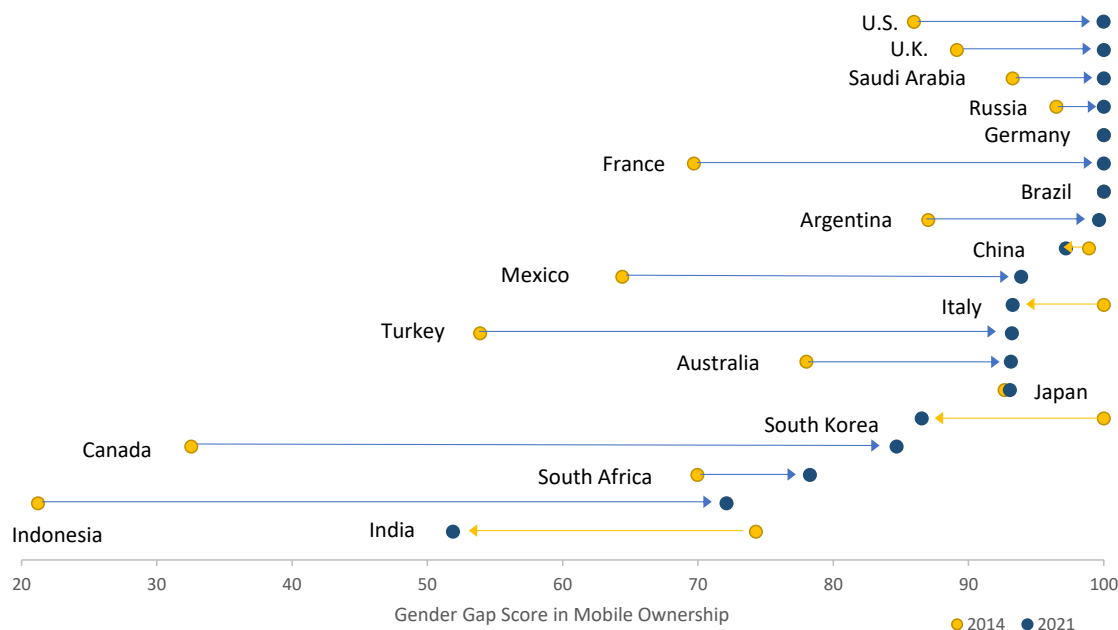
Source: GSMA Mobile Connectivity Report 2022.

Gender gap score is normalised between 0 and 100, with higher values for countries with lower gender gaps.

Figure 16: Urban-rural gaps in digital literacy and skills are higher than gender gaps

| | Search and Browse Internet | Social Media Instant Messaging | Sending Email with Attachment | Software Download and Installing | Connecting Devices |

Urban 66% / Rural 31% — Male 48% / Female 37%
Urban 61% / Rural 27% — Male 44% / Female 33%
Urban 38% / Rural 9% — Male 22% / Female 16%
Urban 12.9% / Rural 5% — Male 8.2% / Female 6.4%
Urban 5.2% / Rural 1.7% — Male 3.4% / Female 2.3%
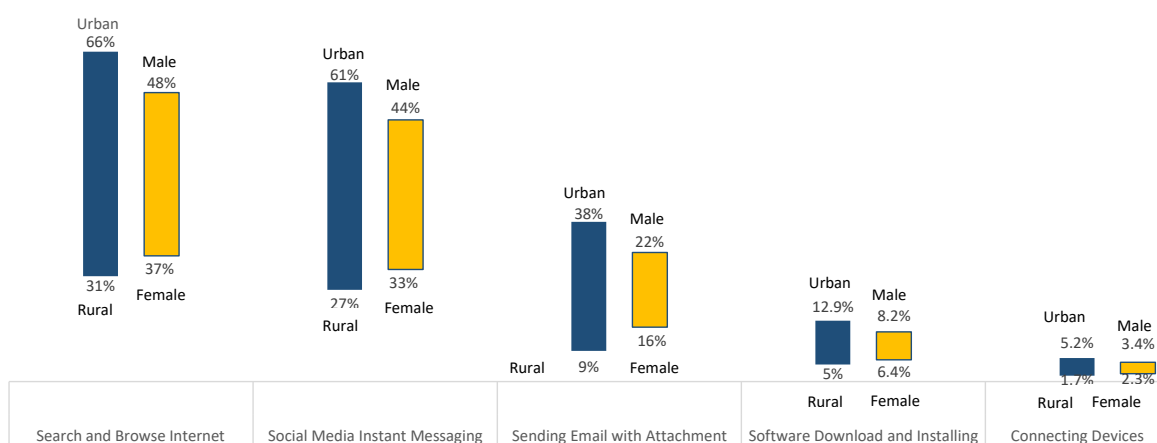
Source: IMRB Kantar ICUBE, 2020

Geographical disparity: Variation across Indian States

The digital divide across Indian states is large and shows little sign of convergence. In general, states with lower per capita income have lower internet penetration, with these gaps appearing to persist over time, except the recent convergence in 2021 (see Figure 17). In 2013, Delhi had the highest penetration at 92

internet subscribers per 100 population, and Bihar had the lowest at 7. While the numbers improved significantly in 2021, Delhi continued to be the state with the highest number of internet subscribers per 100 population at 187, while Bihar had the lowest at 33.

Figure 17: Persistent digital divides across states
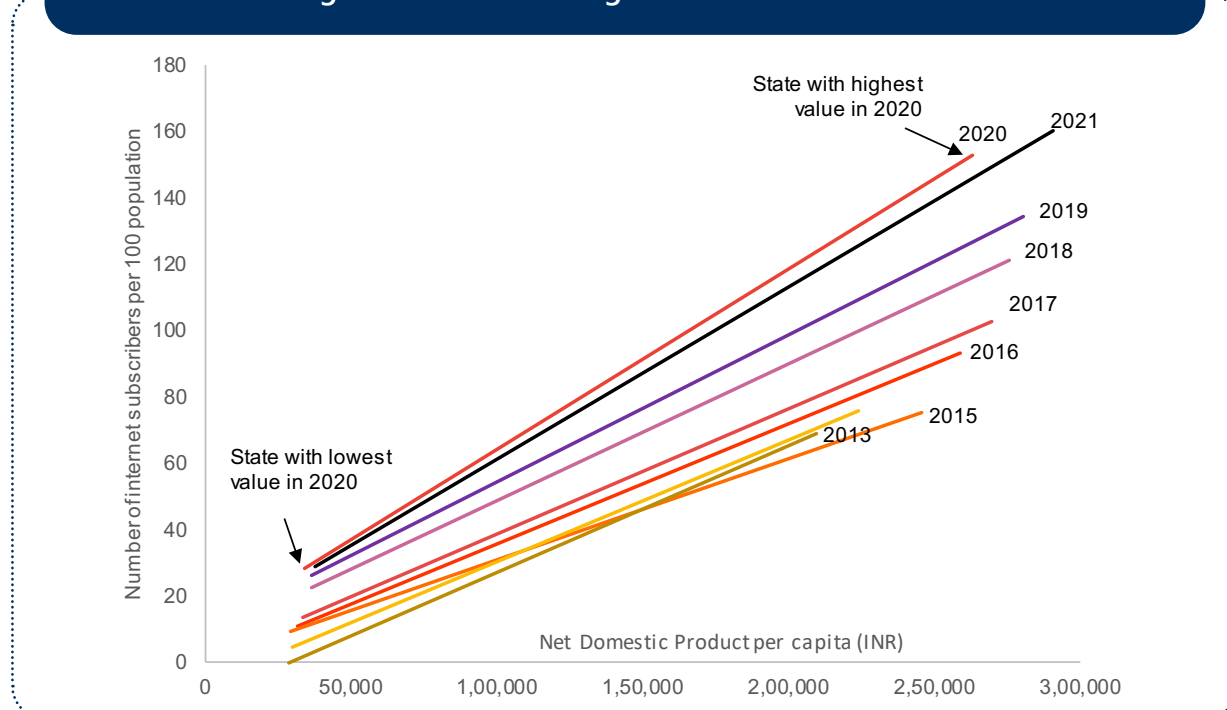
Source: TRAI Performance Indicator Reports for internet subscribers and RBI, 2021 for Net State Domestic Product per capita.

Note: Since data on internet subscribers per 100 is at the service area level, the data on NSDP per capita estimates was aggregated to service area levels weighted by population (from https://www.census.gov/geographies/mapping-files/time-series/demo/international-programs/subnationalpopulation.html). Population estimates for the starting year of the NSDP fiscal year was used. Previous year values were used where latest data was not available.

Many state governments have taken initiatives to digitise and build state wide area networks (SWAN). With a strengthened strategy, the central government is now operating in close co-ordination with states to fill infrastructure gaps. The government's flagship Bharat Net programme, though delayed, has seen resounding success in the state-led model adopted by Maharashtra, Telangana, Andhra Pradesh, Jharkhand, etc. Models suited to other states include private sector-led (in Punjab and Bihar), public sector unit-led (in Madhya Pradesh, Sikkim, etc.), public private partnerships (in Assam, West Bengal, Rajasthan) and satellite model (in North East and parts of other states).[14] Very recently, the Department of Telecom (DoT) set up the National Broadband Mission to operationalise universal broadband access by working in collaboration with states. As a part of the mission, states have to align their right-of-way policies to those notified by the central government as well as identify viable financial models to define 'common duct' norms. These initiatives will instil competition among states for significant growth of fibre and help bridge gaps in infrastructure.

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[14] Pavithra K M (2020). Explainer: What is the BharatNet program and what is its status of implementation? Factly.in. Retrieved on January 26th 2023 from https://factly.in/explainer-what-is-the-bharatnet-program-and-what-is-the-status-of-implementation/.

Sharp Rise in Adoption of Digital Activities

There has been a sharp rise in adoption across a wide range of digital activities such as digital payments, e-commerce, online learning, food delivery, etc. According to the World Bank, more than 80 million adults in India made their first digital merchant payment after the start of the pandemic.[15] In the third quarter of 2022-23, India recorded 23 billion transactions.[16] Recent estimates suggest that roughly 300 million Indians are using UPI, making India the second largest digital payment system in the world after China.[17] Despite low per capita income figures, the total annual value of digital transactions is higher than that of many developing countries as well as higher than of countries like Canada and Australia.

Figure 18: India is now the second largest digital payment market in the world

Individuals aged 15+ who have made a digital payment (in millions)

China 983
India 258
U.S.A 248
Brazil 120
Japan 99
Germany 71
Indonesia 59
France 55
U.K 55
Italy 48
Korea 44
Turkey 40
Canada 32
South Africa 30
Australia 20
Saudi Arabia 19
Mexico 0

2014
2021
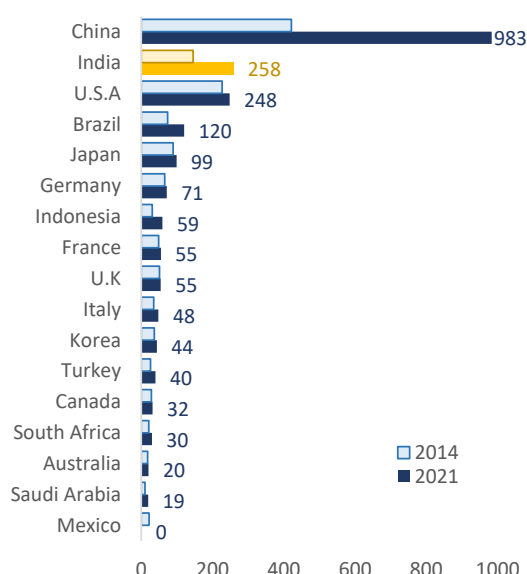
Source: World Bank Findex Database (2021) for per cent of population (age 15+) that made or received digital payments, and World Bank Data Bank for population values.

Note: Per cent of population (age 15+) has been multiplied by population aged 15+ (calculated as total population minus population age 0-14). See Appendix 3 for percent of population using digital payments.

[15] World Bank. 2022. "COVID-19 Drives Global Surge in use of Digital Payments". Retrieved on February 11, 2023 from https://www.worldbank.org/en/news/press-release/2022/06/29/covid-19-drives-global-surge-in-use-of-digital-payments#:~:text=In%20India%2C%20more%20than%2080,2014%20to%2057%25%20in%202021.

[16] WORLDLINE. 2022. Worldline India Digital Payments Report Q3 2022. Retrieved on February 11, 2023 from https://in.worldline.com/news/worldlines-india-digital-payments-report-Q3-2022#:~:text=How%20India%20Pays%3F,transactions%20amounting%20Rs%2038.32%20trillion.

[17] Ministry of Information and Broadcasting, Government of India (2022). Rise of a New Era of Digital Payments. Retrieved February 10, 2023 from https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/nov/doc20221116125801.pdf

Other digital activities also saw a sharp rise in the years following the Covid-19 pandemic (see Figure 19). E-commerce start-ups closed 279 deals and raised a total of USD 10.7 billion in 2021.[18] The market share of tier 3 cities grew from 34.2 per cent in 2021 to 41.5 per cent in 2022 while for tier 2 cities, it rose from 19.4 per cent to 21.2 per cent, demonstrating the inclusive expansion of e-commerce in India.[19] Among other sectors, venture capital funding received in 2021 for online learning (edtech), fintech and food tech was USD 5.8 billion, USD 5.1 billion and USD 1.5 billion respectively.[20] According to industry estimates, the edtech user base has almost doubled in the last couple of years, including both free and paid users, and the number of users willing to pay has increased by almost 40 per cent.[21] With advances in technology, the demand for interactive learning experiences, supported by augmented and virtual reality (AR/VR) is only going to expand in the future.

The sector directly impacted by the pandemic was health. Telemedicine, both through public and private platforms, saw rapid increase, making it possible to deliver medical help in rural and remote parts of the country. 80 per cent of the 50 million users of telemedicine in India, during the first two months of the pandemic were first time users.[22] India relied on the government's e-Sanjeevani services as a part of the larger government scheme to connect hospitals and health centres in remote areas to strengthen their telemedicine infrastructure. The All India Institute of Medical Science (AIIMS) also launched a 24/7 telehealth hub to provide health assistance using simple mobile technology. During this time, the government also introduced the Telemedicine Practice Guidelines.[23] The Ayushman Bharat Digital Mission will give further impetus to digital health in India.

Despite the uptake in online services, many consumers in India prefer to purchase large ticket products and services offline. This explains low revenues and poor monetisation of digital services despite their rapid diffusion. For example, the average estimated expenditure per user on online food delivery is USD 40 in India, compared USD 194 for G20 countries. The comparable numbers for e-commerce are USD 130 and USD 1,220 respectively. (For more details, refer to Appendix 4.)

[18] Inc42. 2022. State of Indian Ecommerce, Q1 2022. Retrieved on June 19, 2022 from https://inc42.com/reports/state-of-indian-ecommerce-report-q1-2022/#:~:text=The%20Indian%20ecommerce%20sector%20is,of%20the%20same%20due%20to

[19] Unicommerce. 2022. India Retail and E-Commerce Trends Report 2022. Retrieved on September 11, 2022 https://infowordpress.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/08/01122926/Unicommerce_and_Wazir_Advisors_Report_2022.pdf

[20] Upadhyay, H and Pathak, S (2022). Indian startups raised $38 billion in 2021: Entrackr report. Retrieved on January 25th 2023 from https://entrackr.com/2022/01/indian-startups-raised-38-billion-in-2021-entrackr-report/.

[21] Aditya Agrawal. 2020. EdTech – COVID Tailwinds – The Time is Now. Redseer Strategy Consultants. Retrieved on January 26, 2023 from https://redseer.com/insights.

[22] Practo. 2020. How India Retrieved on healthcare in the last three months. The role of telemedicine in an evolving healthcare environment. Retrieved on January 26, 2023, from https://www.practo.com/company/insights/practo_insights_report.pdf.

[23] Chakraborty, I., Ilavarasan, P. V., & Edirippulige, S. (2021). COVID-19 as a Catalyst for Telehealth Growth in India: Some Insights. Journal of the International Society for Telemedicine and EHealth, 9, e3 (1-4). Retrieved on December 18, 2022 from https://doi.org/10.29086/JISfTeH.9.e3

Figure 19: India is now the second largest market for a wide range of digital activities

E-Commerce (millions) (2021)

Country	Users (in million)
China	994
India	644
United States	265
Indonesia	159
Brazil	115
Japan	94
Russia	66
Germany	65
Mexico	58
United Kingdom	55
France	49
Turkey	41
South Korea	38
Italy	36
Canada	28
Argentina	27
South Africa	25
Saudi Arabia	21
Australia	19

Users of E-Health (millions) (2021)

Country	Users (in million)
China	661
India	170
United States	159
Japan	57
Russia	54
Brazil	53
Indonesia	51
Mexico	38
Germany	37
United Kingdom	36
France	27
South Korea	23
Italy	22
Turkey	22
Canada	18
South Africa	16
Saudi Arabia	13
Australia	12
Argentina	10

Online Learning Platforms (2021)

Country	Users (in million)
China	361
India	93
United States	28
Brazil	20
Mexico	16
Japan	13
Indonesia	11
Russia	9
Germany	8
United Kingdom	7
Italy	7
South Korea	6
France	5
South Africa	5
Turkey	4
Canada	4
Australia	3
Saudi Arabia	3
Argentina	3

Online Food Delivery (2021)

Country	Users (in millions)
China	643
India	268
United States	150
Brazil	54
Russia	34
South Korea	34
United Kingdom	32
Mexico	26
Germany	26
Japan	24
Turkey	23
Indonesia	18
France	16
Canada	15
South Africa	14
Italy	13
Argentina	12
Saudi Arabia	9
Australia	6

Source: Statista Market Forecast (2021)

The catch-up in use of digital tools by businesses has been limited

While internet connectivity increased very sharply for businesses, the adoption of digital tools such as websites, online marketing and online sales were limited (see Figure 20). In 2021, only 45 per cent of Indian businesses had a web presence (social media or own website) compared to an average of 69 per cent for other G20 countries (Appendix 7).[24] However, 59 per cent of large Indian businesses had a website. The use of social media was prevalent even

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[24] This average is based on the values for Japan, Germany, the UK, Canada, Australia, Italy, France, Brazil, India and Indonesia.

before the pandemic. Between 2019 and 2021, the use of social media increased slowly, from 32 per cent to 35 per cent. This is lower than the average of 58 per cent in other G20 countries[25] (Appendix 8). For websites separately, only 32 per cent of businesses in India had a website compared to a G20 average of 65 per cent in 2021.[26] (For more details, please refer to Appendix 8). Even the growth in online marketing and online sales, albeit high, do not reflect high use across all businesses.

Figure 20: Change in adoption of digital tools by Indian businesses (2021)
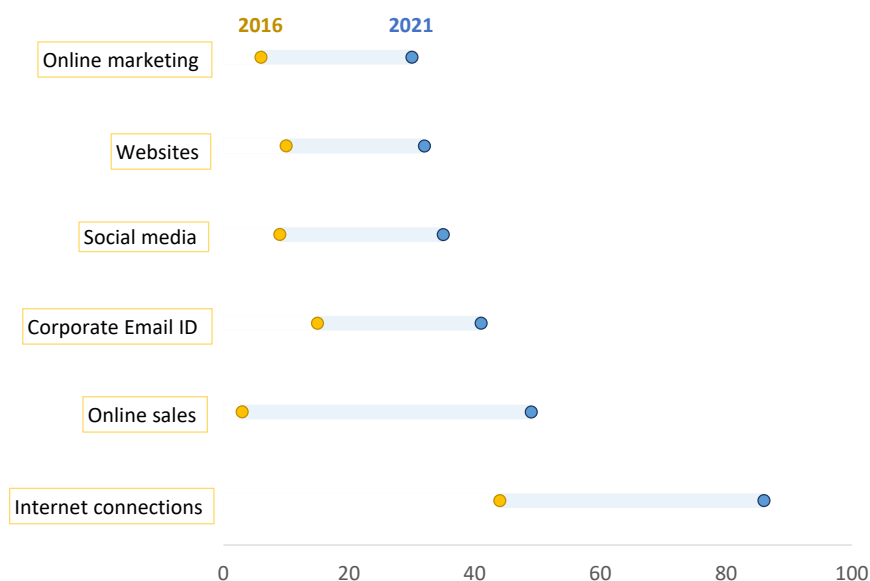
Source: IMRB Kantar 2021 ITOPS.

Note: Sample consists only of firms outside the household with a fixed structure (electric meter connection and separate brick and mortar structure for the business). Most large businesses that do not have internet connections in 2021 are in the education, and media & entertainment industries and largely consist of businesses with less than 500 employees; all businesses with more than 500 employees had an internet connection in 2021.

The pandemic exacerbated divides in adoption of digital tools among firms

While divides in internet access have narrowed across firms by size, the gap has widened in the adoption of digital tools and services (see Figure 21). While many large companies already had a digital transformation plan, others accelerated the digital integration of their customers and supply chains. Online selling, online marketing and websites saw an increase during the pandemic, generally more so for larger firms and those in the services sector. Despite the rise, the post-pandemic difference between big firms and small firms rose to 26 per cent for online sales, 33 per cent for websites, 12 per cent for online marketing and 21 per cent for social media presence. Except for online sales, the services sector had the highest adoption with a rise to 43 per cent in websites, 37 per cent in online marketing and 45 per cent in social

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[25] Average based on the values for Australia, Brazil, Canada, France, Germany, India, Italy, Turkey and the U.K.

[26] Average based on the values for Australia, Brazil, Canada, France, Germany, India, Italy, Japan, South Korea, Turkey, and the UK.

media presence (see Appendix 9). However there are signs of some reversion in the use of digital technologies, with a few businesses returning to pre-pandemic ways of operating (see Appendix 10).

Figure 21: Pandemic exacerbated digital divides among businesses in terms of use of digital tools
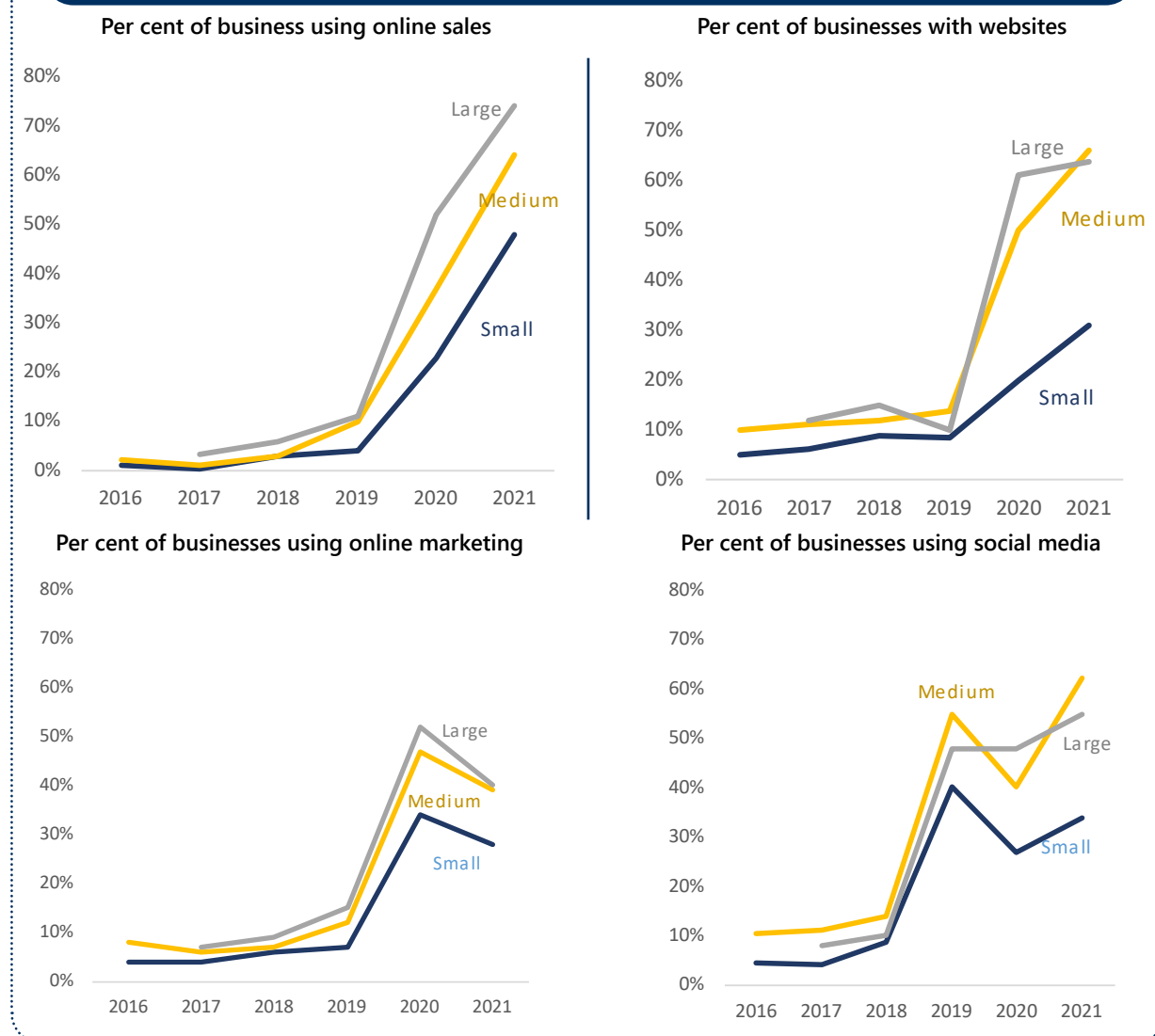
Social media presence is having a business page on social media sites.

Source: IMRB, ITOPS 2021. Sample consists only of firms outside the household with a fixed structure (electric meter connection and separate brick and mortar structure for the business).

India Championing e-Governance

The digital transition in India has created various opportunities for e-governance – the adoption of digital technologies by government entities to improve efficiency, service delivery and citizen engagement.[27] While computerisation of government entities and efforts in India started much earlier, the impetus for e-government, as

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[27] Government of India (2008). Promoting e-Governance. The Smart Way Forward. Second Administrative Reforms Commission. Retrieved on February 2, 2023 from https://darpg.gov.in/sites/default/files/promoting_egov11.pdf.

technology-mediated administrative processes for good governance, emerged in the 1990s. Liberalisation and ICTs had become a policy priority for catalysing growth and enabling systematic reforms in governance (UNESCAP, 2018).[28] The National Informatics Centre (NIC), established in 1976, to promote better use of technology in government departments, is credited with having played an important role in the proliferation of e-governance (NIC, 2013[29]; UNESCAP, 2018). The National e-Governance Plan (NeGP), comprising eight components and 27 Mission Mode Projects (MMPs),[30] was approved in 2006 (MeitY, 2022).[31] Some major initiatives under the NeGP related to core infrastructure include state data centres (SDCs), state wide area networks (SWAN), and common services centres (CSCs). There have also been policies and guidelines on security, human resources, citizen engagement, and social media, and standards related to metadata, interoperability, enterprise architecture, and security.

Figure 22: Improvements in delivery of government services both at the centre and state levels

NeSDA scores for state and centre ministry services portal (2019, 2021)
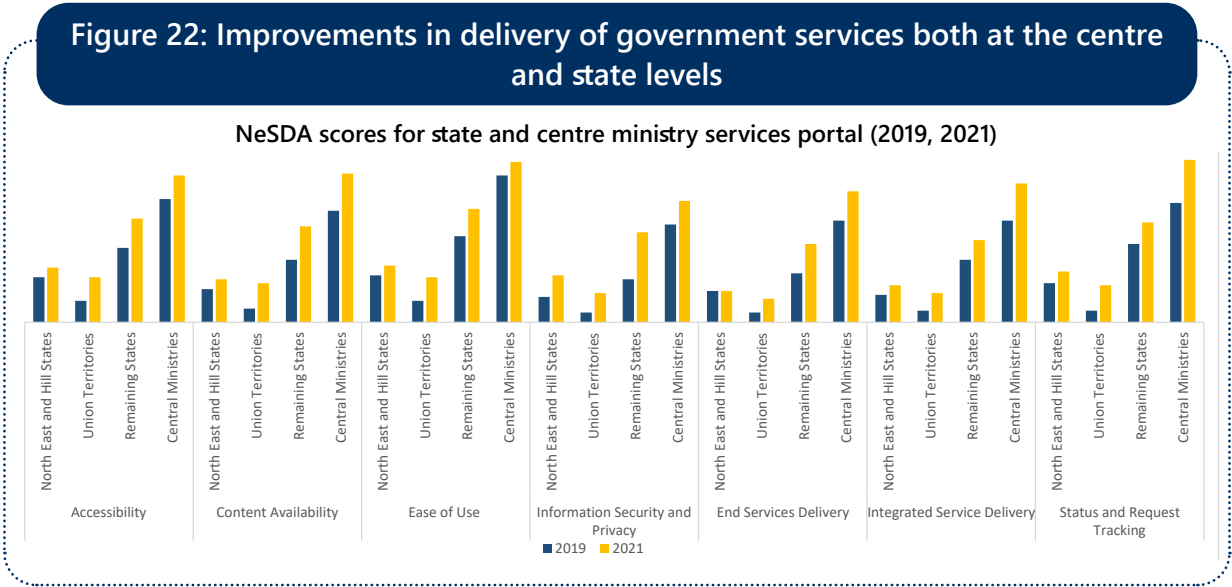
Source: National E-Governance Service Delivery Assessment 2021

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[28] United Nations. 2018. The evolution of e-government in India: the early days. Retrieved on February 2, 2023 from https://egov4women.unescapsdd.org/country-overviews/india/the-evolution-of-e-government-in-india-the-early-days

[29] National Informatics Centre. 2013. Tribute to a Great Visionary: Dr. N. Seshagiri (1940 to 2013) Retrieved on September 5, 2022 from https://informatics.nic.in/uploads/pdfs/f3ebf7bc_Lead%20Story.pdf

[30] Within the NeGP, Mission Mode projects are projects those with clearly defined objectives, scopes, implementation timelines, milestones, and measurable outcomes and service levels. Each MMP can be classified as a state, central or integrated project. Additionally, each state government can define five MMPs specific to its needs. Retrieved on February 2, 2023 from https://www.meity.gov.in/content/mission-mode-projects

[31] National e-Governance Plan. Ministry of Electronics & Information Technology. Retrieved on February 2nd 2023 from https://www.meity.gov.in/divisions/national-e-governance-plan.

In 2015, the Digital India programme was launched to transform India into a digitally empowered society and knowledge economy.[32] The management of the NeGP has been subsumed by a division under the Digital India Corporation.[33] India fares relatively well amongst a number of assessments on e-governance such as the World Bank GovTech Maturity Index (GTMI),[34] the UN E-Participation Index,[35] and the UN Online Services Index.[36] For example, according to the 2020 UN E-Government Survey, India scored a value 0.85 in the Online Services Index, which ranges from 0 to 1 (see Appendix 10). This was the 10th highest score amongst the G20 countries. Consistent with this, the 2021 National e-Governance Service Delivery Assessment (NeSDA) also showed improvements in the performance of state and central ministry service portals. Appendix 11 shows that the most used e-governance services like applications for caste, income, domicile and death certificates, payment of utilities, and scholarship applications are also ones that need lower digital skills and are relatively easy to use.

Although India's rollout of e-governance has seen remarkable growth, the lack of universal access to quality internet and low levels of digital literacy, limit its effectiveness. The 2020 UN E-Government Survey that places India high on the Online Services Index finds it severely lagging in terms of the Telecommunication Infrastructure Index (0.35) and Human Capital Index (0.59) – the lowest amongst all G20 countries (see Appendix 10). There is a need to build institutional capacity and the skills of government employees for effective utilisation of digital technologies by government entities.

State-level performance in e-governance

At the state level, the number of e-government transactions is only loosely correlated with individual internet access. There is significant variation in the number of e-government transactions per person amongst states at similar levels of connectivity (see top panel, Figure 23). This is also true for the quality of state government portals as measured by the NeSDA report, which does not necessarily impact the adoption of e-government services by citizens (see bottom panel, Figure 23). States like Rajasthan, Gujarat and Madhya Pradesh, which have high NeSDA scores, see much lower levels of e-government transactions per person, compared to Haryana and West Bengal. Overall, the states of Haryana, West Bengal, Telangana, Punjab, Andhra Pradesh and Tamil Nadu stand out in the number of e-government transactions per person in the state.

[32] Digital India. Ministry of Electronics and IT, Government of India. Retrieved on January 2, 2023 from https://digitalindia.gov.in/.

[33] Digital India Corporation. Ministry of Electronics and Information Technology (MeitY), Government of India. Retrieved on January 2, 2023 from https://dic.gov.in/index.php/divisions/negd.

[34] Dener, Cem, Hubert Nii-Aponsah, Love E Ghunney & Kinberley D Johns. 2020. GovTech Maturity Index - The State of Public Sector Digital Transformation. World Bank. Retrieved on August 2, 2022 from https://openknowledge.worldbank.org/handle/10986/36233.

[35] United Nations E-Government Knowledgebase. E-Participation Index. Retrieved on February 2, 2023 from https://publicadministration.un.org/egovkb/en-us/About/Overview/E-Participation-Index.

[36] United Nations E-Government Knowledgebase. E-Government Development Index (EGDI). Retrieved on February 2, 2023 from https://publicadministration.un.org/egovkb/en-us/About/Overview/-E-Government-Development-Index

Figure 23: States play an important role in building and delivering e-government services

Internet access and e-government transactions per person

Axis labels:
- Y-axis: No. of e-government trasactions per person (2021), scale 0 to 14
- X-axis: Percent of households with an internet connection (2020), scale 30% to 100%

Data point labels: West Bengal, Haryana, Telangana, Puducherry, Punjab, Tamil Nadu, Andhra Pradesh, Chandigarh, Chhattisgarh, Uttarakhand, Himachal Pradesh, Gujarat, Uttar Pradesh, Odisha, Rajasthan, Bihar, Delhi, Maharashtra, Madhya Pradesh, Andaman and Nicobar, Kerala, Karnataka, Jammu and Kashmir, Jharkhand, Arunachal Pradesh, Assam, Nagaland, Mizoram, Goa, Manipur, Daman & Diu, Dadra & Nagar Haveli, Meghalaya, Tripura

National e-governance service delivery score and e-government transactions per person

Axis labels:
- Y-axis: No. of e-government trasactions per person (2021), scale 0 to 14
- X-axis: NeSDA score (2019), scale 0.00 to 0.70

Data point labels: West Bengal, Haryana, Puducherry, Telangana, Punjab, Tamil Nadu, Andhra Pradesh, Chandigarh, Chhattisgarh, Gujarat, Himachal Pradesh, Odisha, Uttar Pradesh, Rajasthan, Andaman and Nicobar, Delhi, Maharashtra, Karnataka, Bihar, Kerala, Madhya Pradesh, Sikkim, Jharkhand, Mizoram, Goa, Assam, Nagaland, Arunachal Pradesh, Meghalaya, Tripura, Manipur

Source: e-Taal Dashboards, NeSDA 2019 Report, IMRB Kantar 2020 ICUBE report

Note: Transactions between Jan 1, 2021 and Jan 1, 2022, performed through e-Governance applications, including national-level mission mode projects (MMPs) under the National e-Governance Plan (NeGP) as aggregated and reported on the e-Taal platform (Electronic Transaction Aggregation & Analysis Layer). The National e-Governance Service Delivery Assessment (NeSDA) assessed service delivery portals on accessibility, content availability, ease of use, information security and privacy, end-service delivery, integrated service delivery and status and request tracking.

Adoption of digital tools for health and education are limited and regionally dispersed

The government's focus on using digital connectivity and digital tools for access to basic services such as health and education are limited and regionally dispersed. According to the UDISE+ 2020-21 report, only 31 per cent of government schools have functional computer facilities[37] and 14 per cent have internet access at the national level. Regionally, states such as Arunachal Pradesh, Assam, Bihar. Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Tripura, and Uttar Pradesh

have less than 5 per cent of government schools with internet connectivity. For smart classrooms, the all-India average stands at 1 smart classroom per 758 secondary students in government and government-aided schools (see Figure 24). This sort of stark variation is also visible for digital health IDs, the linking of electronic health records, and the availability of tele-consultation services (refer to the case study on Ayushman Bharat Digital Mission in Part II of this report). While the national penetration rate for health IDs is 21 per cent, state level penetrations range from 4 per cent (Meghalaya) to 42 per cent (Andhra Pradesh).

Figure 24: Adoption of digital tools for education is limited

Number of smart classrooms approved at the secondary level between 2020-2022 per 10,000 students in government and government aided schools

India: 13.19

Legend
- No Data
- 1 - 53
- 53 - 80
- 80 - 106
- 106 - 133
- 133 - 160
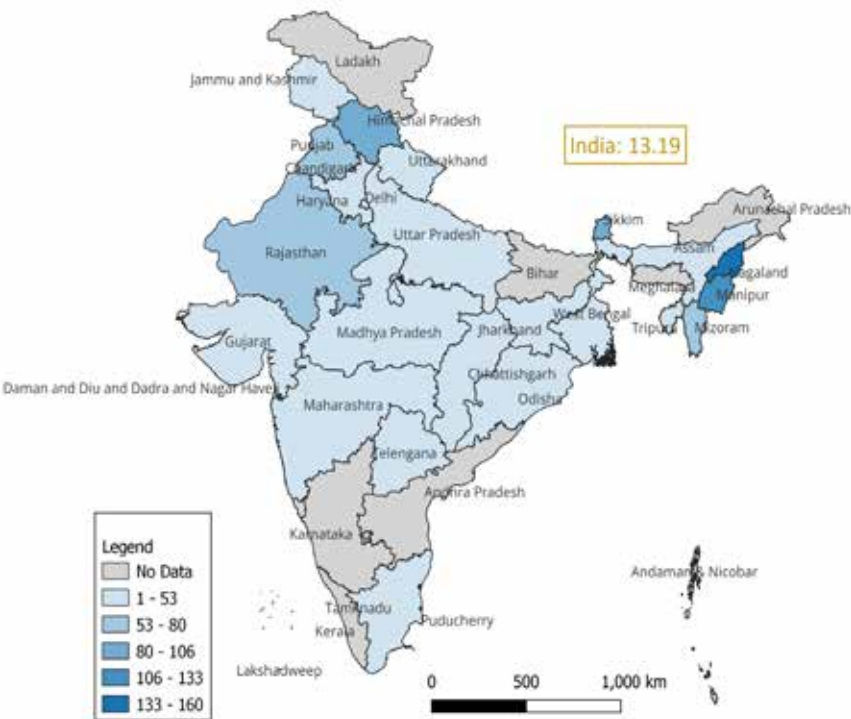
Source: Rajya Sabha Unstarred Question No. 2762 and UDISE+ 2020-21 Report

Notes: Smart classrooms approved under the centrally sponsored scheme of Samagra Shiksha during the two year span of 2020-2022. The number of smart classrooms at the secondary level are normalised by the number of students in secondary schools (grade 9-10) in government and government aided schools in 2021 (UDISE+ 2020-21).

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[37] See Appendix 18 for data on schools with computer facilities.

INNOVATE: PUNCHING ABOVE ITS WEIGHT

All-In on AI

The government's big push towards Artificial Intelligence (AI) has been visible since the launch of the Digital India Initiative in 2015. AI and machine learning are being adopted in the implementation of several government programmes, including the recent announcement of 75 AI-powered defence products.[38] The national programme on AI is being spearheaded by NITI Aayog. With private sector support, the government has organised a series of start-up contests and set up accelerator programmes to nurture the technology and its applications in India.[39] The Ministry of Medium and Small Enterprises also announced a scheme to provide special support to MSMEs for the use of AI tools. The policy momentum has kept up with the announcement of AI for All[40] and the Responsible AI for Social Environment (RAISE)[41] programmes. India has also joined other leading economies such as the US, the UK, the EU, Australia, Canada, France, Germany, Italy, Japan, Mexico, New Zealand, the Republic of Korea and Singapore as a founding member of the Global Partnership on Artificial Intelligence (GPAI), a multi-stakeholder initiative to guide the responsible development and use of AI.[42] In the latest Indian budget (2023), the government has announced its intention to set up three centres of excellence for AI in an attempt to 'make AI in India and make AI work for India.[43] These centres will strive to create a stronger AI ecosystem by developing cutting-edge AI use cases in key areas such as agriculture, health and sustainable cities.

The successful implementation of these policies is visible in India gaining global recognition in AI. AI publications in India have been increasing by 18 per cent in the last two decades from 2000 to 2020; it currently ranks the highest in contribution to open-source AI projects, ahead of developed nations like the US (see Figure 25). Venture capital investments in AI start-ups have also steadily increased (see Figure 26). This includes start-ups in the health sector such as those building intelligent screening solutions through AI-powered analysis of medical visuals, providing business intelligence using computer vision and natural language processing (NLP), building digital capabilities of users (skilling) through AI, creating virtual assistance, insightful customer engagement through machine learning and NLP, etc. Some of the promising start-ups providing conversational AI platforms

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[38] TimesNow. 2022. India makes big push for Artificial Intelligence, Rajnath Singh to launch 75 AI-powered defence products today. Retrieved on January 8, 2022 from https://www.timesnownews.com/india/india-makes-big-push-for-artificial-intelligence-rajnath-singh-to-launch-75-ai-powered-defence-products-today-article-92788215

[39] NITI Aayog (2018). National Strategy for Artificial Intelligence #AIFORALL. Retrieved on January 27th 2023 from: https://indiaai.gov.in/documents/pdf/NationalStrategy-for-AI-Discussion-Paper.pdf

[40] NITI Aayog (2018). National Strategy for Artificial Intelligence #AIFORALL. Retrieved on January 27th 2023 from: https://indiaai.gov.in/documents/pdf/NationalStrategy-for-AI-Discussion-Paper.pdf

[41] NITI Aayog (2021). Responsible AI #AIForAll. Approach Document for India Part 1 – Principles for Responsible AI. Retrieved on January 27th 2023 from: https://www.niti.gov.in/sites/default/files/2021-02/Responsible-AI-22022021.pdf

[42] India takes over as Council Chair of Global Partnership on AI (GPAI). Ministry of Electronics & IT. Retrieved on Februrary 6th 2023 from: https://pib.gov.in/PressReleasePage.aspx?PRID=1877739#:~:text=India%20today%20assumed%20the%20Chair,of%20Artificial%20Intelligence%20(AI).

[43] Godkhindi, A.R. (2023). Union Budget 2023-24 takes AI-forward approach to technology and fintech development. Firstpost. Retrieved on February 6th 2023 from: https://www.firstpost.com/opinion/union-budget-2023-24-takes-ai-forward-approach-to-technology-and-fintech-development-12104102.html

and chatbots in India are Haptik, Gupshup, Uniphore, and Verloop. Similarly, AgNext Technologies deploys AI-based solutions across the global agricultural value chain, Artivatic simplifies risk assessment for insurance products and Beatoven.ai solves the problem of music acquisition and licensing issues for content creators. The start-ups are spread across many industries for a variety of applications.

Figure 25: India is a leading contributor to AI publications and projects

AI Publications by country (2000-2021)

Per cent of worldwide Github commits in open-source AI projects contributed by country (2011-2022)
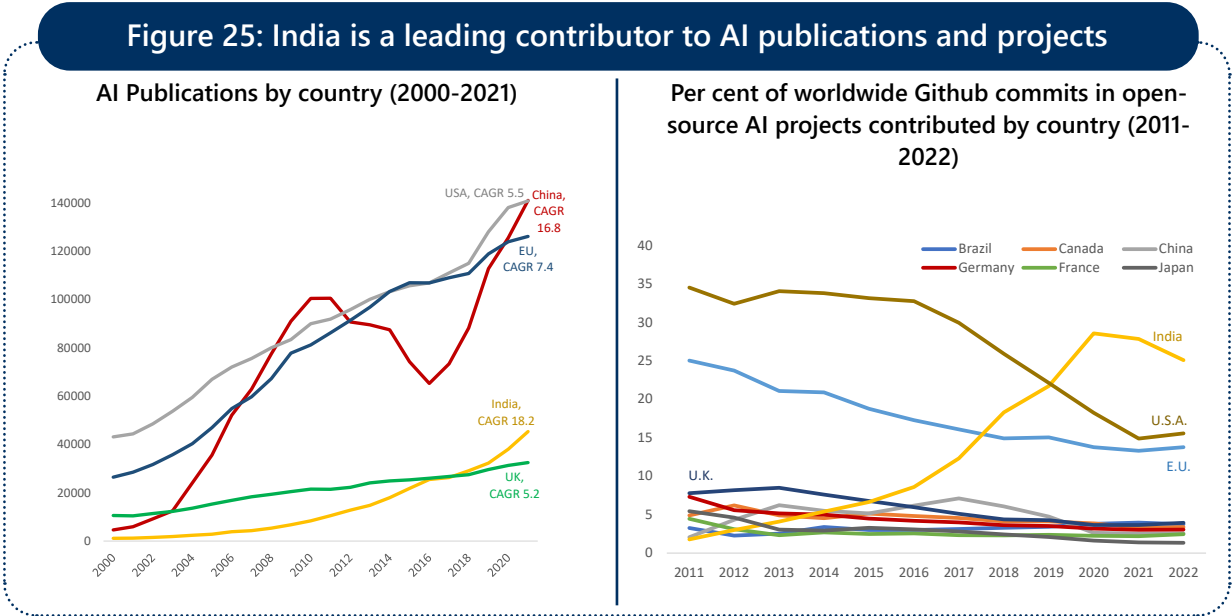
Source: OECD.AI Policy Observatory

While the EU and the US have maintained consistent trends, China has seen exponential increase after 2001. India and China both stood at similar levels in 2000 but China has seen a greater rise since then. It is only in 2017 that India overtook the UK in AI publications.

Source: OECD.AI Policy Observatory

India, the US and EU have the most contributions to open-source AI projects. India's contributions have increased significantly since 2016.

Figure 26: Venture capital investments in AI in million USD (2018-2022)
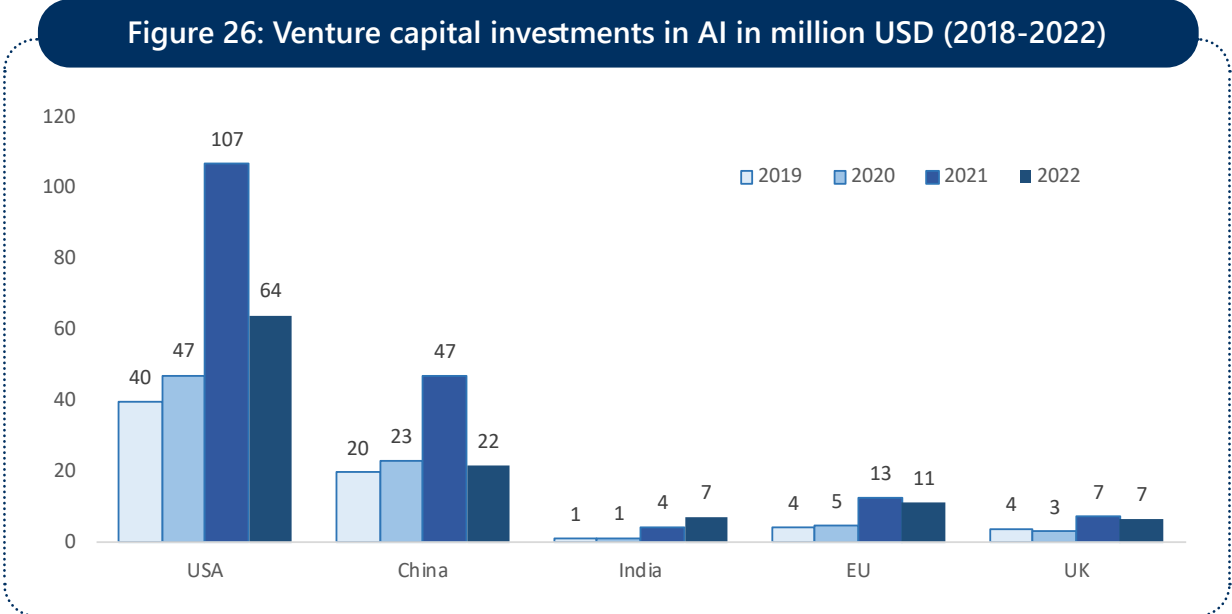
Source: OECD.AI Policy Observatory

Building the AI resource pool

With investments pouring into AI, there is a rising demand for AI skilled workers. The demand for AI has been consistently rising among employers – an IT job posting in India has a 4.2 per cent chance of seeking candidates with AI skills, the highest among all G20 countries (see Figure 27). However, there is a significant skill mismatch. According to Equinix 2022 Global Tech Trends Survey, the shortage of skilled personnel is one of the biggest threats to their business. According to their survey, the biggest skills gaps lie in the areas of data protection, AI/machine learning, cloud computing and security administrator.[44] The private sector is responding to the problem by running collaborative training programmes with higher educational institutions and offering student internships to develop real work experience. The government has also launched a series of initiatives to upskill and reskill talent in high tech sectors. Some programmes include the Visvesvaraya PhD Scheme,[45] Responsible AI for Youth[46] and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS).[47] Most recently, the National e-Governance Division, Ministry of Electronics and Information Technology, Government of India, in collaboration with its partners, launched 'YUVAi: Youth for Unnati and Vikas with AI' – a national programme for school students (from classes 8 to 12) to develop

Figure 27: Demand for AI skills is among the highest in India

Probability that the selected AI skills appears in an IT-related job posting (per cent), 2021

Country	Value
Brazil	0.33
Italy	0.44
France	1.18
Australia	1.69
Germany	1.75
South Africa	1.92
United Kingdom	2.85
United States	2.95
Canada	3.32
India	4.21
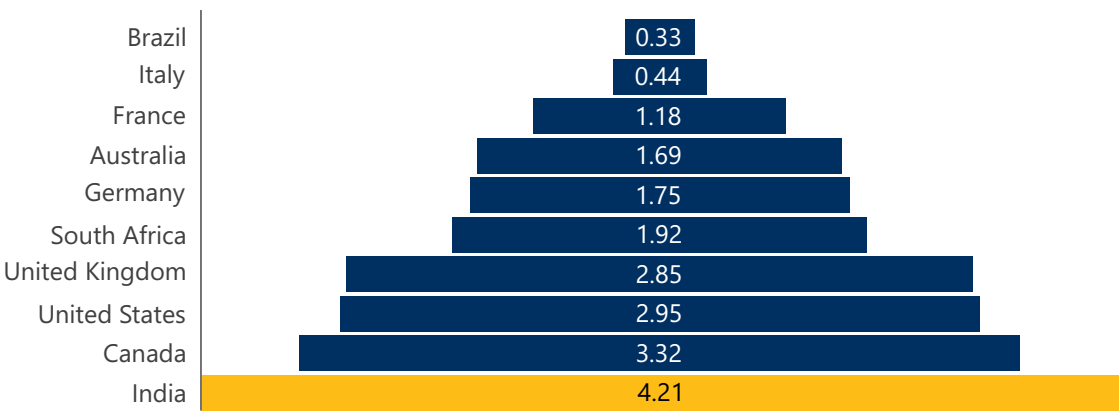
Source: OECD.AI (based on LinkedIn) 2021

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[44] EQUINIX (2022). 2022 Global Tech Trends Survey. The accelerated evolution of digital – a critical time for transformation. Retrieved on January 31st 2023 from https://www.equinix.se/content/dam/eqxcorp/en_us/documents/resources/infopapers/ip_2022_global_tech_trends_and_strategies_en.pdf

[45] Ministry of Electronics & IT (2022). Visvesvaraya PhD Scheme. Government of India. Release ID: 1883486. Retrieved on January 27th 2023 from https://pib.gov.in/PressReleasePage.aspx?PRID=1883486

[46] Ministry of Electronics & IT (2022). Responsible AI for Youth. A National Program for Government Schools. Retrieved on January 27th 2023 from: https://responsibleaiforyouth.s3.ap-south-1.amazonaws.com/RAI4Y-Portal+introduction+guide.pdf

[47] NM-ICPS – National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS). Ministry of Science & Technology, Government of India. Retrieved on February 13, 2023 from https://nmicps.in/.

AI tech and social skills.[48] The Ministry has also partnered with NASSCOM to launch Future Skills PRIME. On March 2022, the programme is reported to have trained 1.2 lakh people and an additional 4292 government officials. Within the cohort of trained professionals, according to OECD, India has the highest likelihood of having AI skills for both genders and across most industries among G20 countries (see Figure 28).

Figure 28: India has a promising talent pool for AI

Likelihood of a worker having AI skills against the cross-country average, by gender (2015-2021)

Across countries

Female Value	Country	Male Value
0.43	Turkey	0.91
0.48	Italy	0.65
0.57	South Africa	0.66
0.6	Brazil	0.73
0.65	Japan	1.11
0.66	France	1.02
0.89	U.K.	1.33
0.92	Australia	0.79
0.95	Germany	1.69
1.13	China	1.18
1.22	Korea	0.84
1.39	Canada	1.31
2.21	U.S.A	2.31
3.96	India	3.15

■ Female Value ■ Male Value

Across sectors

Finance
Education
Software and IT services

Source: OECD.AI AI (based on LinkedIn) 2015-2021

Note: The average includes the countries shown above plus Israel, Singapore, Greece, Spain, Norway, Netherlands, Poland, Finland, Hong Kong, Sweden, Switzerland, the UAE, Austria, Denmark, Portugal, Belgium, Colombia, Hungary, Czech Republic, Mexico, Chile, New Zealand (for males); Singapore, Israel, Finland, the Netherlands, Switzerland, Poland, Spain, Greece (for females).

Note: The average includes the countries shown above plus Israel, Korea, Greece, Japan, Switzerland, Norway, Spain, South Africa, Singapore, Sweden, the Netherlands, Ireland, Finland, Hong Kong, Poland, Belgium, New Zealand, Austria, Denmark (for education); Singapore the Netherlands, Hong Kong, Sweden, Switzerland, Poland (for finance); Japan, Israel, Singapore, Korea, Sweden, Netherlands, Greece, Poland, Spain, the UAE, Finland, Norway, Denmark Hungary, Ireland, Switzerland, Belgium, Hong Kong, Austria, Portugal, Czech Republic, Mexico, Colombia (for software and IT services).

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[48] YUVAi. Youth for Unnati & Vikas with AI. Ministry of Electronics Information Technology. Retrieved on January 31st 2023 from https://innovateindia.mygov.in/yuvai/

Not Leaving Behind Other Technologies

While AI is a special carve out, India has been steadily pursuing the development and adoption of other emerging technologies like cloud computing, big data analytics, internet of things, augmented, mixed and extended reality, etc. India has the third highest number of unicorns in the world, adding 14 new unicorns in the first half of 2022 (see Appendix 13). Additionally, in a global survey of frontier firms, top Indian businesses rank well, at least in terms of adopting technologies such as cloud computing, encryption, big data analytics, text and image processing (see Figure 29). The contribution of private companies such as Google Cloud, Microsoft Azure and Amazon Web Services have created robust cloud computing infrastructure in India.[49] The government is supplementing the growth of cloud infrastructure with efforts such as Meghraj,[50] the cloud computing initiative of the government and AIRAWAT,[51] an AI-powered cloud computing infrastructure that enables the development of new technologies.

Big data analytics in India has found applications in fraud detection for businesses that are involved in transaction processing, and for the government, in the use of sensor data in the agriculture sector to optimise crop efficiency. Among the top 10 countries in the world, the big data market in India was valued at INR 132.63 billion in 2021 and it poised to reach INR 558.24 billion by 2023 expanding at a CAGR of 26.8 per cent.[52] As for encryption and cybersecurity, the increasing demands for security protocols and the need to combat increasing data theft is driving the growth of the Indian cybersecurity market. From USD 2200.23 million in 2021, it is expected to achieve a market value of USD 3543.37million by 2027, growing at a CAGR of 8.05 per cent.[53] Although rapidly growing, the country overall continues to remain underinvested in cybersecurity.[54] We explore this in more detail in the next section.

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[49] Abbey, N (2022). Cloud Computing in India: Scope, Benefits, Investments & Infrastructure. STL. Retrieved on January 31st 2023 from: https://www.stl.tech/blog/cloud-computing-in-india-what-lies-ahead/

[50] MeitY. 2022. GI Cloud (MeghRaj). Retrieved on December 15, 2023 from https://www.meity.gov.in/content/gi-cloud-meghraj

[51] INDIAai (2020). AIRAWAT – Establishing an AI Specific Cloud Computing Infrastructure in India. Retrieved on February 1st 2023 from: https://indiaai.gov.in/research-reports/airawat-establishing-an-ai-specific-cloud-computing-infrastructure-in-india

[52] Netscribes (India) Pvt Ltd (2022). Big Data Market in India 2022. ID: 5568514. Retrieved on February 1st 2023 from: https://www.researchandmarkets.com/reports/5568514/big-data-market-in-india-2022?utm_source=BW&utm_medium=PressRelease&utm_code=jlwtkh&utm_campaign=1760791+-+Big+Data+Market+in+India+2022%3a+Increasing+Demand+for+Cloud-Based+Collaboration+Tools+Boosting+Growth&utm_exec=como322prd

[53] TechSci Research (2022). India Cyber Security Market, By Security Type, By Solutions Type, By Deployment Mode, By End Use Industry, By Region, By Top 12 States, Competition, Forecast & Opportunities, FY2017-FY2027. Retrieved on February 1st 2023 from: https://www.researchandmarkets.com/reports/5457874/india-cyber-security-market-by-security-type-by

[54] Davos. 2023. "India Needs to invest more in Cybersecurity to Avoid AIIMS like cyberattacks, says expert". Retrieved on February 15, 2023 from https://www.moneycontrol.com/news/business/davos-2023-india-needs-to-invest-more-in-cybersecurity-to-avoid-aiims-like-cyber-attacks-wef-9900401.html; and Businessline. 2023. Organisations in India need to step up investments in security, says report. Retrieved on February 15th, 2023 from https://www.thehindubusinessline.com/info-tech/organisations-in-india-to-step-up-investment-in-security-as-cyberattacks-grow-report/article65320590.ece

Figure 29: Frontier firms in India are adopting a number of new technologies
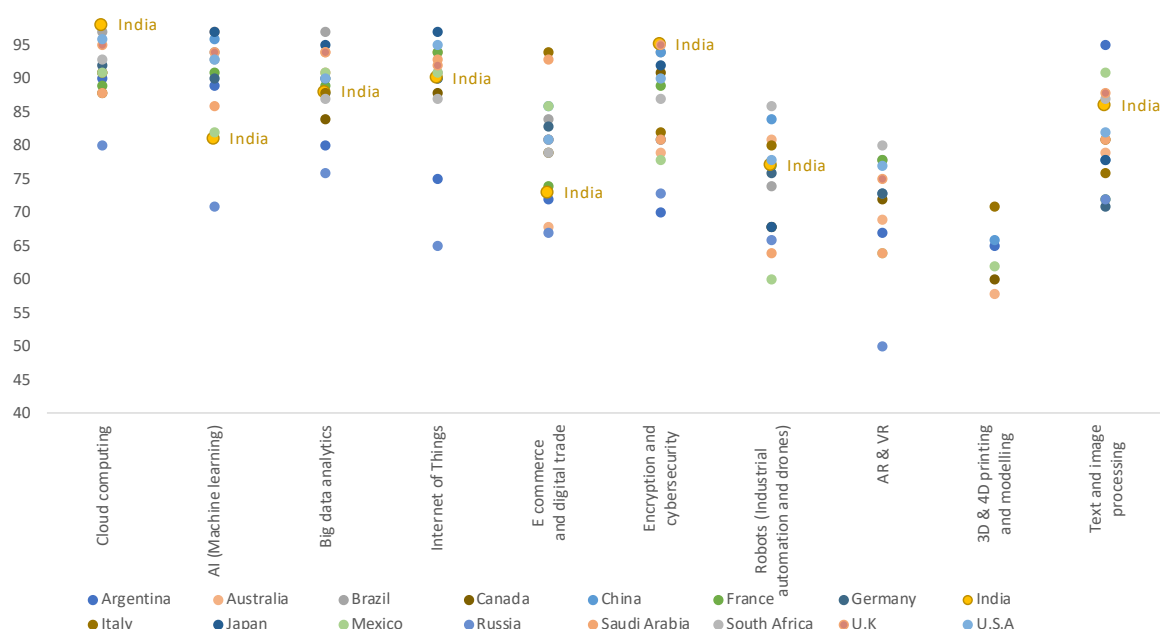
Source: World Economic Forum Future of Jobs report, 2020

Note: The report's data set contains 291 unique responses by global companies, collectively representing more than 7.7 million employees worldwide. Sixty-five per cent of the final sample is composed of multinational companies, while 35 per cent is from larger local companies, significant in terms of revenue or size, across various sectors. Small companies with less than 100 employees and informal sector companies are not included..

As in the case of AI, there is a significant demand-supply gap of skilled workers in other new technologies including cloud, big data analytics, encryption and cybersecurity. According to Coursera's latest Global Skills Report (2022), India ranks 68th globally in terms of overall skills proficiency. India has improved in the domain of key tech skills like cloud computing, theoretical computer and web development,

which significantly pushed up its rank in a single year. However, the broader labour force continues to require upskilling not only in terms of specific data sciences and digital skills but also general education. The skills component of the Frontier Technology Readiness Index, which includes expected year of schooling and high skill employment, finds India lagging behind (see Figure 30).

Figure 30: India needs to invest in education and digital skills

Technology Frontier Readiness Index – Skills (2019)

Country	Index (0 to 1)
Australia	1
Norway	0.85
Sweden	0.83
Singapore	0.82
U.K.	0.79
Israel	0.75
Germany	0.74
U.S.	0.74
France	0.72
Canada	0.71
South Korea	0.67
Japan	0.53
Brazil	0.50
U.A.E	0.49
Thailand	0.39
China	0.37
Nigeria	0.33
India	0.31
Viet Nam	0.29
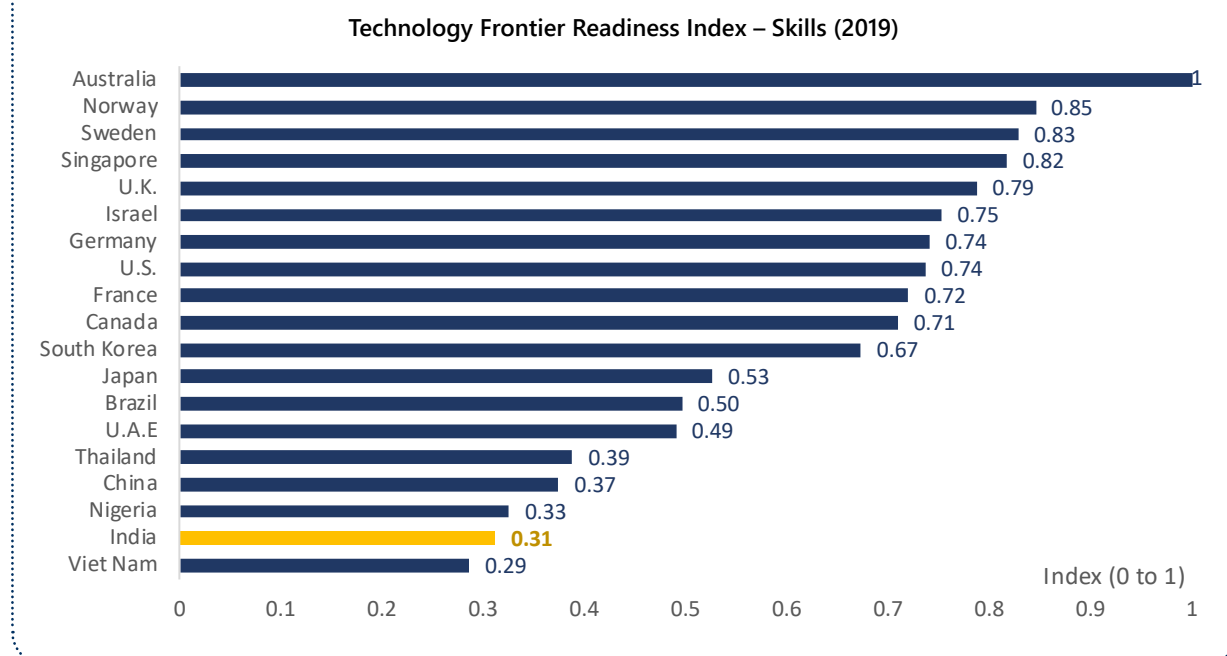
Source: UNCTAD (2019)

While India performs relatively well on the Frontier Tech Readiness Index (0.61 on a scale of 0 to 1), the skills aspect is lagging behind (0.31). Developing appropriate human capital and skills is crucial to harness emerging technology and promote technological innovations.

An emerging group of technology firsts among Indians

Even among individuals, there are small sub-groups of the population that participate in advanced digital activities. This is especially true with respect to the use of smart devices. Users are initially reliant on smartphones, but gradually invest in specific smart devices to enhance value addition. For example, while many users stream OTT platform videos on their phones, at least a few invest in smart TVs, smart speakers and smart home entertainment.[56] According to TechARC's India Connected Consumer 2023 report, adoption of smart technologies has grown with smart plugs, smart lights, televisions, speakers and smart appliances becoming much more affordable.[57]

In an unrelated area of technological innovation, the cryptocurrency market grew from 6 million users in March 2020 to almost 90 million users in March 2022.[58] According to Chainalysis, India ranks very high in decentralised finance activity when data across countries are normalised for

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[56] IANS (2020). Indians fast embracing other smart, not just phones. The Economic Times. Retrieved on February 2nd, 2023 from: https://economictimes.indiatimes.com/tech/hardware/indians-fast-embracing-other-smart-devices-not-just-phones/the-connected-indian-consumer/slideshow/77997140.cms

[57] Techarc. 2023. India Connected Consumer 2023. Retrieved on February 14, 2023 from https://techarc.net/wp-content/uploads/2022/12/Techarc-India-Connected-Consumer-Report-2023.pdf

[58] Vijayakumar, V. 2022. India's Cryptocurrency Boom. Comscore. Retrieved on February 2, 2023 from https://www.comscore.com/Insights/Blog/India-s-Cryptocurrency-Boom

purchasing power parity and level of internet usage, and relatively low in terms of peer-to-peer (P2P) trading (see Figure 31). This indicates that engagement in cryptocurrency by individuals is related to individual transactions and savings rather than trading and speculation and high-volume transactions by professional and institutional entities.[59]

Figure 31: Individuals in India are also beginning to adopt emerging technologies

Ranking of countries by cryptocurrency activity (2021)

● P2P exchange trade volume   ▲ DeFi Adoption Index

Use of emerging technologies by G20 countries (2021)

— Russia — Australia — South Korea — United Kingdom — United States — China — India

Source: Chainalysis, The 2021 Geography of Cryptocurrency Report.

Source: Statista Market Forecast, 2021

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[59] The DeFi Adoption Index measures three aspects: 1) total on-chain cryptocurrency value received by DeFi platforms 2) total retail value (transactions under USD $10,000) received by DeFi platforms and 3) individual deposits to DeFi platforms per internet user. These components are weighted by PPP per capita to favour countries with greater activity, given the average wealth.

PROTECT: THE ACHILLES HEEL

India's digital expressways lack strong rail guards

Despite massive digitisation, India has made only modest progress in developing cybersecurity rail guards. While the National Cybersecurity Index[60] finds that the level of cybersecurity preparedness in India is aligned to the level of digital development, it would be myopic to not worry about the need to accelerate efforts towards securing India's digital economy, especially given the rate of digital transformation the country is currently witnessing and the commensurate increase in cybercrimes. Even at current levels of digitisation, India has seen a steady rise in the number of data thefts and, in 2022, the fourth highest number of data breaches, following Russia, the US and France.[61] Among the G20 countries, the percentage of internet users who have experienced any cybercrime is the highest in India.

Figure 32: The threats of cybercrimes loom large

Percentage of internet users in selected countries who have ever experienced any cybercrime (2021)

Number of cybercrimes reported in India
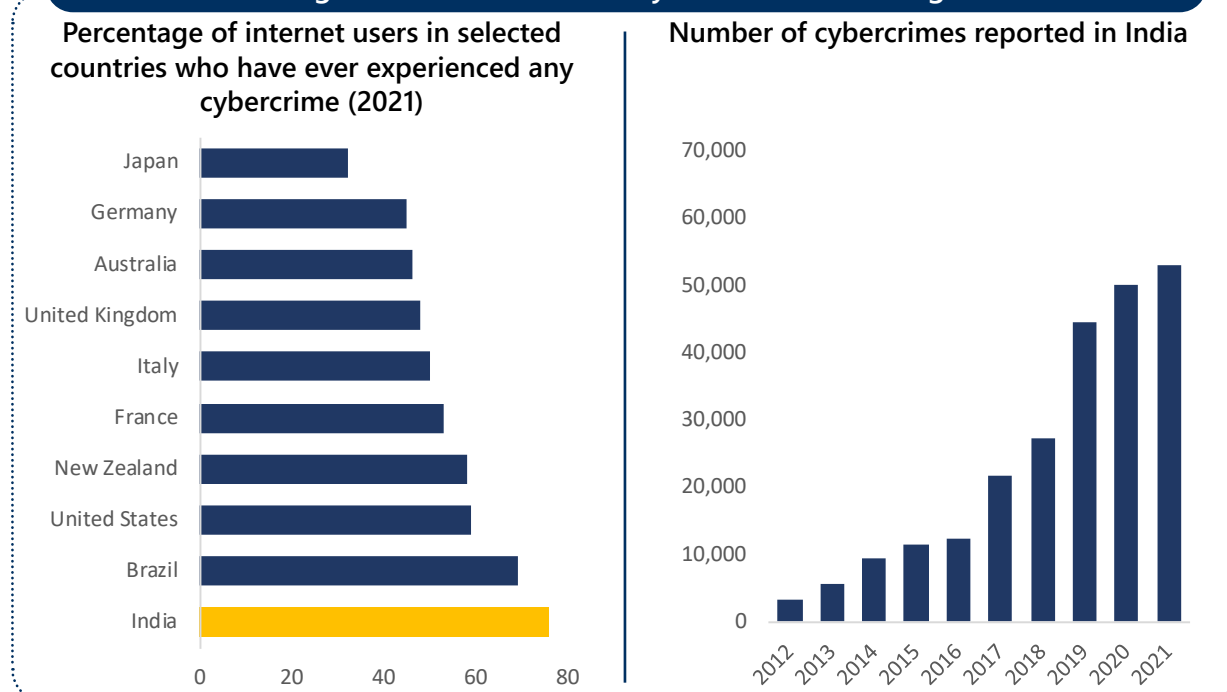
Source: Norton LifeLock Cyber Safety Insights report.

Based on a survey with the following sample sizes: Australia (1002), France (1001), Germany (1000), India (1000), Italy (1000), Japan (1000), New Zealand (1000), the UK (1000), the US (1000) and Brazil (1000). Results presented in the report are after data was weighted according to their actual proportions in the population. India was weighted to the population of those who are online. Weighted variables varied by country and included one or more of the following: age, gender, race/ethnicity, region, education, marital status, internet usage, household size, household income, urbanisation, and propensity to be online. A global post-weight was applied to ensure equal weight for each country in the global total.

Source: NCRB 2021, volume 2, page 785

The statistics on cybercrimes are collected under the following heads:

i) Offences registered under the Information Technology Act, 2000.

ii) Offences under the IPC related to cybercrimes

iii) Offences under the special and local laws (SLL) related to cybercrimes

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[60] See Appendix 14.

[61] See Appendix 15.

India does not have an exclusive cybersecurity law. Instead, it uses the IT Act and various other sector regulators to promote cybersecurity standards including the RBI's Cyber Security Framework in Banks. The government recently proposed amendments to the IT Act offering new cybersecurity guidelines;[62] however, they are being currently contested. The rules require companies to maintain log files for 180 days and report any cyber incidents defined within the rules within six hours[63] - this would require significant investment in security technologies and hiring of specialists. According to some industry estimates, this could cost a company with 10 employees between INR 2 -15 lakh and a bank, which uses 200 or more applications at a time, almost INR 40 -50 lakh for a year's contract.[64]

Nature of Cybercrimes

There is increasing sophistication in cybercrime, cyber espionage, compromising organisational networks and data systems, etc. Incidents of cybercrimes against women and children have been on a rise as the adoption of internet keeps increasing in these groups. As per the latest "Crime in India" report published by the National Crime Records Bureau (NCRB), cybercrimes against children rose from 305 to 1102 during 2019-2020 while that against women rose to 10405 from 8379 during the same period.[65] The crimes are clustered in a few pockets that record a higher incidence than the rest of the country (refer Appendix 16).

Sectorally, most cybercrimes are being reported in the financial services sector, with UPI frauds complaints having increased four and a half times in Q2 2020, compared to that in Q2 of 2021. There is also a rising trend of attacks in the health care sector, both globally as well as in India. The Cyber Peace Institute's tracker, shows that while there were no major cyber-attacks attacks in 2018 and 2019, this rose to 11 incidents between June 2020 and June 2022 (See Appendix 17).

Another worrying pattern is the increasing number of attacks in the government sector and state-sponsored attacks. In 2022, India had the highest number of cyberattacks against the government compared to other G20 countries and several publicly known attacks falling in the category of espionage. This is a strong signal for the government to immediately escalate its spending on cybersecurity, including in the training of professionals.

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[62] MeitY, 2022. Retrieved on 30 Janurary 2023 from: https://www.meity.gov.in/writereaddata/files/Press%20Note%20dated%206%20June%2022%20and%20Proposed%20draft%20amendment%20to%20IT%20Rules%202021.pdf

[63] Ministry of Electronics and Information Technology & Indian Computer Emergency Response Team (CERT-In). (2022). Directions under sub-section (6) of section 70B of the Information Technology Act, 2000 relating to information security practices, procedure, prevention, response and reporting of cyber incidents for Safe & Trusted Internet. Retrieved on 13th February 2023 from https://www.cert-in.org.in/PDF/CERT-In_Directions_70B_28.04.2022.pdf

[64] Bagchi, Sohini & Abhijit Ahaskar. 2022. "MSMEs seek more time to meet CERT-In's cybersecurity rules". Retrieved on 13th February 2023 from: https://www.livemint.com/industry/msmes-seek-more-time-to-meet-cert-in-s-cybersecurity-rules-11663918033947.html

[65] Ministry of Women and Child Development (2022). Online Cyber Grooming of Women and Young Children. Retrieved on 30 January 2023 from: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1806602#:~:text=The%20latest%20published%20report%20is,registered%20as%208379%20and%2010405. Accessed: January 30, 2023.

Figure 33: Financial services are vulnerable to cybercrimes

Cybercrime incidents reported on the National Cybercrime Reporting Portal in Q2 2022

Online Financial Frauds, 67.8%

Online and Social Media related Crimes, 13.4%

Any Other Cyber Crime, 12.1%

Child Pornography, Cryptocurrency, Hacking, Sexually explicit/Obscene material, Ransomware, 6.7%
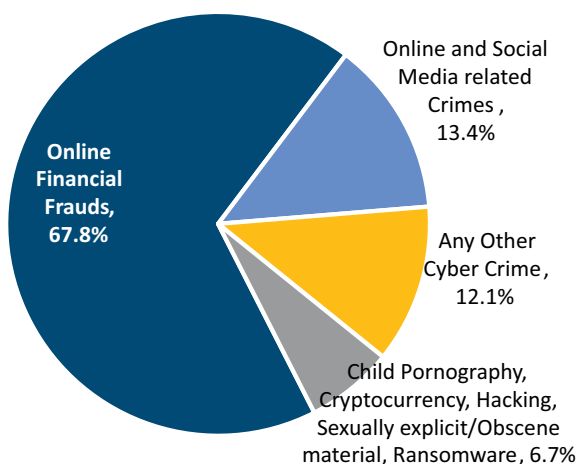
Number of complaints on the National Cybercrime Reporting Portal (2021-22)

UPI fraud

Debit/Credit/Sim Swap fraud

Internet banking fraud
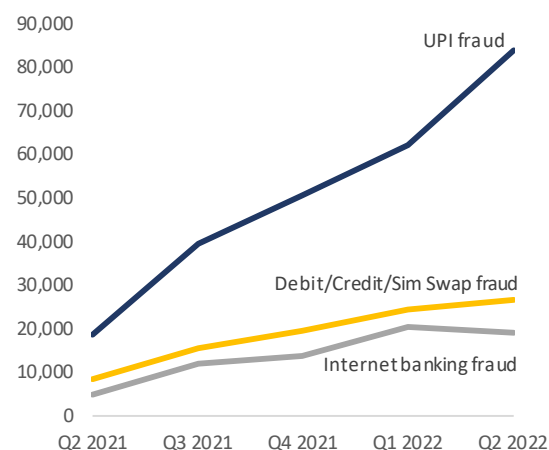
Source: Indian Cybercrime Coordination Centre, CyberPravaha. Fifth Quarterly Issue. Q2 2022.

Figure 34: India has reported large increase in cyberattacks against government entities

Per cent of attacks recorded against government sector

2021
2022

Saudi Arabia, Brazil, Mexico, Russia, China, Indonesia, USA, India
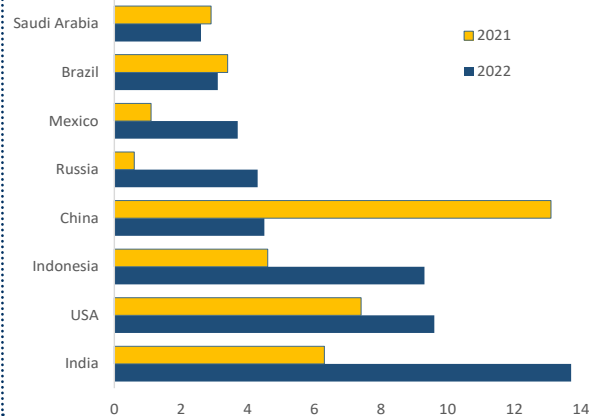
Number of cyberattacks on the government sector (2021)

Month	Value
December	32
November	39
October	50
September	89
August	61
July	59
June	61
May	60
April	65
March	44
February	38
January	53
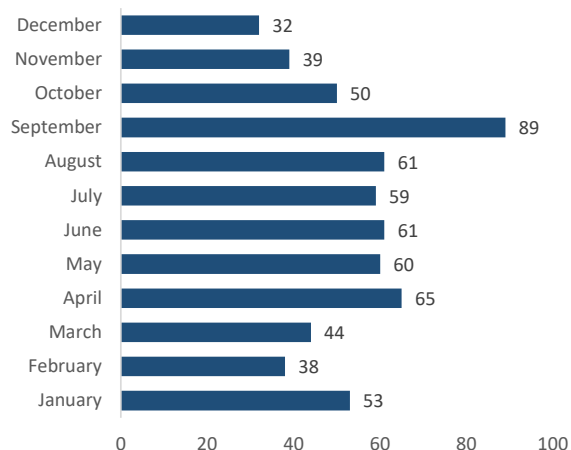
Source: CloudSEK XVigil, 2022.

Source: CloudSEK XVigil, 2022.

Figure 35: Publicly known state-sponsored cyber-attacks on India (2008-2022)

Legend:
- Espionage
- Sabotage
- Financial Theft
- Not Classified
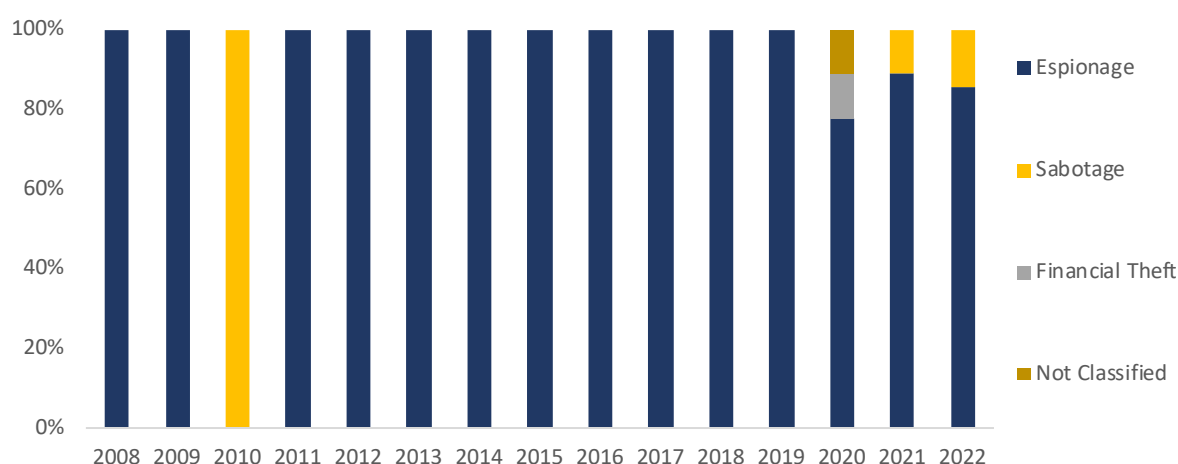
Source: Cyber Operations Tracker, Council on Foreign Relations

The 2022-23 budget allocated a cumulative amount of INR 21,713 crore for cybersecurity in India. Since 2015, the underutilisation of the cybersecurity budget has been diminishing, with actual expenditure exceeding allocated budget in 2018-19 and 2020-21.[66] Increases in both allocation and expenditure reflect necessary prioritisaton of cybersecurity. With the recognised increase in cost of data breaches and the advantages of building secure servers, many companies have begun investing in cybersecurity. According to PwC's 2022 Digital Trust Insights Survey, 82 per cent of the Indian respondents have predicted an increase in their cybersecurity budget in 2022.[67] Four out of ten organisations in India have initiated, or are planning to initiate, investment in cybersecurity by focusing on areas such as customer identity and access management, zero trust architecture, managed security services, cloud security and endpoint security. There is a simultaneous focus on building skills – a new opportunity for cybersecurity professionals. According to industry estimates there is a shortage of 3.4 million cybersecurity professionals worldwide,[68] and India could help build this capacity for itself as well as for the rest of the world.

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[66] Gunjan Chawla, Ananya Moncourt and Vagisha Srivastava, Working Paper: The Cybersecurity Budget Brief, Centre for Communication Governance, National Law University Delhi_ January 2023.

[67] Dynamic Cisco. (2022). Changing Scenario of Cybersecurity Investment in India 2022: Digital Trust Insight Survey. Retrieved on January 16, 2023 from https://dynamicciso.com/changing-scenario-of-cybersecurity-investment-in-india-2022-digital-trust-insight-survey/; (2022). PwC. 2022 Global Digital Trust Insights Retrieved on January 5, 2023 from. https://riskproducts.pwc.com/resources/2022-global-digital-trust-insights

[68] 2022 (ISC)² Cybersecurity Workforce Study. Retrieved on december 12 2022 from: https://www.isc2.org/News-and-Events/Press-Room/Posts/2022/10/20/ISC2-Research-Reveals-the-Cybersecurity-Profession-Must-Grow-by-3-4-Mil-to-Close-Workforce-Gap

Figure 36: Investments in cybersecurity helps build resilience

Growth rates for secure servers and cyberattacks (2015-2020)
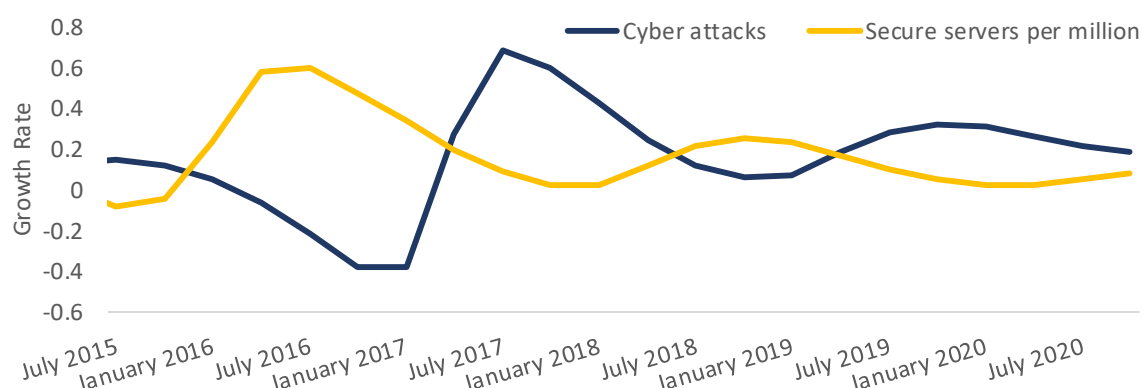
Source: World Bank databank for secure servers and Statista for cyberattacks

Figure 37: Average cost of data breaches in million USD (2022)
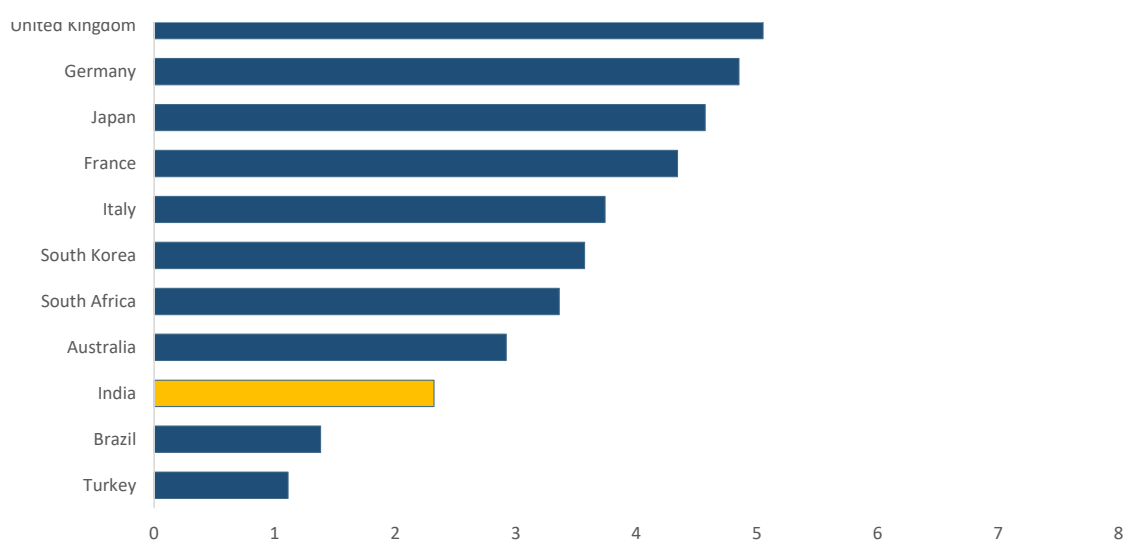
Source: Cost of a Data Breach Report 2022, pages 9-10

Notes: reaches included range from 2200-102,000 compromised records. Researchers collected in-depth qualitative data through over 3,600 separate interviews with individuals at 550 organisations that suffered a data breach between March 2021 and March 2022. Interviewees included IT, compliance and information security practitioners familiar with their organisation's data breach and the costs associated with resolving the breach.

The techno-economics of the industry in India results in mobile data networks being optimised for broad coverage, but not necessarily quality. The poor financial health of the telecom sector and low revenue realisation from a price sensitive market means that investment in infrastructure has not kept up.

Vicious Cycle of Poor Access, Low Income, Poor Affordability, Low Revenues, Low Investment and Low Quality

The rapid growth of internet users in India has flattened recently, largely explained by devices and data still being unaffordable to many. Significant expansion of networks in the past decade has meant that today almost 99 per cent of the Indian population has mobile broadband coverage of 3G or more – up from 61 per cent in 2014.[69] However, infrastructure is only part of the answer to universal access or usage. The share of population that lives within the reach of a mobile network but do not use it – the usage gap – is particularly high for India, estimated at 63 per cent in 2020.[70] While falling prices of internet-enabled devices and mobile data, along with rising incomes have been key in improving access, affordability is still a major constraint to universal access. In 2020, India had one of the cheapest mobile data costs at USD 0.09 per GB, a 65 per cent decrease in price compared to the country's average cost in 2019. Mobile data costs had increased again by 2021, but are still relatively low compared to global levels. However, given the relatively low incomes of a considerable proportion of the population, affordability is still a barrier.

Figure 38: Given India's low levels of per capita income, mobile broadband is unaffordable even at very low prices
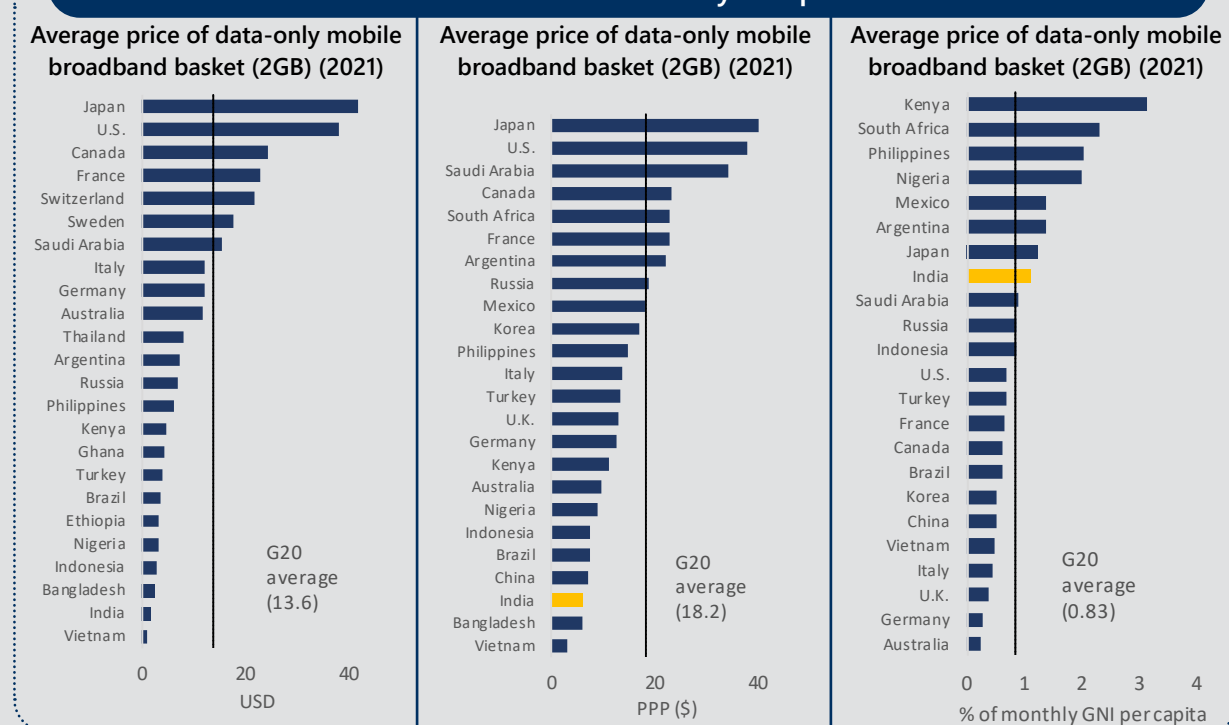
Source: ITU Statistics ICT Price Baskets, 2021. Data-only 2GB broadband basket for connection of 3G or higher.

[69] GSMA (2021). Data Set. Retrieved on January 26 2023 from : GSMA Mobile Connectivity Index.

[70] GSMA (2022). The Mobile Economy Asia Pacific. Retrieved: GSMA Mobile Connectivity Index. Reterieved on January 26, 2023

The Challenge of Affordable Devices

Affordability of internet-enabled devices is perhaps an even greater barrier than mobile data costs. Improvements in device quality and changes in income distribution are the main drivers of growth in smartphone sales in India.[71] With the decline in smartphone prices, there has been a sharp rise in the number of smart phone users in India (refer Appendix 5). According to estimates by Newzoo, the number of smartphone users[72] in 2021 stood at 492.78 million and 647.53 million in 2022.[73] In comparison to other countries, the price of the cheapest feature phone and smartphone as a percentage of average monthly income continues to remain high for India.

Figure 39: Affordability of devices amongst the biggest constraints in internet adoption

Price of cheapest feature phone as a percentage of average monthly income (2021)

Price of cheapest smartphone as a percentage of average monthly income (2021)
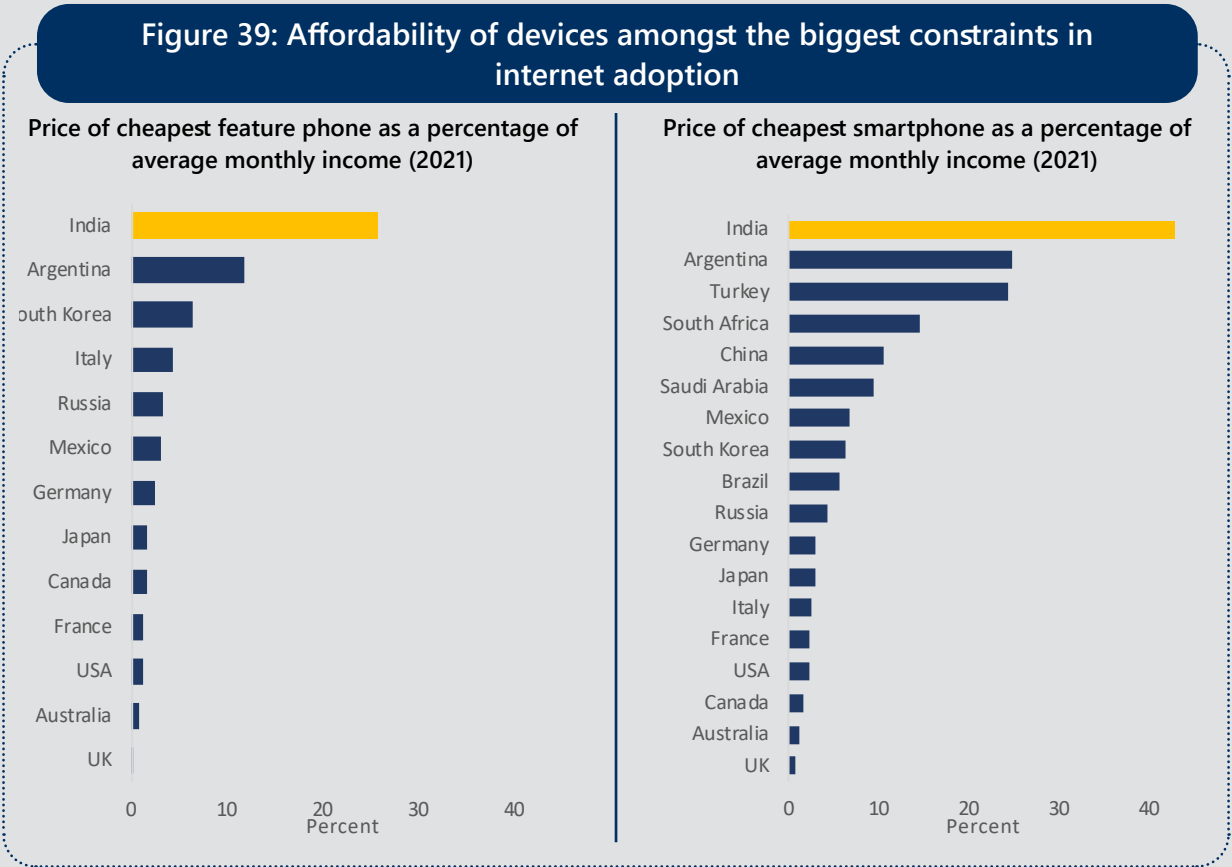
Source: Alliance for Affordable Internet (2021)

[71] Shreeti, V (2021). Explaining Smartphone Adoption in India [Unpublished Manuscript]. Toulouse School of Economics. Job Market Paper. Retrieved on January 13th 2023 from: https://drive.google.com/file/d/1OoFyPJfdEda_UWdGmkSFHegNdn99NJP_/view

[72] Smartphone users refers to individuals of any age who own at least one smartphone and use the smartphone(s) at least once per month.

[73] Newzoo. 2021. Newzoo Global Mobile Market Report 2021. Retrieved on 14th February 2023 from: https://newzoo.com/insights/trend-reports/newzoo-global-mobile-market-report-2021-free-version ; Top Countries by Smartphone Users. 2023. Retrieved on 14th February 2023 from: https://newzoo.com/insights/rankings/top-countries-by-smartphone-penetration-and-users

This challenge is more acute for the bottom 40 per cent of the income distribution. The price of the cheapest smartphone is about 2.6 times the average monthly income of the bottom 40 percentile. This is also much higher than several developing and developed countries (see Figure 40). Further, individuals in the bottom 60 per cent of the income distribution are estimated to be nearly four times as price sensitive as individuals in the top 40 per cent.[74] Accordingly, users in rural areas are much more likely to use feature phones than smart phones. According to 2020 survey responses, there are 42 per cent feature phone users in rural areas, compared to 22 per cent in urban areas. Smartphone usage is expected to have increased since then.

Figure 40: For the bottom 40 per cent, the challenge of affordability is very acute

Price of cheapest smartphone (2021) as a share of mean monthly income/consumption of the bottom 40% (2018/2019/2020)

Type of mobile phone users (2020)
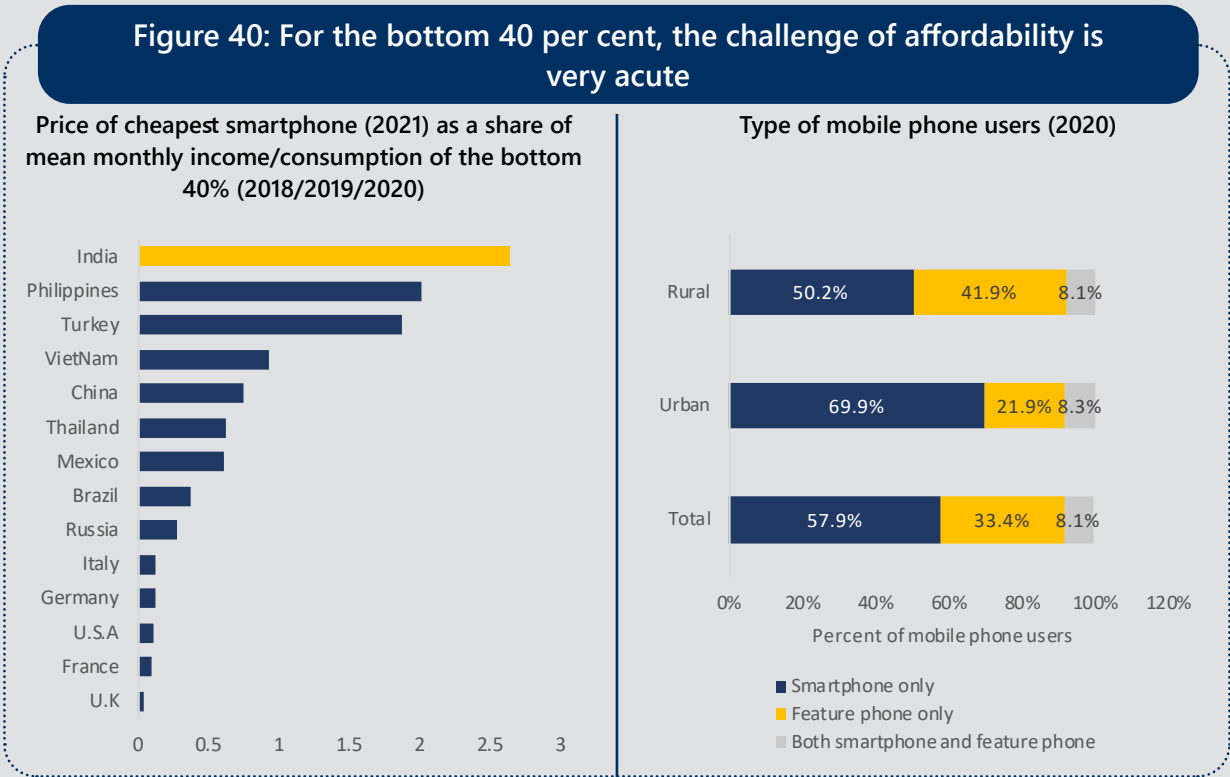
Source: Alliance for Affordable Internet (2021) for cheapest internet enabled smartphone, World Bank Global Database of Shared Prosperity for mean income/consumption of the bottom 40 per cent per day (2017 PPP $) for the years 2018, 2019 or 2020 depending on the latest data available, World Development Indicators for CPI and PPP conversion factors to deflate and adjust device prices to match the income/ consumption data.

Source: IMRB Kantar ICUBE 2020

Limitations of Revenue Upside

Poor affordability, low literacy and limited digital skills collectively limit the revenue mobilisation for internet service providers and providers of digital services. Even with very low data prices and zero-priced digital services, the bottom 40 per cent of the population are usually less likely to use services on the internet. With mobile phone expenditures already increasing significantly between 2016 and 2021 (Figure 41), the scope of further increases in mobile expenditure i.e., revenues for telecom service providers is limited.

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[74] Shreeti, V (2021). Explaining Smartphone Adoption in India. Toulouse School of Economics. Job Market Paper.

According to CMIE, the mean monthly expenditure on mobile phone charges by rural users is INR 297, as compared to INR 386 in urban areas.[75] While the ratio of urban to rural monthly household expenditure on cell phone charges is 1.29, the average income in urban India is around twice[76] that in rural India. The divides in rural-urban incomes are larger than the divides in mean monthly expenditure on cell phone charges. This highlights the lack of affordability as one of the key reasons why parts of the population continue to remain unconnected in India; this is also reflected in ground surveys. According to an NPCI survey on the adoption of digital payments in India, the bottom 40 per cent is half as likely as the top 20 per cent to use digital payments.[77] The 2022 Oxfam report on digital divides, based on CMIE data, reports a much wider gap with the richest 60 per cent being four times more likely to make a digital payment than the poorest 40 per cent.[78]

Figure 41: Increases in household expenditure on mobile phone charges

Mean monthly household expenditure on cell phone charges (2015-2016 & 2021-2022)
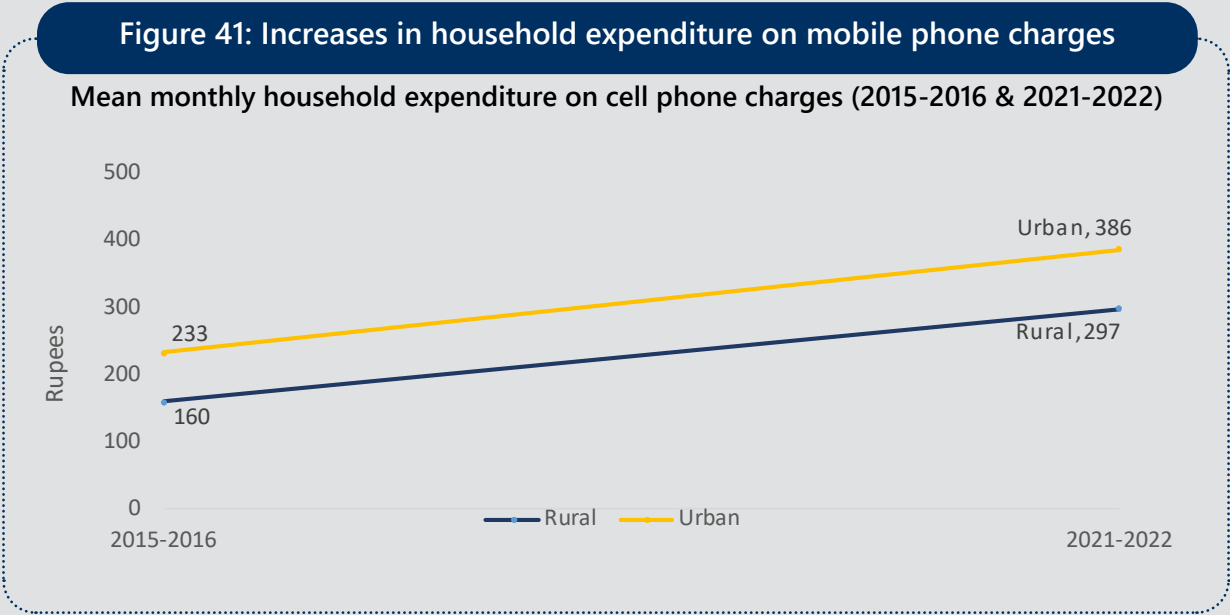
Source: CMIE Consumer Pyramids Survey. Averaged monthly expenditures over August 2015-2016 and August 2021-2022. Weights provided by CMIE were applied but have not been adjusted for non-responses.

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[75] Estimates obtained using the national weights provided in the dataset but not adjusted for non-responses.

[76] Kumar, R., Loungani, P. and Balasubramanian, S. Sustaining India's growth miracle requires increased attention to inequality of opportunity. VOXEU Columns. Retrieved on January 30 2023 from: Sustaining India's growth miracle requires increased attention to inequality of opportunity | CEPR

[77] NPCI (2020). Digital Payments Adoption in India. Retrieved on Janurary 26 2023 from: https://www.npci.org.in/PDF/npci/knowledge-center/Digital-Payment-Adoption-in-India-2020.pdf

[78] OXFAM (2022). India Inequality Report 2022: Digital Divide. Retrieved on January 26 2023 from: https://www.oxfamindia.org/knowledgehub/workingpaper/india-inequality-report-2022-digital-divide

Figure 42: Low revenues lower investment capacity

Investments in Telecommunication Infrastructure versus Mobile ARPU per month
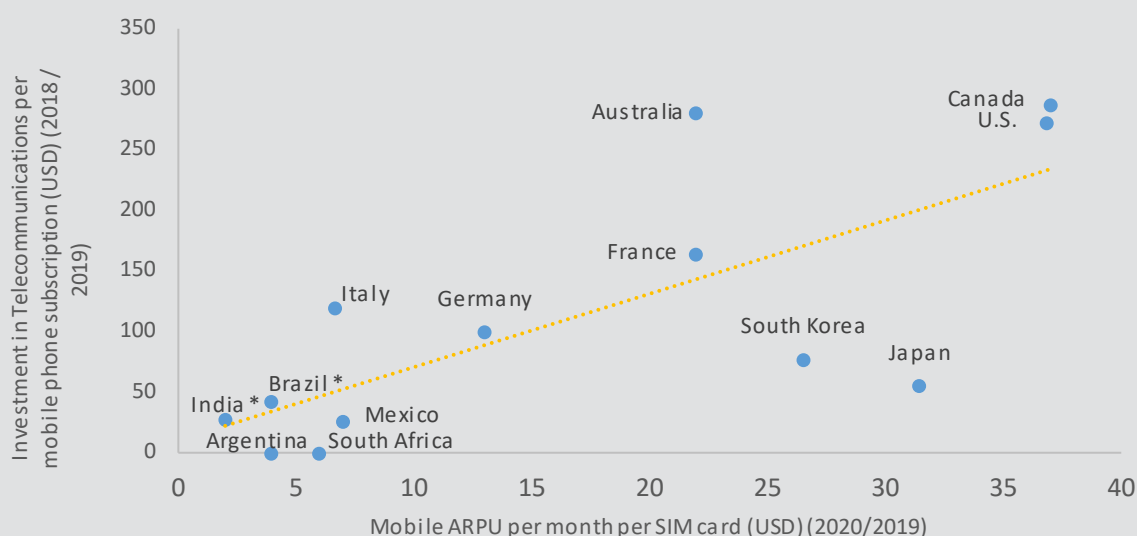
*Source: Investment in telecommunication (fixed, cellular mobile and other wireless) (2018) was taken from OECD Statistics. * Investment data for Brazil is from 2019 and for India from 2019-2020. For Brazil, investments of telecommunication providers for 2019 was taken from Statista and converted to USD using the average 2019 exchange rates. For India, gross capital formation for "communication & services related to broadcasting" (current prices) was taken for 2019-2020 and converted to USD using the average 2020 exchange rate. India's investment is calculated by assuming that investments in telecommunications comprises ~ 30% of the "Communications & services related to broadcasting" sector, proportionate to its share in total output of this broader category. Mobile ARPU per SIM card was taken from Statista, with the original source of American Tower Corporation: International Market Overview Fourth Quarter 2020. For the U.S., Japan and South Korea from Statista, with original source of ETNO; Analysys Mason (State of Digital Telecommunications 2021 report) and for Italy from Statista with the original source of AGCOM.*

Inadequate Infrastructure Reflecting in Poor Quality Access

Investments in infrastructure have not been commensurate with the rapid increase in adoption of digital services and use of data heavy applications, with poor internet quality being the consequence. Despite considerable improvements in the past few years, internet quality in India remains relatively low (Figure 43). In a recent development, the Department of Telecommunications, India, has revised the definition of broadband to having a minimum download speed of 2 Mbps to an individual subscriber from the point of presence.[79] Although the median mobile download speed in India had jumped to over 25Mbps as of December 2022,[80] network congestion can cause speeds to fall below 2 Mbps when several devices connect to a single tower.[81]

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[79] Deep, A. (2023). Now, at least 2 Mbps speed required to get broadband tag. SCI-TECH. Retrieved: https://www.thehindu.com/sci-tech/technology/india-broadband-definition-updated-to-2mbps-download-speed/article66466409.ece Accessed: February 6, 2023.

[80] https://www.speedtest.net/global-index#mobile

[81] COAI Response on Consultation Paper on Roadmap to Promote Broadband Connectivity and Enhanced Broadband Speed. Retrieved: https://trai.gov.in/sites/default/files/COAI_10112020.pdf Accessed: February 6, 2023.

Figure 43: Poor Quality of Internet Access in India

Median Fixed Broadband Download Speed (Global) (2022)

China
U.S.
Spain
Japan
Switzerland
Norway
South…
Canada
France
Brazil
Germany
Russia
U.K.
Italy
Australia
India
Mexico
South…
Turkey
Indonesia

0   40   80   120   160
Mbps

Median Mobile Download Speed (Global) (2022)

Norway
South Korea
China
Switzerland
Canada
Australia
U.S
France
Germany
U.K
Japan
Italy
Spain
South Africa
Turkey
Mexico
Brazil
Russia
Indonesia
India

0   40   80   120
Mbps
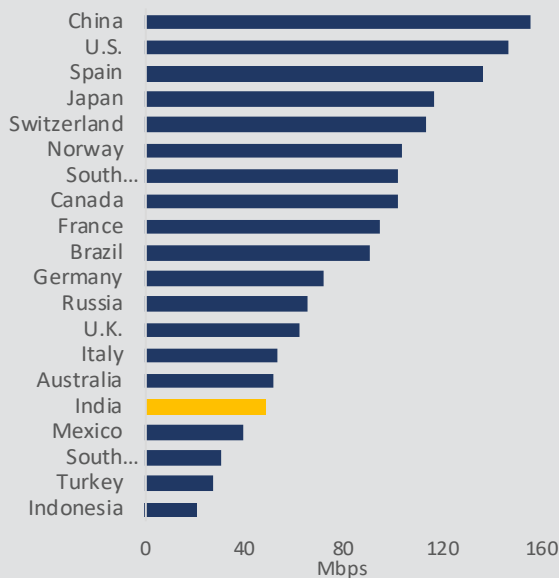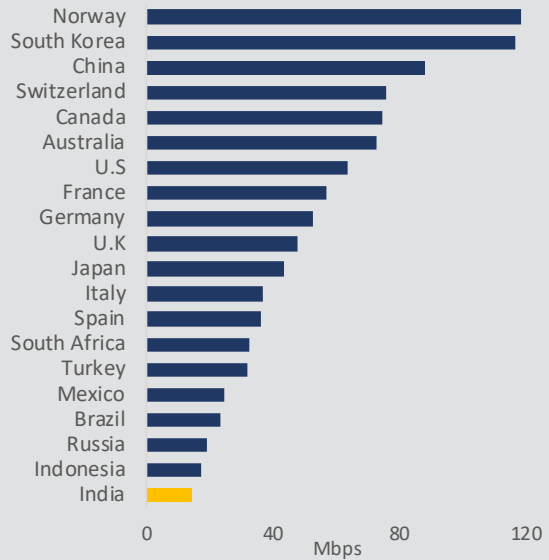
Source: Speedtest.net, February/March 2022

Results for mobile are based on all cellular technologies. Fixed broadband includes mobile Wi-Fi results. Speed tests are consumer-initiated and thus dependent on their number and connection type

Source: Speedtest.net, August 2022

Results for mobile are based on all cellular technologies. Fixed broadband includes mobile Wi-Fi results. Speed tests are consumer-initiated and thus dependent on their number and connection type

Median Mobile Download Speeds (India) (2022)

Legend
No Data
0 - 10
10 - 20
20 - 30
30 - 41
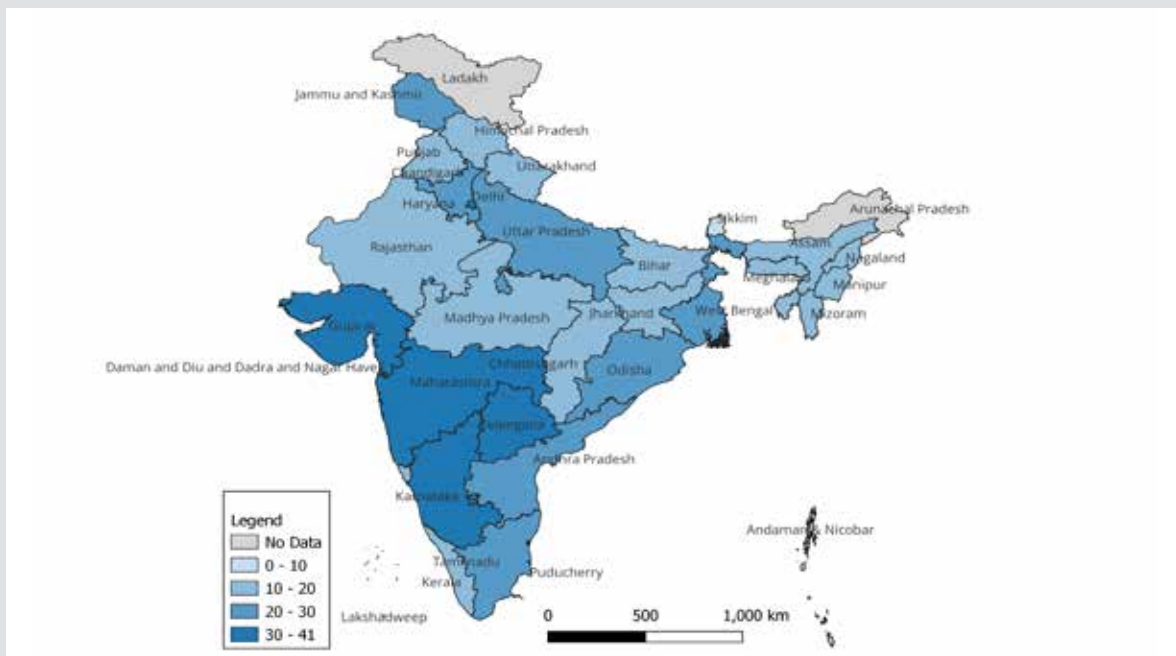
Source: Speedtest.net, August 2022

The level of telecome infrastructure as measured by specific indicators, falls short of the requirement given the demand. For example, spectrum per user, a key driver of higher mobile internet speeds, are relatively low compared to global levels. Similarly, the number of fiberized telecom towers, fibre density, and the number of internet exchange points are all lower than is required for a rapidly growly data-intensive user group.

Figure 44: India fares poorly on many indicators of telecom infrastructure that determine quality in India

| Low fiberization of telecom towers	Low fibre density
• 34.4 per cent of telecom towers (base transceiver stations) are connected with fibre as against an average of 65-80 per cent in the US, China and Korea. • India needs to reach at least 70 per cent to fully utilise the potential which 5G services could offer. *Source: TRAI, Ernst and Young*	• India's per capita fibre deployment is 0.09 km compared to other countries including China with 0.87 km, and the US and Japan with more 1.3 km or more. • There is a need to deploy 100 million fibre km optical fibre cable (OFC) per year, in order to have a robust 5G network across the country. *Source: TRAI, Ernst and Young*
Low per capita spectrum	Fewer internet exchange points
• India has low spectrum for the scale (0.27 Hz per cellular subscription and 0.43Hz per active mobile-broadband subscriptions); compared for example to 0.45 and 0.57 for China, 2.87 and 3.09 for Brazil, 5.7 and 12.06 for the Philippines) (2020) (Source: GSMA and ITU). • Spectrum relates to the radio frequencies allocated to the mobile industry and other sectors for communication over the airwaves. *Source: TRAI, Ernst and Young*	• There are 754 internet exchange points in the world as of April 2022, with the highest number in the Unites States (121), followed by Russia (35), Brazil (34), Argentina (29), Australia (28), Germany (27), and India (23). • It has been shown that access speeds for local content can improve as much as tenfold with an IXP, as traffic is routed more directly (Internet Society, 2015). *Source: Packet Clearing House, Internet exchange point directory reports.*

This section demonstrates how the dual challenges of universal access and quality are closely intertwined. India has a large existing user base and presents a growing market opportunity for telecom service providers. However, given the price-sensitive nature of the market, with incomes still low for a large share of the population, the opportunity for service-providers to raise revenues are limited – limiting their ability to invest in infrastructure improvements, creating a vicious cycle that affects both quality and universal access. Regulation and policy have an important role in striking a balance. High-quality universal usage in India is unlikely without significant government investments.

Empowering India's Digital Revolution through Digital Public Infrastructure and Platforms (DPIPs)
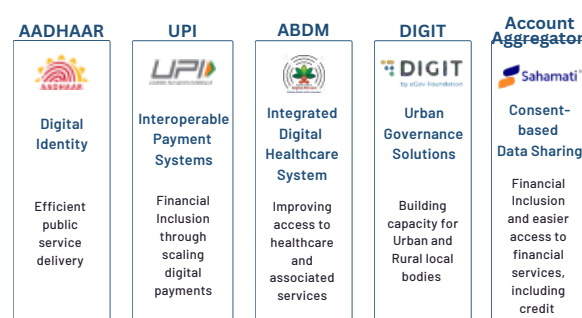
Digital Public Infrastructure and Platforms (DPIPs) are redefining India's development story. Through their sheer scale and spread, they have become the backbone of public service delivery, ensuring that services reach poor households, underserved communities and remote areas, making development more inclusive. Implemented at low cost and easily integrated with third-party software, DPIPs are cutting through the siloed approach of designing and implementing digital solutions to avoid vendor lock-in, thereby making the development process more efficient.[83] Finally, their modular, interoperable, and customisable design is helping the development process to become more innovative.

Given that India's experimentation with DPIPs has just taken off, their benefits are obvious to all, but the potential risks remain hidden. Since the new system is like an inter-connected expressway on which new processes and platforms are being rapidly built, if a person is left out of the base structure, she faces the risk of **exclusion** from the entire ecosystem, exacerbating existing divides. Similarly, DPIPs carry the risk of **concentration**, especially if they enjoy regulatory advantage and become public monopolies. Finally, given the amount of data likely to pass through and stored in DPIPs, they will become the natural targets of criminals and hostile entities, carrying with them the risk of **security and privacy**.

In this report, we examine five DPIPs that are currently in operation in India, namely, *aadhaar*, Unified Payment Interface (UPI), Ayushman Bharat Digital Mission (ABDM), Digital Infrastructure for Governance, Impact & Transformation (DIGIT), and the Account Aggregator (AA) Framework (see Figure 45). Each case study presents an analysis of benefits and risks that have emerged from their implementation. The benefits focus on aspects of inclusion, efficiency and innovation while the risks raise concerns of exclusion, concentration, and security and governance among others. Some case studies provide relevant international comparisons, weighing the advantages and disadvantages of alternate models.

Figure 45: Five DPIPs that are redefining India's development story

AADHAAR	UPI	ABDM	DIGIT	Account Aggregator
Digital Identity	Interoperable Payment Systems	Integrated Digital Healthcare System	Urban Governance Solutions	Consent-based Data Sharing
Efficient public service delivery	Financial Inclusion through scaling digital payments	Improving access to healthcare and associated services	Building capacity for Urban and Rural local bodies	Financial Inclusion and easier access to financial services, including credit

Note: The Sahamati logo represents the Account Aggregator Framework

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82 See Ministry of Finance, Government of India. (2023). Economic Survey 2022-2023. Retrieved February 11, 2023, from https://www.indiabudget.gov.in/economicsurvey/; and the World Bank. (2016). World Development Report 2016: Digital Dividends. Retrieved on January 23, 2022 from https://www.worldbank.org/en/publication/wdr2016 .

83 Digital Public Goods Alliance. (n.d.). Digital Public Goods. Retrieved on February 11, 2023, from https://digitalpublicgoods.net/digital-public-goods/

84 The Open Network Digital Commerce is still running as a pilot.

The five DPIs are at different stages of product maturity – *aadhaar* has been around for more than a decade and UPI since 2016 while the others including DIGIT, ABDM, and AA are more recent interventions. As there has been no formal assessment of the impact of DPIPs, this section attempts to fill the gap. The purpose of the analysis is to highlight best practices and the areas that need improvement to strengthen India's DPIP initiatives, and their potential contribution to India's growth and development. We propose a seven-step DPIP checklist at the end of this section.

1. Aadhaar: The world's largest digital identity programme

With more than 1.3 billion identities generated, *aadhaar* is among the earliest and largest digital identity programmes in the world. Started in late 2010, *aadhaar* is foundational digital public infrastructure introduced with two primary objectives: (i) to improve inclusion and (ii) to increase the efficiency of government schemes. It is now a key component of the India stack that is built for the larger purpose of harnessing India's digital ecosystem (see Figure 46).

The scale, magnitude, and speed of the *aadhaar* project from ideation to implementation remains extraordinary. The design and execution of *aadhaar* for over a billion people was achieved in less than a decade. The cumulative expenditure by the Unique Identity Authority of India (UIDAI) since 2009-10 is estimated at INR15,398 crore (USD1.86 billion).[85] The modular open-source identity platform (MOSIP), a digital public good based on insights from *aadhaar*, was developed by the International Institute of Information Technology, Bangalore (IIIT-B). MOSIP is already being used by several nations including Sri Lanka, Morocco, the Philippines, Guinea, Ethiopia and the Togolese Republic to build their own national digital identities (see Table 1).[86]

Figure 46: Aadhaar within the Digital Public Ecosystem

- **Digitised** Government Services
- Digital Public **Platforms**
- Digital Public **Infrastructure**
- Digital Public **Goods**
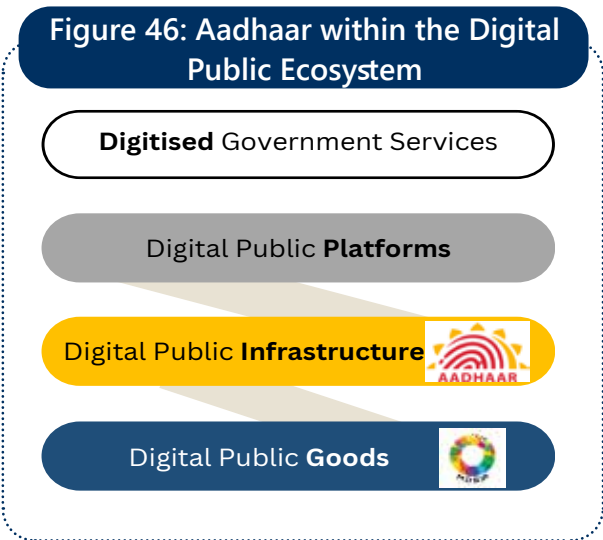
Source: ICRIER Policy Brief 3 (2023)

Table 1: *Aadhaar* Facts

First *Aadhaar* number issued: September 2010
Aadhaar Act: July 2016; Amendment: July 2019
Statutory body: Unique Identification Authority of India (UIDAI)
Aadhaar saturation level (July 2022): 93%
Total *Aadhaar* cards (January 2023): 1.36 billion
Cumulative *Aadhaar* authentications (January 2023): 86.27 billion

Source: UIDAI dashboard

85 Finance and accounts, UIDAI. (n.d.). UIDAI. Retrieved February 11, 2023, from https://uidai.gov.in/en/about-uidai/unique-identification-authority-of-india/finance-accounts.html

86 ID systems analysed: MOSIP. (n.d.). Privacy International. https://privacyinternational.org/case-study/4657/id-systems-analysed-mosip; About Us | MOSIP. (n.d.). https://mosip.io/about.php; Registry» Digital Public Goods Alliance. (n.d.). Digitalpublicgoods.net.

Nearly universal, updates are growing faster than registrations

Aadhaar has reached almost universal saturation in most of India. The states of Nagaland and Meghalaya and the union territory (UT) of Ladakh remain exceptions where a sizeable population is without *aadhaar* (see Figure 47 and 48). *Aadhaar* is not a proof of citizenship, but is the only identity which can be issued to every resident in the country. The other universal identity available to Indian citizens is the voter identity card, but it can only be issued to individuals aged 18 years and above (see Figure 49). *Aadhaar* has required updating for a sizeable portion of population. There have been 41.6 crore demographic updates (31 per cent of total *aadhaar*) and 23.2 crore biometric updates (17 per cent of total *aadhaar*).[87,88,89]

Figure 47: Cumulative *aadhaar* generation and updates (2010-22)
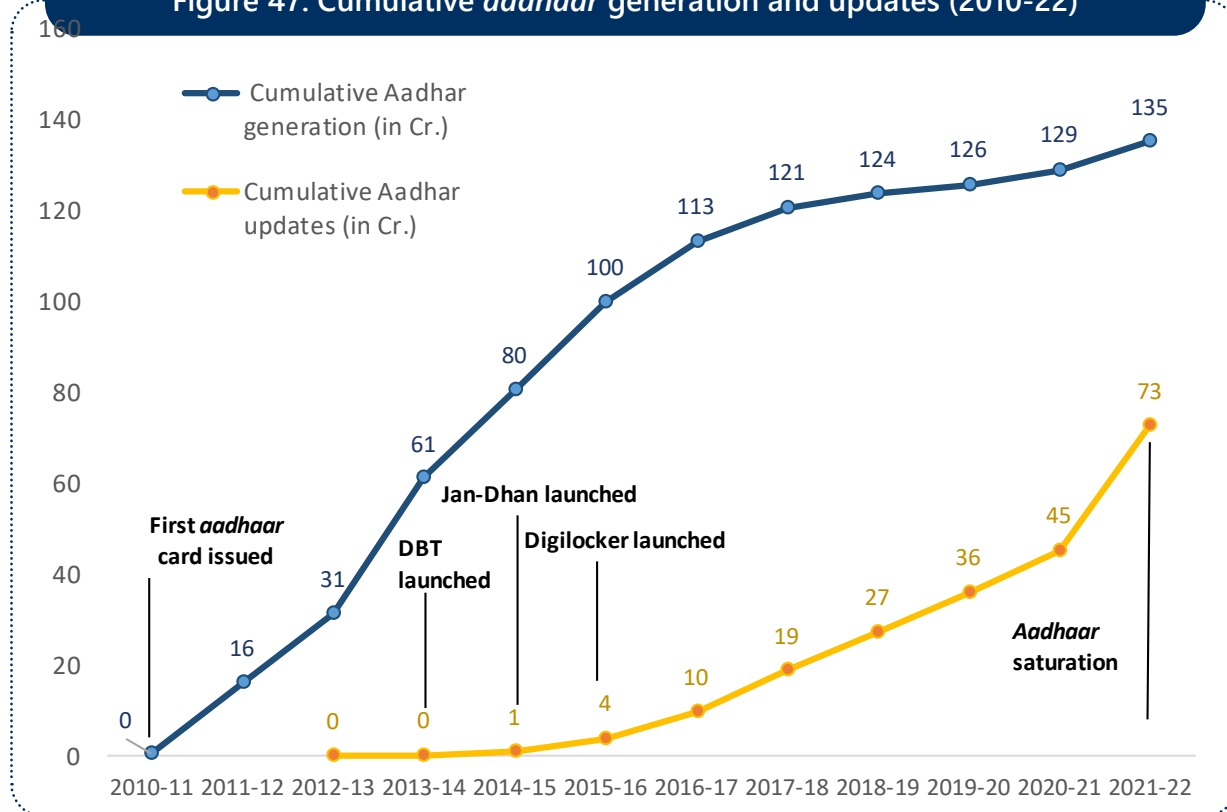
Source: Aadhaar dashboard and UIDAI annual report

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[87] Demographic updates are related to changes in name, address, and mobile number. Biometric updates are related to change in fingerprints and iris data.

[88] Until September 2022, data provided by UIDAI

[89] According to a Comptroller and Auditor General of India (CAG) 2021 report, 73 per cent (2.23 crore) of biometric updates for just the year 2018-19 indicated a high volume of authentication failures. As per data provided by UIDAI, it had identified and cancelled approximately 6 lakh (0.045 per cent of total *aadhaar*) duplicate aadhaar numbers till May 2022, out of which 54 per cent belonged to children below 5 years.

Figure 48: *Aadhaar* saturation levels across states in India
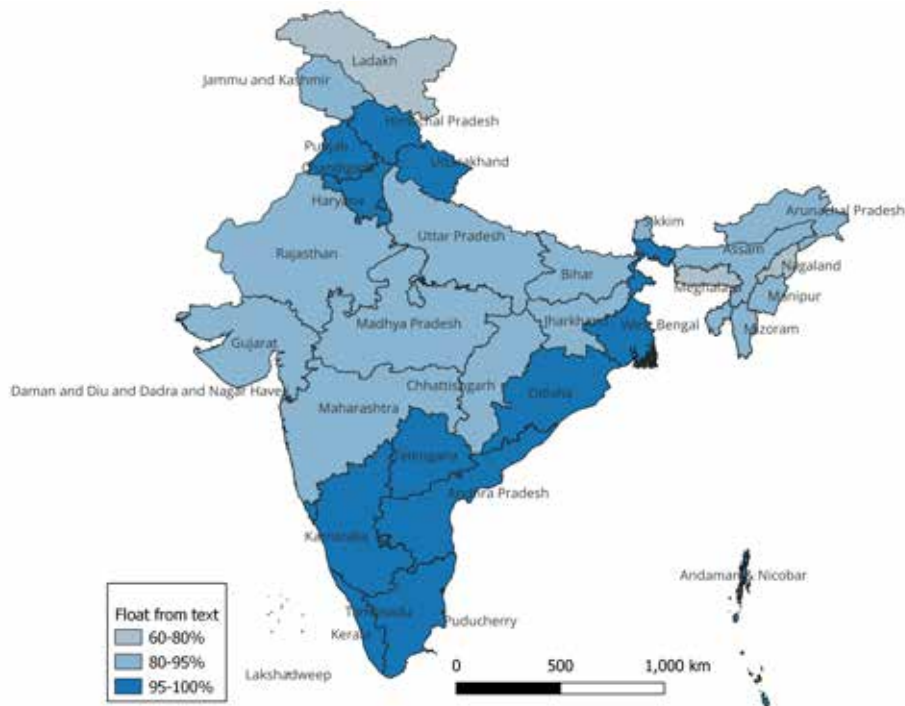
Source: UIDAI dashboard

Figure 49: *Aadhaar* and Voter cards in India (2009-19)
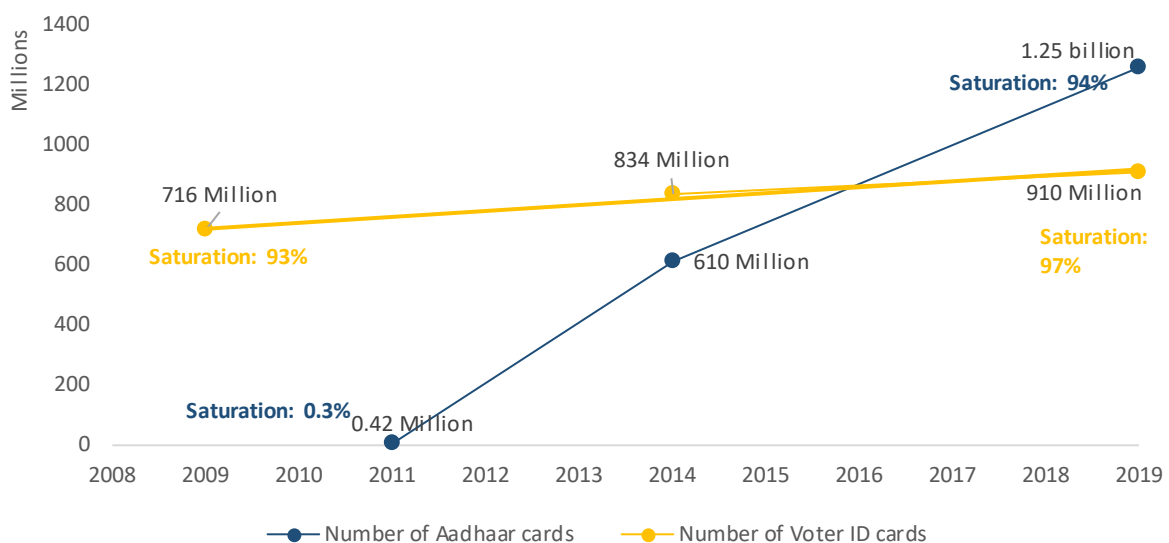
Source: UIDAI, ECI, MoHFW, and International Institute for Democracy and Electoral Assistance

Note: Voter ID cards were introduced in 1993; Aadhaar cards were introduced in 2011

A massive boost to financial inclusion

The *Jan-Dhan-Aadhaar*-Mobile (JAM) trinity, first proposed in the Economic Survey 2014-15, became the transformative force of India's digital economy.[90] The government's initiative of linking *aadhaar*, mobile numbers and *Jan Dhan* bank accounts massively improved account ownership among hitherto neglected sections of society (see Figure 50). It also plugged leakages in the transfer of government benefits. By 2021, India had reached significantly high levels of account ownership, closing the gap between the rich and poor and between men and women (see Figure 51).

Figure 50: Percentage of poorest 40 per cent and richest 60 per cent (age 15+) with bank accounts in India

Figure 51: Percentage of men and women (age 15+) with bank accounts in India
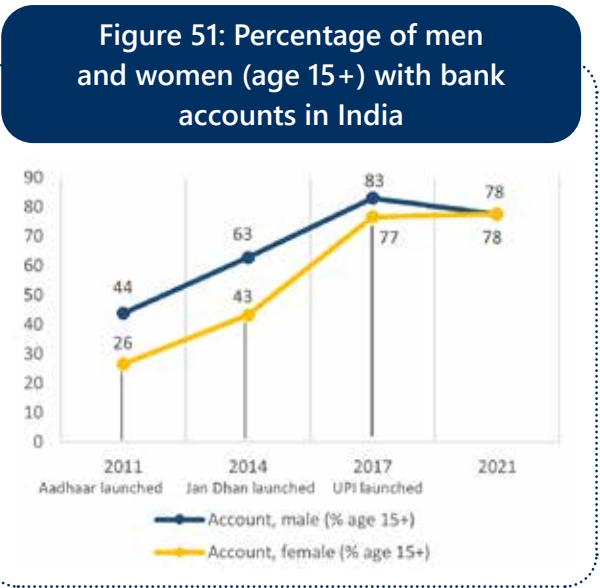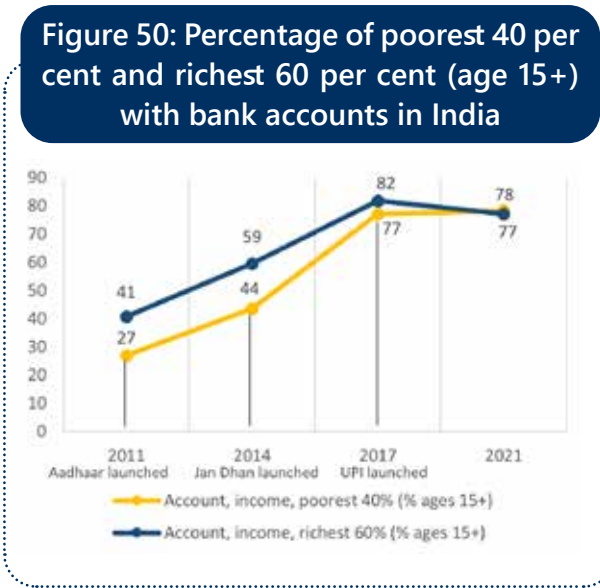
Source: Global Findex Database, World Bank

Transformed government welfare delivery

The direct benefit transfer (DBT) scheme was launched by the government in 2013 to minimise duplication and frauds in disbursement of government benefits. The scheme was actualised through the Aadhaar Payments Bridge (APB) that facilitated timely payments to beneficiaries, both in urban and rural areas. One good example is the Direct Benefit Transfer for Liquefied Petroleum Gas (LPG) known as DBTL, or Pratyaksh Hanstantrit Labh (PAHAL), launched in 2015. The scheme replaced direct sale of LPG at subsidised prices, with a DBT of the amount equivalent to the subsidy in individuals bank accounts using the *Aadhaar* based payments system. The Dhande committee report stated, "*Aadhaar* based cash transfer enabled detection of duplicate and ghost LPG connections." This was over and above improvements during the pre-DBTL reforms which included computerisation, KYC, consumer data cleaning, etc. DBT schemes have also grown rapidly, from 28 in 2013 to 381 by 2020. The latest data shows 310 schemes across 53 different ministries.[91] The effectiveness of the scheme was particularly noteworthy during the pandemic years, providing 85 per cent rural households and 69 per cent urban households

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[90] Commonly referred as the Jan-Dhan, *Aadhaar*, Mobile (JAM) trinity

[91] Direct Benefit Transfer. (n.d.). Dbtbharat.gov.in. Retrieved February 10, 2023, from https://dbtbharat.gov.in/scheme/scheme-list

at least one social protection benefit of food and cash support through the DBT network.[92] According to government estimates, the scheme has led to an overall savings of INR 2 trillion.[93] In Table 2, we capture the savings across some of the schemes for which recent data is available. *Aadhar*, along with other governance reforms, has significantly reduced delays in disbursement of payment for welfare schemes such as MGNREGS (see Figure 52).

Table 2: Estimated savings due to DBT and other governance reforms[94]				
Department	Scheme	Expenditure on the scheme 2020-21 (in Cr)	Estimated savings 2020-21 (in Cr)	Savings as a percentage of expenditure
Department of Rural Development	MGNREGS	1,11,170	7,803	7 %
Department of Rural Development	NSAP	42,617	6.4	0.02 %
Ministry of Petroleum and Natural Gas	PAHAL	35,195	1,609	5 %
Department of Food and Public Distribution	PDS	5,41,330	34,700	6.4 %

Source: Author Calculations, DBT website, Union Budget documents, PRS India

Figure 52: Trends in payment delays under MGNREGS (in per cent)
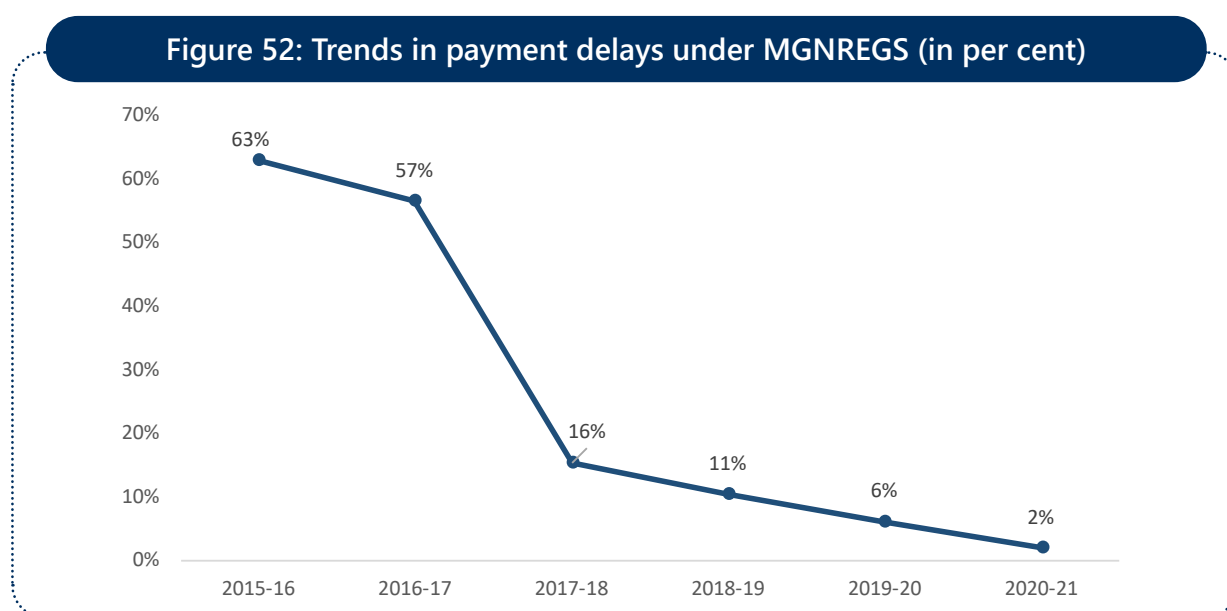
Source: PRS India, MGNREGS MIS report, delayed payments (as on Feb. 8, 2021)

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[92] Bhattacharya, S., & Sinha Roy, S. (2021, June). Intent to implementation: Tracking India's Social Protection Response to COVID-19, World Bank Discussion Paper, Open Knowledge Repository. Retrieved on February 7, 2023, from https://openknowledge.worldbank.org/handle/10986/35746

[93] Based on estimates by the government, Source: Direct Benefit Transfer. (n.d.). Dbtbharat.gov.in. Retrieved on February 10, 2023, from https://dbtbharat.gov.in/scheme/scheme-list

[94] Notes: Expenditure on NSAP (2020-21) includes PM *Garib Kalyan* Package transfers INR 30,957 crore spent on direct benefit transfers to women account holders of *Pradhan Mantri Jan Dhan Yojana* (INR 500 for three months). Expenditure on PDS (2020-21) includes *Pradhan Mantri Garib Kalyan Anna Yojana* (PMGKAY). Data was unavailable for other schemes.

Reduced KYC costs

Besides bringing efficiency to the delivery of government schemes through annual authentications, *aadhaar* has enabled e-authentication for other services, now extended to 300 fintech platforms and non-banking finance companies (NBFCs).[95] The number of annual authentications and e-kyc transactions have both seen a huge jump in 2021-22. According to UIDAI estimates, this has brought down customer acquisition costs from INR500-700 per person to INR3.[96] The process of authentication and verification has been further improved by the launch of DigiLocker in 2015, an online repository of digital documents issued by different government and quasi-government organisations. As the documents are already verified, it reduces the costs of authentication and risks of forgery. These digital versions of identity documents can be utilised to access various services without carrying physical copies as proof. The 2023-24 Union Budget proposes to extend the DigiLocker scheme to business entities to cut costs, ease transactions and enable seamless financial access.[97]

Figure 53: Annual authentications and e-KYC transactions (2013-22)
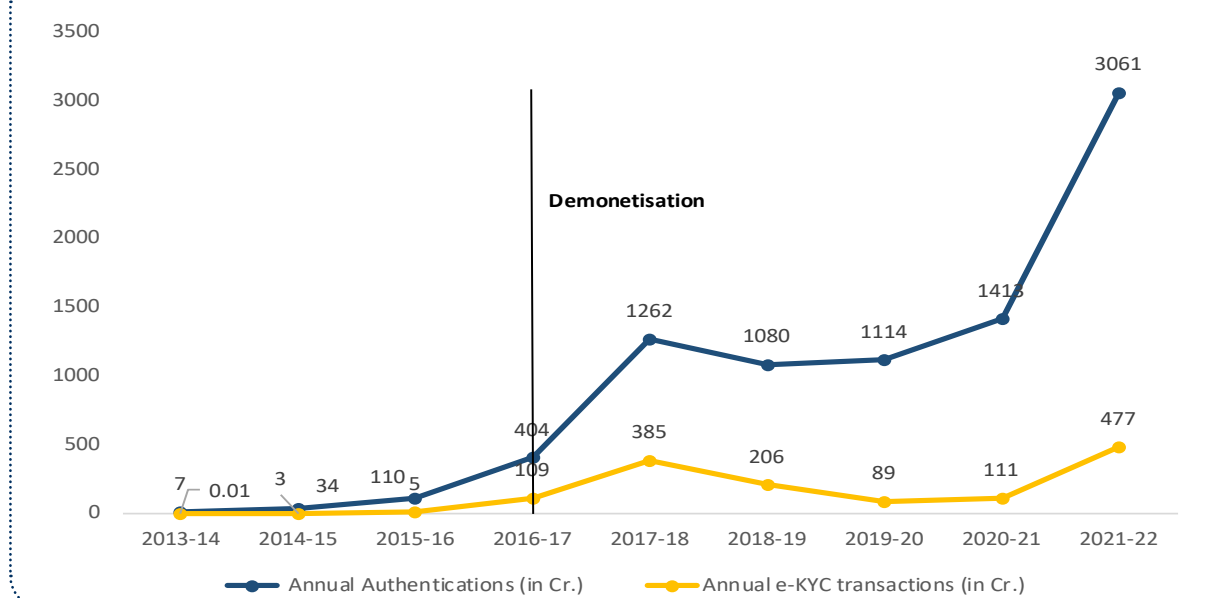
Source: Aadhaar dashboard and UIDAI annual reports

Dealing with existing and emerging risks

As with any national digital identity, *aadhaar* is also exposed to many risks. These include privacy risks, data security and exclusion. As a centralised and inter-linked data base, *aadhaar* faces the risk of data leakages, security breaches and privacy threats.[98] According to the World Economic Forum's Global Risks Report 2019, there have been instances of data breaches that potentially compromised the

[95] Sahu, P. (2022, December 1). Aadhaar's e-KYC facility extended to 300 fintechs, NBFCs: UIDAI CEO Saurabh Garg. Financial Express. Retrieved on February 11, 2023, from https://www.financialexpress.com/aadhaar-card/aadhaars-e-kyc-facility-extended-to-300-fintechs-nbfcs-uidai-ceo-saurabh-garg/2898179/

[96] Op Cit

[97] Budget Speech 2023-24; Retrieved on February 11, 2023, from https://www.indiabudget.gov.in/

[98] The risks of privacy are exacerbated by the lack of an umbrella legislation on privacy in India; the Digital Personal Data Protection Bill (2022) is still pending.

records of over a billion people.[99] However, the source of such data breach is unclear. In a response to the Rajya Sabha, the government has stated that UIDAI has never reported an instance of data breach from *aadhaar* servers/ database (Central Identities Data Repository).[100] Missteps and glitches in other portals and websites have reportedly led to *aadhaar* data leaks.[101,102] The audit report by the Comptroller and Auditor General of India (CAG)[103] in 2022, has also flagged the issue, stating that it was *"unable to derive required assurance that the entities involved in the authentication ecosystem are maintaining their information systems in complete compliance with UIDAI standards."* In the absence of recent data, it is difficult to ascertain the current exposure of *aadhaar* to the risks of data protection and privacy.

Despite high levels of saturation, the *aadhaar*-based system for authentication can result in exclusion. The Economic Survey 2016-17 had reported high authentication failure rates in some states.[104] While authentication failure could be due to multiple factors ranging from connectivity issues, deficient biometric capture due to old age and extensive manual labour, the final outcome is denial of services, as *aadhaar* is mandatory for most, if not all, central and state government services and schemes. *Aadhaar* is required for services ranging from filing tax returns to availing government pensions (disability or old-age) and even getting a death certificate. The State of Aadhaar report (2019) found that 1.5 per cent PDS users experienced a biometric authentication failure and did not receive rations in their last attempt.[106] This translated into 1.07 crore people facing the risk of exclusion from PDS.[107] There is no authentic data in the public domain that can ascertain if the magnitude of these risks has increased or weakened over time.[108] From data presented

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[99] World Economic Forum. (2019). Global Risks Report 2019. Retrieved on December 7, 2022 from https://www3.weforum.org/docs/WEF_Global_Risks_Report_2019.pdf

[100] Government of India, Ministry of Electronics and Information Technology, Rajya Sabha Unstarred Question No. 693 (2019). Retrieved on February 7, 2022 from https://uidai.gov.in/images/rajyasabha/RSPQ_693_Unstarred.pdf

[101] Singh, S. (2022, June 14). New Aadhaar data leak exposes 11 crore Indian farmers' sensitive info. Zee News. Retrieved on February 11, 2022 from https://zeenews.india.com/personal-finance/aadhaar-data-breach-over-110-crore-indian-farmers-aadhaar-card-data-compromised-2473666.html

[102] The Hindu BusinessLine. (2021, December 6). 1 bn records compromised in Aadhaar breach since January: Gemalto. The Hindu BusinessLine. Retrieved on February 12, 2022 from https://www.thehindubusinessline.com/news/1-bn-records-compromised-in-aadhaar-breach-since-january-gemalto/article25224758.ece

[103] CAG. (2022). Report no. 24 of 2021, Report of the Comptroller and Auditor General of India on Functioning of Unique Identification Authority of India. cag.gov.in. Retrieved on February 11, 2023, from https://cag.gov.in/webroot/uploads/download_audit_report/2021/24per cent20ofper cent202021_UIDAI-0624d8136a02d72.65885742.pdf

[104] Estimates include 49 per cent failure rates for Jharkhand, six per cent for Gujarat, five per cent for Krishna District in Andhra Pradesh and 37 per cent for Rajasthan, Source: CAG. (2022). Report no. 24 of 2021, Report of the Comptroller and Auditor General of India on Functioning of Unique Identification Authority of India. cag.gov.in. Retrieved on February 11, 2023, from https://cag.gov.in/webroot/uploads/download_audit_report/2021/24per cent20ofper cent202021_UIDAI-0624d8136a02d72.65885742.pdf; and Ministry of Finance, Government of India. (2017). Economic Survey 2016-2017. Retrieved February 11, 2023, from https://www.indiabudget.gov.in/budget2017-2018/es2016-17/echapter.pdf

[105] Bhatia, G. (2017). You need Aadhaar for over 100 schemes and services. Hindustan Times. Retrieved on February 11, 2023, from https://www.hindustantimes.com/interactives/aadhaar-mandatory-schemes-timeline/

[106] Totapally, S., Sonderegger, P., Rao, P., Gosselt, J., and Gupta, G. (2019). State of Aadhaar: A People's Perspective. Retrieved on December 22, 2022 from https://stateofaadhaar.in/assets/download/SoA_2019_Report_web.pdf?utm_source=download_report&utm_medium=button_dr_2019

[107] Total PDS users (2021): 71 crores. Sinha, S. (2021, October 4). PDS DBT beneficiaries number hits record 71 cr so far in FY22. The Hindu BusinessLine. Retrieved on February 16, 2023, from https://www.thehindubusinessline.com/economy/dbt-beneficiaries-number-hits-record-71-cr-so-far-in-fy22/article36812367.ece

[108] UIDAI's response to the request for data on authentication failure was 'Not available at present'.

in the past, exclusion is a concern. Making data on authentication failures as well as on action being taken to fool proof the system, building strong governance, and evaluating the ecosystem including third party agencies will collectively build trust in a system that is foundational to India's digital economy. Moreover, disaggregated data at the district and city level can become useful inputs into policy analysis on welfare and economic well-being, unleashing the real power of data as a public good.

2. UPI: Digital Payments for the Masses

The Unified Public Interface (UPI) launched in 2016, is an instant, real-time interoperable payments system built over India's existing Immediate Payment Service (IMPS) infrastructure. Integrating banks, third party payment service providers and recently digital wallets, UPI allows 24 X 7 transfer of money through mobile devices. It was developed by the National Payments Corporation of India (NPCI), a not-for-profit umbrella organisation of public and private sector banks, and is regulated by the RBI.

Figure 54: UPI within Digital Public Ecosystem

- **Digitised** Government Services
- Digital Public **Platforms** — BHIM
- Digital Public **Infrastructure** — UPI
- Digital Public **Goods**

Source: ICRIER Policy Brief 3 (2023)

Table 3: UPI Facts

Launch Date: April 2016
Product: Digital Public Infrastructure for real-time digital payments
Implementing Agency: National Payments Corporation of India (NPCI)
Regulator: Reserve Bank of India (RBI)
Unique users (October 2022): 300 million
No. of banks live (December 2022): 382
No. of Third-Party Apps (December 2022) - 23

Source: NPCI (2023)

The growth of UPI has made it a dominant player in the digital payments' ecosystem (Table 4). The market share of UPI has increased from 2 per cent in 2016-17 to 52 per cent in 2021-22.[109] NPCI's development and marketing of the Bharat Interface for Money (BHIM) as a reference mobile payments platform integrated with UPI helped in catalysing the ecosystem. From the participation of 35 banks in December 2016, the number increased to 382 by the end of 2022. The growth of unique users has similarly increased, reaching over 300 million users by the end of 2022. As of June, 2022, there were over 50 million merchants

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[109] Ministry of Information and Broadcasting, Government of India (2022). Rise of a New Era of Digital Payments. Retrieved on February 10, 2023 from https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/nov/doc20221116125801.pdf

onboarded onto the UPI network.[110] Adoption has increased at a compounded annual growth rate (CAGR) of 380 per cent and 314 per cent in UPI transactions volume and value respectively (Figure 55). Despite sharp increases, the value of transactions on UPI contributes only about 3.3 per cent to the digital payments market, with NEFT and RTGS dominating the market for high-value transactions.

Figure 55: Growth of UPI users & transactions
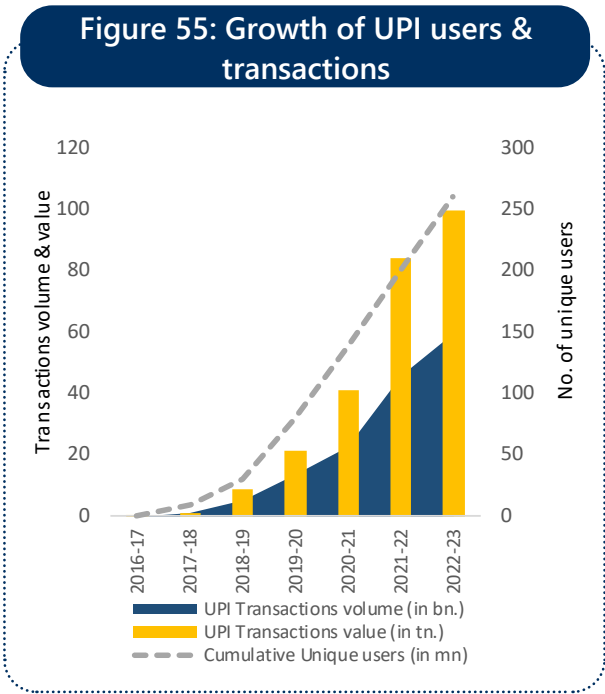
Source: NPCI and media reports

Table 4: Evolution of UPI ecosystem

Financial Year	No. of banks live on UPI	No. of Third-Party App Providers (TPAPS)	PPI Apps
2016-17	35	NA	NA
2017-18	67	NA	NA
2018-19	129	NA	NA
2019-20	143	19	NA
2020-21	207	21	NA
2021-22	282	22	NA
2022-23	382	23	5

Source: NPCI

The UPI ecosystem is dominated by P2P transactions

Peer-to-peer (P2P) payments constitute the bulk of UPI transactions, both in terms of volume and value (Figure 56). There are several factors that led to the rise of P2P payments, including the onboarding of public sector banks, partnerships to enable cross-border remittances, etc. On the other hand, merchant onboarding has been relatively slow, with a recent uptick, especially after the deployment of QR codes. However, the average ticket size of P2P is significantly higher than that for merchants. The average ticket size for P2P during the period of 2016-17 to December 2022 was INR 2,509, compared to INR 565 during the same period for merchants. In fact, the UPI system has often been criticised for over burdening the banking infrastructure with small value transactions that were previously done in cash.[111]

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[110] Reserve Bank of India (2022, June 16). Statement on Developmental and Regulatory Policies. Retrieved on February 10, 2023 from https://www.rbi.org.in/SCRIPTs/BS_ViewBulletin.aspx?Id=21062#:~:text=UPIper cent20hasper cent20becomeper cent20theper cent20most,onboardedper cent20onper cent20theper cent20UPIper cent20platformper cent20.

[111] UPI transactions are rising, but who will foot the bill? (2022, September 07). The Economic Times. Retrieved on February 10, 2023 from https://bfsi.economictimes.indiatimes.com/news/fintech/upi-transactions-are-rising-but-who-will-foot-the-bill/94032077

Figure 56: Evolution of P2P and P2M transactions in UPI

Average Ticket Size (P2M) — red
Average Ticket Size (P2P) — blue

Rs.4334 · Rs.400
Rs.1315 · Rs.434
Rs.1943 · Rs.488
Rs.2159 · Rs.670
Rs.2670 · Rs.823
Rs.2567 · Rs.743
Rs.2576

Legend:
- P2M Value (in tn) (right axis)
- P2P Value (in tn) (right axis)
- P2M Volume (in bn) (left axis)
- P2P Volume (in bn) (left axis)
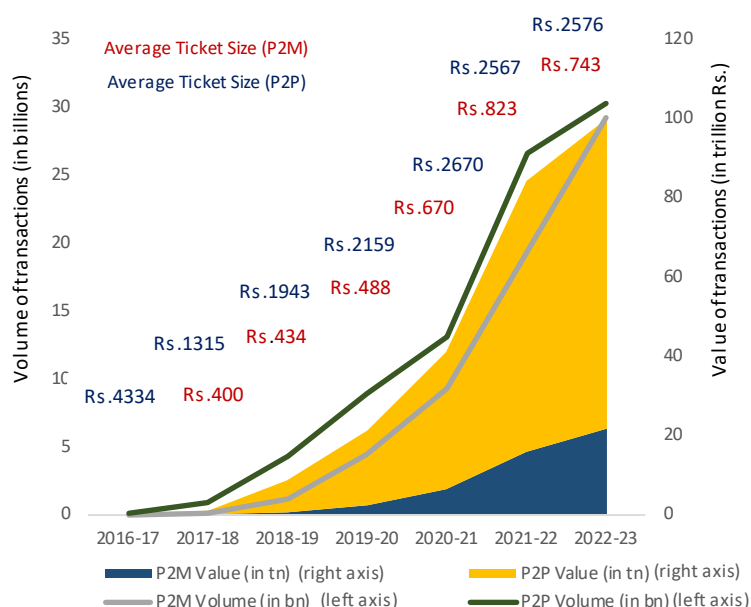
Box 1: UPI cross-border payments

- In 2021, NPCI partnered with IndusInd Bank to offer real-time cross-border remittances using UPI IDs.

- In 2023, NPCI issued a circular allowing NRIs from select countries with international mobile numbers to be onboarded on UPI under certain conditions.

The recent growth growth in merchant transactions have been driven by certain high transacting categories such as retail, health and telecom sectors (see Table 5). Additionally, as per PhonePe, a leading market player on UPI, financial services offerings have seen traction in Tier 2 and 3 cities and beyond.[113] Although merchant transactions are expanding beyond major cities, challenges pertaining to onboarding exist in some regions. In the North-East region, for instance, merchant adoption is constrained by high acquisition costs, nearly twice the national average (Figure 57). Other challenges include low consumer demand, low awareness among merchants, high transaction failures, etc.[114]

[112] National Payments Corporation of India (2023). UPI Ecosystem Statistics: UPI P2P and P2M Transactions. Retrieved on February 10, 2023 from https://www.npci.org.in/what-we-do/upi/upi-ecosystem-statistics

[113] BCG and PhonePe Pulse (2022). Digital Payments in India: A US$10 Trillion Opportunity. Retrieved February 10, 2023 from https://www.phonepe.com/pulse-static-api/v1/static/docs/PhonePe_Pulse_BCG_report.pdf

[114] Ministry of Electronics & Information Technology, Government of India & Better than Cash Alliance (2021). Catalysing Responsible Digital Payments in the North East Region of India. Retrieved February 10, 2023 from https://btca-production-site.s3.amazonaws.com/documents/650/english_attachments/Catalyzing_Responsible_Digital_Payments_in_the_North_East_Region_of_India.pdf?1632441593

Figure 57: Cost of acquisition per merchant on UPI

Costs (in Rs)	North-East	India
Misc.	72	36
e-KYC	21	21
Agent Salary	333	167
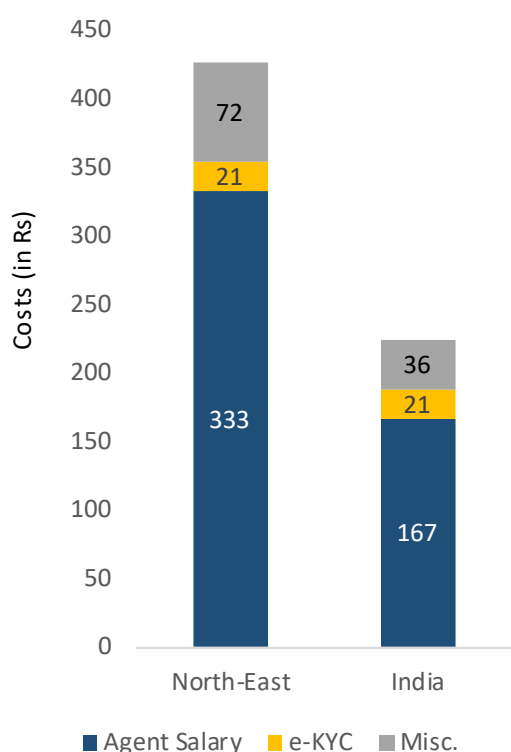
Source: Dalberg estimates

Table 5: Classification of transactions

Transaction Category	Merchant Type
High transacting	Groceries and supermarkets
	Eating places and restaurants
	Telecommunication services
	Drug stores and pharmacies
Medium transacting	Miscellaneous and speciality retail outlets
	Bakeries
	Utilities- electric, gas, water and sanitary
	Financial institutions
All other categories	Government services - not elsewhere classified
	Professional services not elsewhere classified
	Cable and other pay television services

Source: NPCI

UPI is a story of inclusive growth

The economic divide in digital payments adoption between the poorest 40 per cent and the richest 60 per cent is estimated to be around 15 per cent, with a penetration rate of only about 26 per cent in the poorest income group.[115] However, UPI has emerged as a popular payments method among digital payments users even at the bottom of the income pyramid (see Table 6). The launch of UPI123Pay for feature phone users and UPILite

to enable offline transactions has eased access to UPI even among users lacking access to smartphones (estimated penetration of 33 per cent in this segment) and high quality internet connectivity.[116,117] On gender divides, while there are no specific statistics on usage of UPI, trends in overall digital payments indicate that gaps exist. According to Findex, women are 13 per cent less likely than men to make or receive digital payments and 8 per cent less likely to use mobile phones or the internet to pay bills.

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[115] The Global Findex Database (2021). The World Bank. Retrieved on February 10, 2023 from https://www.worldbank.org/en/publication/globalfindex/Data#sec3

[116] UPILite enabled partly offline transactions (expected to become fully offline) for small value transactions; limit set at INR 200 for a transaction and for a wallet at INR 2000

[117] National Payments Corporation of India (NPCI) and People Research on India's Consumer Economy & Citizen Environment (PRICE) (2022, January 14). Digital Payments Adoption in India, 2020. Retrieved on February 10, 2023 from https://www.npci.org.in/PDF/npci/knowledge-center/Digital-Payment-Adoption-in-India-2020.pdf

Table 6: UPI penetration among digital payment users by income group (2020)		
Bottom 40% (Average annual household income: INR 1.10 lakh)	Middle 40% (Average annual household income: INR 1.80 lakh)	Top 20% (Average annual household income: INR 3.60 lakh)
56%	45%	56%

Source: NPCI-PRICE Digital Payments Adoption in India Report, 2020

Figure 58: State-wise adoption of PhonePe

PhonePe, the largest market player on UPI provides some indication of the regional divide. States with the lowest penetration rate of 0-10 per cent are in the northeast (Mizoram, Meghalaya, Nagaland, Assam). The top ten states and UTs account for 40 per cent of the users while constituting only about 24 per cent of the population. While internet access, smartphone penetration and digital payments instruments penetration is on par with national averages, three times more network downtimes, 50 per cent slower internet speed, lack of assistance in use, etc., are some of the major roadblocks to the adoption of UPI in the northeast.

Source: PhonePe Pulse 2021

Note: At the regional level, we use PhonePe data as surrogate for state-wise adoption of UPI.[118]

The economics of UPI

UPI is currently the cheapest alternative among digital payment channels, roughly estimated at INR 2 for an average P2M transaction of INR 800 (see Table 7).[119] This however, comes because of a mandated zero merchant discount rate (MDR) and continued annual fiscal support

of almost INR 1,500 crore to UPI. The estimated cost to ecosystem players, however, is estimated to be INR 8,000 crore.[120] The cumulative subsidy to date amounts to INR 26,000 crore and is expected to increase further.[121] The argument in favour of fiscal support is efficiency gains arising from a UPI-led speedy transition to a cashless economy. As per recent SBI research, the share

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[118] PhonePe Pulse (2021, September). Beat of Progress. Retrieved on February 10, 2023 from https://www.phonepe.com/pulse-static-api/static/docs/Pulse_Report_2021_M_B.pdf

[119] Reserve Bank of India (2022, August 17). Discussion Paper on Charges in Payment Systems. Retrieved on February 10, 2023 from https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/DPSSDISCUSSIONPAPER5E016622B2D3444A9F294D07234059AA.PDF

[120] Pandey, S. (2023, January 10). Payment firms, banks seek Rs 8,000-cr Budget support. The Financial Express. Retrieved on February 10, 2023 from https://www.financialexpress.com/economy/payment-firms-banks-seek-rs-8000-cr-budget-support/2941765/

[121] Mathi, S (2023, January 23). For How Much Longer Will The Indian Government Bankroll UPI And RuPay? MediaNama. Retrieved on February 10, 2023 from https://www.medianama.com/2023/01/223-upi-rupay-financial-incentive-scheme/?mc_cid=270f494ec1&mc_eid=3aa1efa265

of currency in circulation (CIC) in payments has declined from 88 per cent in FY16 to 20 per cent in FY22 and is expected to further decline to 11.5 per cent in FY2027, resulting in savings on the costs of issuing currency.[122]

Table 7: Cost comparison of UPI with other payments methods			
Digital wallets	**Debit cards**	**IMPS**	**UPI**
Digital wallets typically charge 1-2 per cent of total transaction as MDR and an additional GST charge.	For small merchants, MDR on debit card transactions can be up to 0.4 per cent and for large merchants, it can be up to 0.9 per cent.[123]	IMPS fund transfer service attracts transaction charges (which differ from bank to bank) and are typically in the range of INR2.5-INR15 (depending on amount) and GST charges.	0.25 per cent processing cost for an average P2M transaction of INR800. Government regulation mandates 0 MDR.

Source: RBI Discussion Paper (2022), PwC,[124] bank websites

Innovations on UPI

Over the years, NPCI has brought about regular updates to UPI that have expanded the scale and scope of transactions on UPI, opening doors to the entry of innovative and diverse offerings from private fintech players. The rollout of UPI 2.0 in August 2018 with features such as one-time mandate, linking of overdraft account, etc., have enabled tapping of new use cases across sectors. For instance, linking of an overdraft (OD) account to UPI enables offering of credit access by financial institutions as does the sharing of digital invoices accompanied with collection requests. MSME digital lending, catalysed through UPI, could potentially reach USD 80-100 billion worth of transactions annually.[125] Another innovation of significance is **UPI AutoPay**, launched in July 2020 to enable recurring payments for mobile bills, electricity bills, EMI payments, etc. The AutoPay facility has been adopted by users of various edtech and healthtech platforms offering massive convenience and time savings.[126]

[122] SBI Research (2022, November 03). Ecowrap Issue No. 42. The State Bank of India. Retrieved on February 10, 2023, from https://sbi.co.in/documents/13958/25272736/031122-Ecowrap_20221103.pdf/cd4b1203-b560-54b5-0b24-600015b2a81c?t=1667455438553

[123] Reserve Bank of India (2022, August 17). Discussion Paper on Charges in Payment Systems. Retrieved on February 10, 2023, from https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/DPSSDISCUSSIONPAPER5E016622B2D3444A9F294D07234059AA.PDF

[124] PwC (2019, December). Changing preferences: UPI's dominance over digital wallets in the payments market. Retrieved on February 10, 2023, from https://www.pwc.in/assets/pdfs/consulting/financial-services/fintech/point-of-view/pov-downloads/changing-preferences-upis-dominance-over-digital-wallets-in-the-payments-market.pdf

[125] United Nations, Economic and Social Commission for Asia and the Pacific, MSME Access to Finance: The Role of Digital Payments, MSME Financing Series No.7 (Bangkok: United Nations, 2022). Retrieved on February 10, 2023, from https://www.unescap.org/kp/2022/msme-financing-series-role-digital-payments

[126] RazorPay (2020, July 27). UPI AutoPay: A Powerful Addition to Your Payment Options Bouquet. Retrieved on February 10, 2023, from https://razorpay.com/blog/how-to-use-upi-autopay/

The risks of market concentration

Figure 59: Market shares of dominant apps on UPI

The UPI platform was initially dominated by BHIM, the reference platform widely promoted through cashback schemes.[127] Subsequently, with the entry of private players, GooglePay, PhonePe and Paytm began to dominate the market. The current market is dominated by two non-bank apps – Google Pay and PhonePe that constitute around 81 per cent of the market (Figure 59 and 60). NPCI has responded by imposing market caps on the dominant players, though this is still to be enforced. Banks have a very small market share, with PayTM bank occupying more than an 80 per cent share in the segment. Fintech companies have won this space due to the network effects arising from a large user base and deep pockets that can afford a zero MDR ecosystem.

Source: NPCI & media reports

Figure 60: Dominant banking apps on UPI

Figure 61: Dominant non-banking apps on UPI
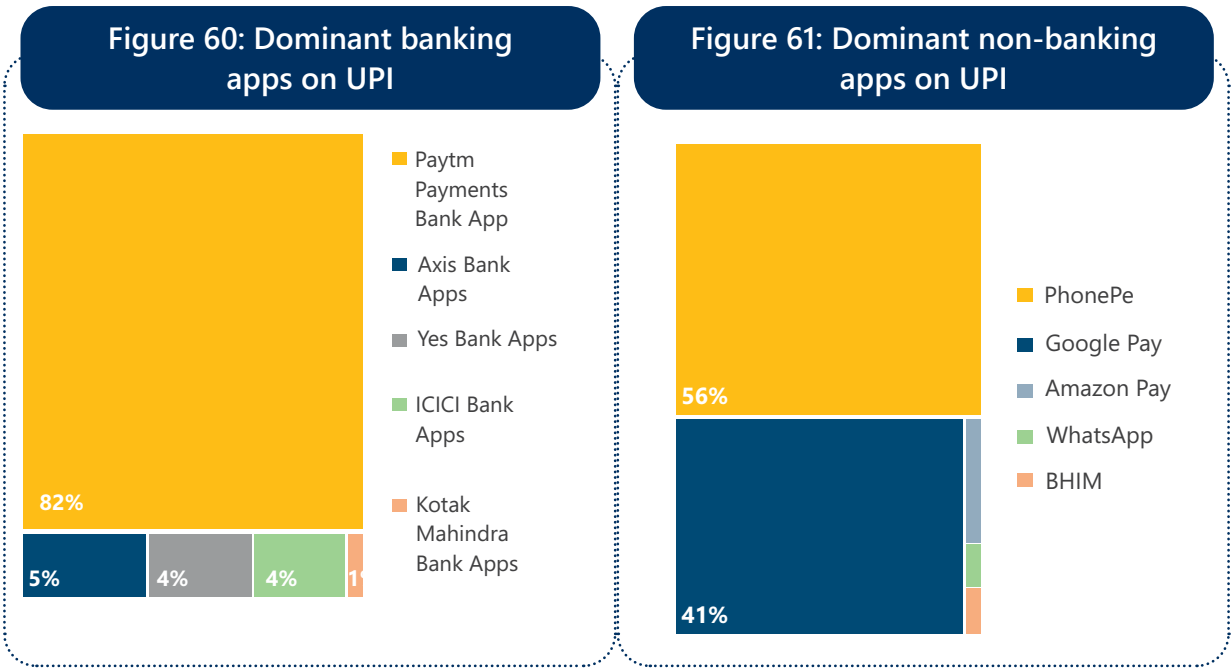
Source: NPCI Ecosystem statistics (June, 2022)

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[127] K.J., Shashidhar (2019, October, 28). The weaponization of cashbacks on UPI by Google Pay. The Observer Research Foundation. Retrieved on February, 10, 2023, from https://www.orfonline.org/expert-speak/the-weaponisation-of-cashbacks-on-upi-by-google-pay-57099/

Cognizant of the outcomes, RBI proposed competition not only within UPI but also to UPI by issuing licenses for new umbrella entities to compete with UPI in the retail payments sector.[128] This agenda seems to have been deferred in light of concerns related to data storage, security risks and macroeconomic impact.[129] The assumed interoperability of UPI has not led to a competitive retail payments market as one would have expected. In fact, when it comes to competition in the digital payments market, India seems no different from China, which is dominated by Alipay and Tenpay, and the US, where Apple Pay and Google Pay have captured the largest number of users (see Figure 62).

Figure 62: Market share of companies in retail digital payments

UPI India (2020)

PhonePe 46%, Google Pay 34%, Paytm 15%, Others 5%

- PhonePe
- Google Pay
- Paytm
- Others

Source: NPCI

China (2020)

AliPay 55%, TenPay 39%, Others 6%

- AliPay
- TenPay
- Others

Source: iResearch[130]

USA (2020)*

Apple Pay 43.9, Starbucks 31.2, Google Pay 25, Samsung Pay 16.3

- Apple Pay
- Starbucks
- Google Pay
- Samsung Pay

Source: eMarketer[131]

Note:* Represents no. of US proximity mobile payments users (in millions)

Lessons from rest of the world

Pix in Brazil is a good example against which to benchmark UPI. Pix is both operated and regulated by the *Banco Central do Brasil*, the country's central bank; UPI is implemented by NPCI and regulated by the RBI. In a short span of just over a year since its launch in November, 2020, Pix had managed to acquire 114 million users, covering about 67 per cent of adults in Brazil.[132] This growth may be attributed to differences in the initial conditions under which

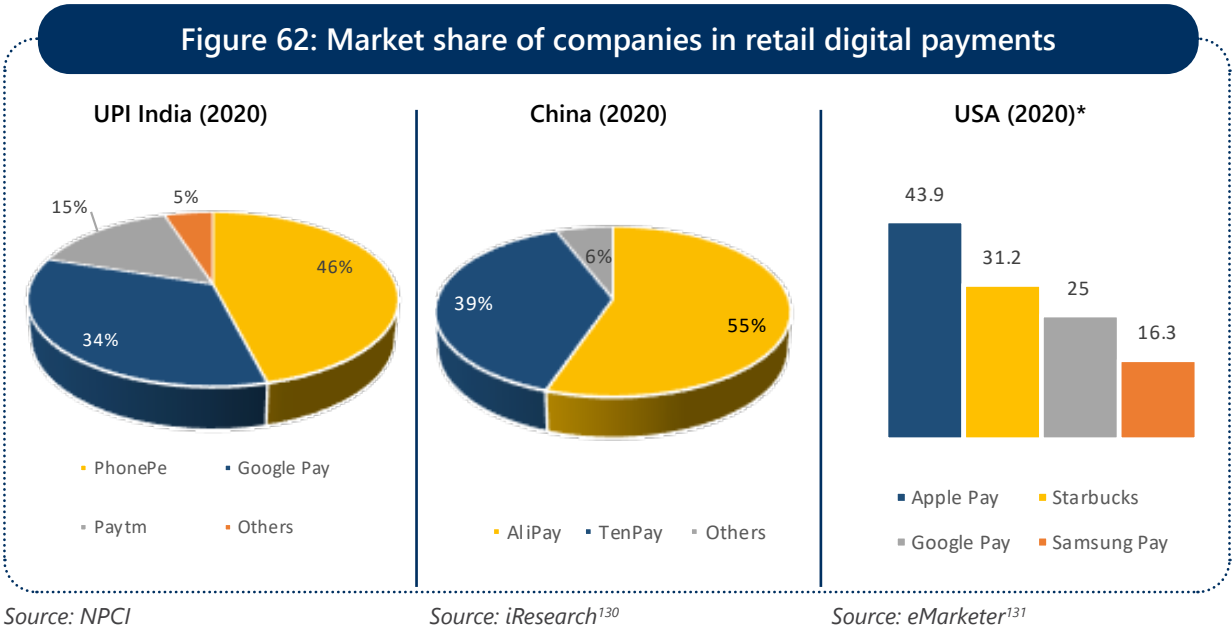128 Reserve Bank of India (2020, August). Draft Framework for authorisation of a pan-India New Umbrella Entity (NUE) for Retail Payment Systems. Retrieved on February 10, 2023, from https://rbidocs.rbi.org.in/rdocs/Content/PDFs/DANUE6F1C5983ACA84C5D9462D3DCA803FF9C.PDF

129 Shreyashi, T. (2021, September, 13). New umbrella entities explained: Why India has delayed their retail payment systems. The Financial Express. Retrieved on February 10, 2023, from https://www.financialexpress.com/industry/banking-finance/new-umbrella-entities-explained-why-india-has-delayed-their-retail-payment-systems/2329445/

130 Tech2Thai (2020). iResearch report shows Alipay remains as China's mobile payment market leader. Retrieved on February 10, 2023 from https://www.tech2thai.com/mobile_tech/358/iresearch-report-shows-alipay-remains-as-china-rsquo-s-mobile-payment-market-leader

131 Curry, D. (2023, January 9). Mobile Payments App Revenue and Usage Statistics (2023). Business of Apps. Retrieved on February 10, 2023 from https://www.businessofapps.com/data/mobile-payments-app-market/

132 Duarte, A. et al. (2022, March 23). Central banks, the monetary system and public payment infrastructures: lessons from Brazil's Pix. BIS Bulletin No. 52. The Bank for International Settlements. Retrieved on February 10, 2023, from https://www.bis.org/publ/bisbull52.pdf

both initiatives were launched. Several enabling initial conditions in Brazil, such as high internet penetration, smartphone access and adoption of digital payments, could have catalysed rapid adoption of Pix. Moreover, mandating financial institutions with over 500,000 active accounts to integrate with Pix helped it to achieve impressive growth in monthly transactions volume – around 174 times that of UPI in the first year and 13 times in the second year (see Figure 63). The absence of an upper limit on transaction values during business hours has also enabled Pix to expand B2B and P2B payments. Forty-seven per cent of Pix transactions value accrued

to these two segments, besides P2P. This is in contrast to UPI where both volume and value of transactions remain dominated by P2P (see Figure 64). Moreover, allowing participants to charge MDR (0.22 per cent) for merchant payments has ensured that the system remains profitable for banks and other participants while still being the cheapest alternative for merchants in comparison to other payment instruments such as credit cards (2.2 per cent).[133] The economics of UPI are currently different. A comparison of Pix and UPI is provided in Table 8.

Figure 63: Pix[134] versus UPI growth

Figure 64: Comparison of Pix[135] and UPI in terms of shares of transaction value
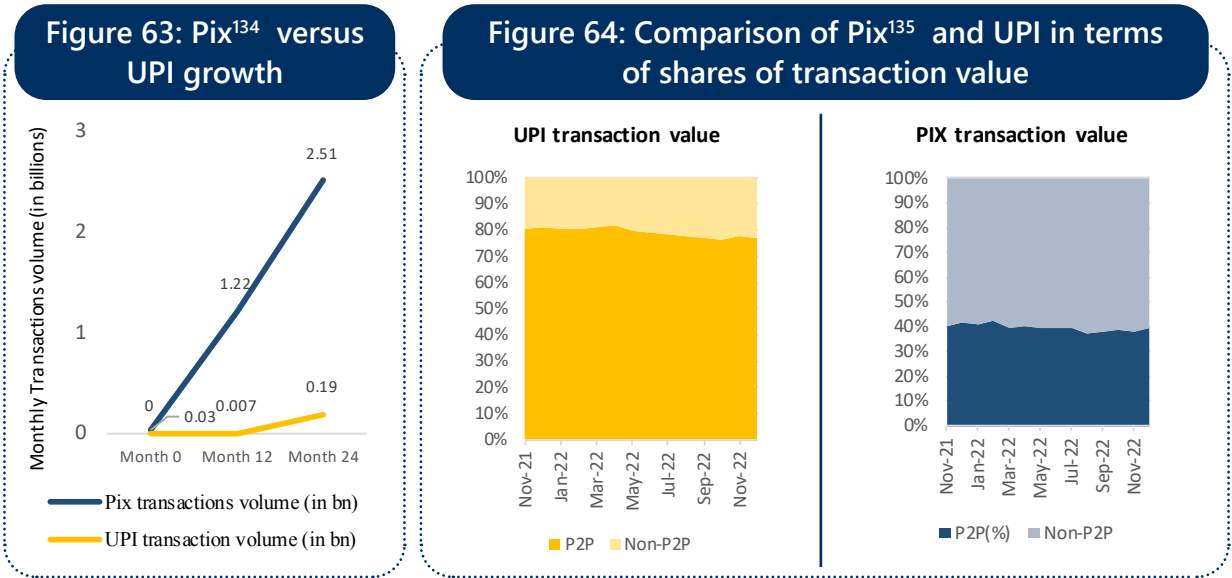
Source: NPCI and Central Bank of Brazil

Table 8: Comparison of Pix vis-à-vis UPI		
Parameter	Pix Brazil	UPI India
Initial country conditions	Internet penetration (2020):[136] 81 per cent Smartphone penetration: 73 per cent Digital Payments users (2021): 76.52 per cent	Internet penetration:[137] 31 per cent Smartphone penetration: 23per cent Digital Payments users (2017): 28.69 per cent

[133] ibid

[134] Central Bank of Brazil. Pix Statistics. Retrieved on February 10, 2023 from https://www.bcb.gov.br/en/financialstability/pixstatistics

[135] ibid

[136] Consulate General of India, Sau Paulo, Brazil (n.d.). Fact-sheet on Brazil. Retrieved on February 10, 2023, from https://www.cgisaopaulo.gov.in/Fact-sheet-on-Brazil.php

[137] Telecom Regulatory Authority of India (2022). The Indian Telecom Services Performance Indicators April – June, 2022. Retrieved on February 10, 2023, from https://www.trai.gov.in/sites/default/files/QPIR_23112022.pdf

Table 8: Comparison of Pix vis-à-vis UPI		
Parameter	**PIX Brazil**	**UPI India**
Institutional setup	Created and managed by the Central Bank of Brazil (BCB).	Implemented by NPCI and regulated by the Reserve Bank of India (RBI), India's central Bank.
Participation	All financial institutions (FIs); Non-banks allowed to directly participate. Mandatory for all FIs with over 500,000 active accounts; voluntary for FIs with lower number of active accounts.[138]	Third-Party apps can only participate on UPI through payment service provider (PSP) banks. Participation on UPI was voluntary, some recent changes mandated UPI integration.[139]
Transaction limits	No limits other than a transaction limit set at R1,000 between 8 p.m. and 6 a.m. However, in order to mitigate fraud risks, participants can establish maximum limits for transactions per payer, per day and per month within the parameters of Pix rules. Account holders can request reduction in limits, which must be complied with, but requests to increase limits are at the discretion of the participating entity (e.g., bank).[140]	Transaction limit set at INR. 2 lakhs per day.[141]
Transaction cost	No fees/charges for P2P; for P2M, average cost to merchant is 0.22 per cent of transactions value (in comparison to 2.2 per cent for credit cards and a little over 1 per cent for debit cards).[142] PSPs pay a low fee (BRL 0.01 per 10 transactions) to the BCB so that the BCB can recover the cost of running the system[143]	Government regulations mandate zero MDR. However, the approximate processing cost of a P2M transaction is INR 2 for an average ticket size of INR 800 (0.25 per cent of transaction value).[144]

[138] Jain, Prince (2021). Brazil's PIX and the parallels with UPI (#43). Unit Economics. Retrieved on February 10, 2023, from https://uniteconomics.substack.com/p/brazils-pix-and-the-parallels-with

[139] NPCI (n.d.) UPI Product Booklet. Retrieved on February 10, 2023, from https://www.npci.org.in/PDF/npci/upi/Product-Booklet.pdf

[140] Latin American Business Stories (2021, August 27). After a wave of scams and frauds, Brazil's Central Bank announces new rules to increase PIX security. Retrieved on February 10, 2023, from https://labsnews.com/en/news/economy/brazil-central-bank-announces-new-rules-to-increase-pix-security/#:~:text=After%20a%20wave%20of%20scams%20and%20frauds%2C%20Brazil%27s,em%20Bras%C3%ADlia%2025%2F08%2F2021%20REUTERS%2FAmanda%20Perobelli%20Reuters%20and%20LABS

[141] ET Bureau (2020, March 06). UPI transaction limit for stores doubled to INR 2 lakh. The Economic Times. Retrieved on February 10, 2023, from https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/upi-transaction-limit-for-stores-doubled-to-rs-2-lakh/articleshow/74503442.cms

[142] Duarte, A. et al. (2022, March 23). Central banks, the monetary system and public payment infrastructures: lessons from Brazil's Pix. BIS Bulletin No. 52. The Bank for International Settlements. Retrieved on February 10, 2023, from https://www.bis.org/publ/bisbull52.pdf
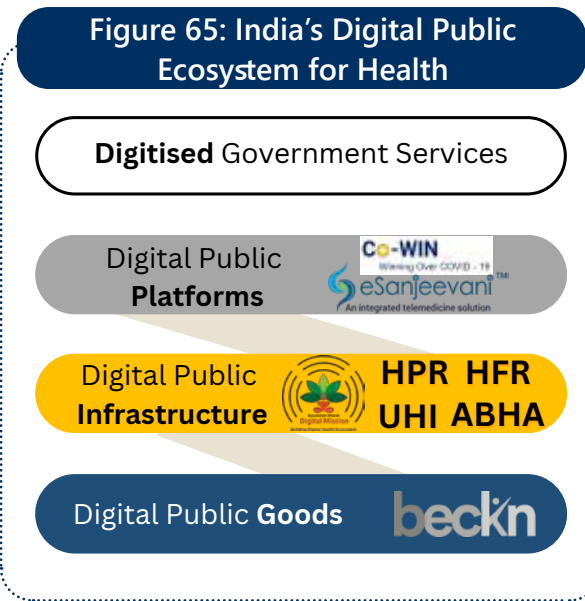
[143] ibid

[144] Reserve Bank of India (2022, August 17). Discussion Paper on Charges in Payment Systems. Retrieved on February 10, 2023, from https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/DPSSDISCUSSIONPAPER5E016622B2D3444A9F294D07234059AA.PDF

3. ABDM: An ambitious solution for health care

The Ayushman Bharat Digital Mission (ABDM) is the digital public ecosystem for the healthcare sector in India and includes various DPIPs. It was piloted in six union territories from August 15, 2020, as the National Digital Health Mission, before its national roll out in November, 2021. The objective of ABDM is to create an open and interoperable national digital health ecosystem that enables information sharing and co-ordination among multiple stakeholders to deliver better access to health care services in the country. ABDM currently comprises the Ayushman Bharat Health Account (ABHA) also known as the Health ID, a 14-digit unique health identifier, registries for health care professionals and health facilities as well as a unified health interface (UHI), an interoperable network that connects health information providers and users through open Application Programming Interfaces (APIs).[145]

Figure 65: India's Digital Public Ecosystem for Health

- **Digitised** Government Services
- Digital Public **Platforms** — Co-WIN, eSanjeevani
- Digital Public **Infrastructure** — HPR HFR UHI ABHA
- Digital Public **Goods** — beckn

Source: ICRIER Policy Brief 3 (2023)

Table 9: ABDM Facts

Pilot Phase: August, 2020- September 2021
National Rollout: September 2021
Product: Digital Public Ecosystem for Health
Implementing Agency: National Health Authority
No. of Health IDs created (January 2023): 322.15 million
No. of verified health professionals on HPR (January 2023): 0.13 million
No. of verified health facilities on HFR (January 2023): 0.19 million
No. of applications integrated: 89

Source: National Health Authority of India, ABDM Insights.

Growth of ABDM ecosystem

The components of ABDM have been launched at different points in time. Consequently, their diffusion and adoption have also reached different levels. For instance, the coverage of ABHA launched in September 2021, has grown at a CAGR of 61 per cent between 2020-21 and 2022-23 to reach 322 million, until the end of January, 2023 (see Figure 66). In a little over two years, ABHA penetration is estimated to have reached approximately 21 per cent.[146] Weekly additions indicate that the pace picked up in January 2021. This can be partly attributed to the contemporaneous launch of the Co-Win platform, one of the main channels of ABHA registrations.[147] However, the linkage of health records to these IDs barely managed to exceed

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[145] National Health Authority of India. ABDM Components. Retrieved on February 10, 2023 from https://abdm.gov.in/abdm-components

[146] Author's calculations based on ABHA creation and estimated total population (2022) data taken from ABDM Insights

double digits in the pilot phase. The uptake of the two registries have also increased (see Figure 67). The health professionals' registry (HPR) now includes nurses and other medical professionals, apart from doctors. Awareness programmes, state directives, integration with state telehealth programmes and performance-linked incentives have all driven up the registrations.[148] Despite these efforts, HPR and Health Facility Registration (HFR) have achieved 6 per cent and 18 per cent penetration respectively, at the national level.[149] A recent circular by IRDAI advises insurance companies to capture the Health Professional ID of practitioners while issuing or renewing health policies.[150] These efforts will collectively boost the adoption of ABDM.

Figure 66: Generation of ABHA and linking of health records

Y-axis: Cumulative health IDs generated & health records linked (in mn)

- 2020-21: Cumulative Health IDs (in millions) 124; Cumulative health records linked (in millions) 0
- 2021-22: 243; 14
- 2022-23: 322; 170

■ Cumulative Health IDs (in millions)
■ Cumulative health records linked (in millions)

Figure 67: Verified professionals and facilities on ABDM registries

Y-axis: No. of verified health professionals & facilities (in '000)

- 2020-21: Cumulative Verified Professionals on HPR 3; Cumulative Verified Facilities on HFR 2
- 2021-22: 79; 163
- 2022-23: 130; 199

■ Cumulative Verified Professionals on HPR
■ Cumulative Verified Facilities on HFR

Source: ABDM Insights

Regional variation in diffusion of ABDM

There are considerable regional disparities in the diffusion of different components of ABDM. Certain UTs such as Ladakh, Andaman and Nicobar Islands and Lakshadweep have been able to achieve full saturation in ABHA relatively quickly. Among states, Andhra Pradesh is the best performer, both in terms of ABHA generation and its linkage with health records (see Figure 68 and Figure 71). The state has made efforts to build awareness at the grassroots level, handholding households to create their first electronic health record and linking it to ABHA. This has been achieved through the deployment of a network of National Health Mission (NHM) personnel.[151] ABHA penetration rates in the north-eastern states is below the national average with Meghalaya having the lowest at 4 per cent.

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[148] Based on NHA media releases

[149] Author's calculations based on number of Verified Health Professionals on HPR vs Council Data (2021) and number of Verified Health Facilities on HFR vs. National Health Resources Repository (2018) data taken from ABDM Insights

[150] FE Bureau (2022, November 23). Health insurers can leverage professional registry: Irdai. The Financial Express. Retrieved on February 10, 2023, from https://www.financialexpress.com/money/insurance/health-insurers-can-leverage-professional-registry-irdai/2886358/
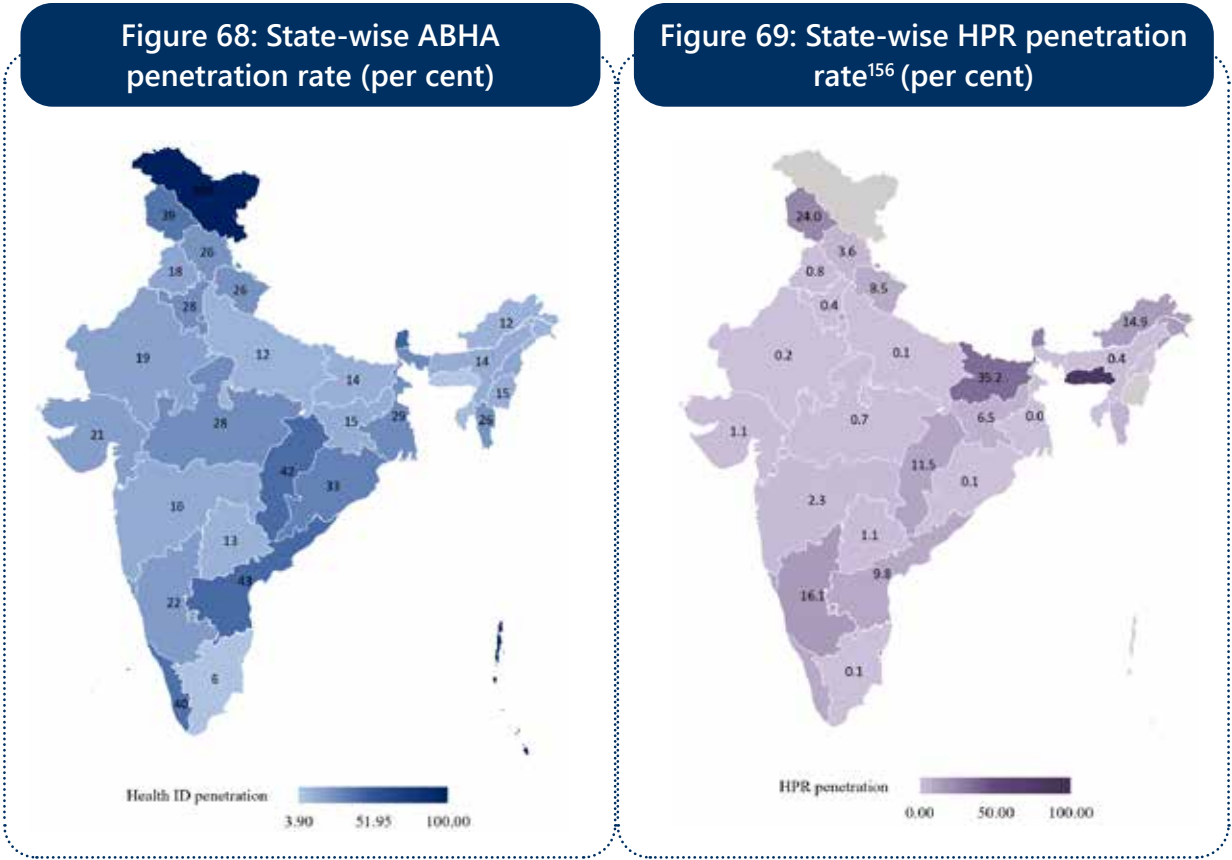
[151] Centre for Policy Research (2022, June). Rapid Adoption of Electronic Health Records: Paths and Pitfalls. Policy Brief. Retrieved on February 10, 2023, from https://cprindia.org/wp-content/uploads/2022/06/Policy-Brief_Electronic-Health-Record_9-June-22_Final_Web-Version.pdf

On the HPR, the best performance has been recorded by Meghalaya (81.7 per cent) and Bihar (35.2 per cent). In 2021, Meghalaya launched the Health Systems Strengthening (MHSS) Project in collaboration with the World Bank to improve human resources supply, planning and management, etc.[152] This initiative is likely to have influenced the HPR outcome in the state. In Bihar, additional manpower and IT infrastructure for regular verification and approval of HPR applications (the state has 84 per cent approval rate of HPR applications), frequent reminder letters from the state health adminitration and follow-up meetings with district teams, arrangement of camps for the HPR drive at the district and block levels, reward and recognition incentives for the best performing districts, etc., are some of the factors behind the state's success.[153,154] HPR penetration is lowerst in Tamil Nadu, Tripura and West Bengal. Karnataka has the highest HFR penetrations, followed by Uttar Pradesh where the pre-existing state portal (UP Swasthya Kendra) held information on HFRs. However, penetration levels are still low.[155]

Collectively, with the exception of Andhra Pradesh and Karnataka, most states are yet to focus holistically on driving adoption of ABDM. The ecosystem is very fragmented with success in microcosms.

Figure 68: State-wise ABHA penetration rate (per cent)

Figure 69: State-wise HPR penetration rate[156] (per cent)

[153] Agarwal, A. (2022, September 26). The Bihar Journey, Ayushman Bharat Digital Mission. Aarogya Manthan, 2022. NHA. Retrieved on February 10, 2023, from https://abdm.gov.in:8081/uploads/4_PPT_by_Shri_Anhsul_Agarwal_26_Sep_2022_f78da0f108.pdf

[154] National Health Authority of India. ABDM Insights. Retrieved on February 10, 2023 from https://dashboard.abdm.gov.in/abdm/

[155] National Health Authority of India. ABDM Insights. Retrieved on February 10, 2023, from https://dashboard.abdm.gov.in/abdm/

[156] HPR Saturation data missing for Ladakh and Manipur

Figure 70: State-wise HFR penetration rate[157] (per cent)	Figure 71: State-wise health records linked to ABHA
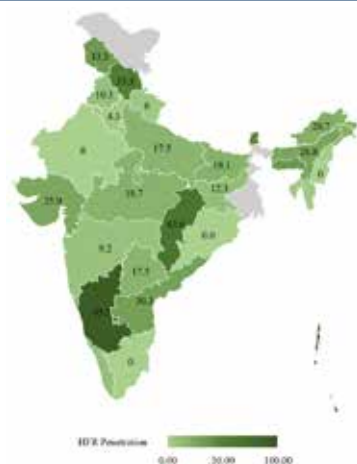
Source ABDM Insights

A public sector driven ecosystem

The current adoption of ABDM is largely driven by the public sector. For instance, the top nine partners, which account for 95 per cent of ABHA generation, are government online applications or offline facilities (see Figure 72). This is in contrast to the *aadhaar* journey, which was largely led by private sector enrolment agencies. Even in the case of registries, state have focused largely on empanelment of public sector health facilities and professionals in the first stage. Government professionals comprise almost 84 per cent of HPR registrations and almost 76 per cent of facilities registered under HFR are publicly owned.[158] By December 2021, Andhra Pradesh had already completed 98 per cent registration of government doctors on their HPR.[159]

Figure 72: Share of partners in ABHA creation
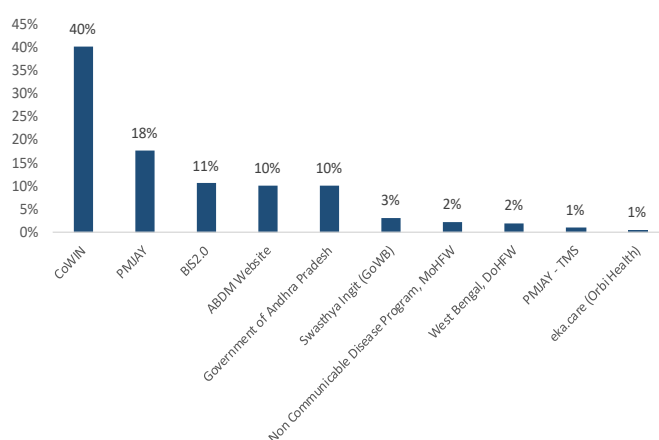
Source: ABDM Insights

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[157] HFR Saturation data missing for Ladakh and West Bengal

[158] National Health Authority of India. ABDM Insights. Retrieved on February 10, 2023, from https://dashboard.abdm.gov.in/abdm/

[159] Kumar, N. (2022, September 26). Ayushman Bharat Digital Mission-AP. Aarogya Manthan, 2022. NHA. Retrieved on February 10, 2023, from https://abdm.gov.in:8081/uploads/2_PPT_by_GS_Naveen_Sir_26_Sep_2022_72d5bacbe4.pdf

The unified health interface (UHI), which is at a nascent stage of development, is expected to provide impetus to private sector participation. Some concerns related to private sector participation are the risk of market concentration, gateway charges, possibility of diminished control over user experience, etc.[160]

Box 2: The case of e-Sanjeevani

e-Sanjeevani, the telemedicine platform of the Ministry of Health and Family Welfare (MoHFW), was integrated with ABDM in June 2022. It has two components: (i) e-Sanjeevani Ayushman Bharat -Health and Wellness Centre (AB-HWC), a doctor-to-doctor service launched in November 2019 that currently accounts for around 90 per cent of all consultations and (ii) the e-Sanjeevani' OPD, a doctor-to-patient service launched in April, 2020 that accounts for the remaining 10 per cent consultations.[161] Overall, there has been remarkable year-on-year (YoY) growth with the registration of 72.3 million patients on the platform during the period November 2019 to January 2023.[162] Growth in AB-HWC is higher than that for OPD. e-Sanjeevani stands out in terms of the number of female users (56 per cent female compared to 44 per cent male),[163] in contrast to the private sector teleconsultation platforms, where female users constitute only 32 per cent of the total users as compared to men (68 per cent).[164]

Figure 73: Cumulative number of patients served

Table 10: e-Sanjeevani facts

Launch date: November 2019	
Product: Telemedicine Platform	
Implementing Agency: Centre for Development of Advanced Computing (R & D agency of Ministry of Electronics & IT)	
No. of patients served: 92.65 million	
No. of providers onboarded: 220,195	
No. of OPDs hosted: 1,147	
No. of hubs established: 15,465	
No. of spokes operationalised: 112,987	

Source: Ministry of Health & Family Welfare

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[160] Stakeholder comments on UHI Consultation paper (2022). Retrieved on February 10, 2023 from https://abdm.gov.in/uhi-comments-view

[161] Ministry of Health & Family Welfare (2022). e-Sanjeevani: National Teleconsultation Service dashboard. Retrieved on February 10, 2023 from https://esanjeevani.in/

[162] Based on data obtained from stakeholder and e-Sanjeevani National Telemedicine Service dashboard. Ministry of Health & Family Welfare, Government of India. Retrieved on February 10, 2023 from https://esanjeevani.in/

[163] Ministry of Health & Family Welfare (2021, August 24). Health Ministry's eSanjeevani initiative completes 1 Crore consultations. Press Information Bureau. Retrieved on February 10, 2023 from https://pib.gov.in/PressReleasePage.aspx?PRID=1748652

[164] Telemedicine Society of India (TSI) & Practo (2020, December). Reinventing Healthcare Delivery With Telemedicine. Retrieved on February 10, 2023, from https://www.practo.com/company/insights/practo_tsi_telemedicine_report.pdf

An impact assessment of the platform in the state of Jharkhand reported several benefits for women, including addressing mobility challenges and the lack of female health care providers.[165] Each e-Sanjeevani teleconsultation at an HWC has on average reduced the distance to be travelled by 21.58 km and cost savings of approximately INR 942.[166] The cumulative cost savings across the country is estimated to be over INR6,600 crore.[167] e-Sanjeevani's model of care was also found to be relatively more patient-centric and safe and offered dignity to vulnerable patients. Even as telemedicine grew in popularity through the pandemic,[168] e-Sanjeevani focused on inclusive access, with nearly 85 per cent of its users living in rural areas.[169] e-Sanjeevani has also been able to achieve greater operational efficiency over time by converting certain functionalities such as reports and dashboards (for administrative users) and patient login page (for end-users) into micro services to help overcome the challenge of traffic overload faced by the platform in its early days.

The modular design of e-Sanjeevani has been the foundation of several innovative features incorporated in the platform over the years. Some of these innovations include AI-based symptom checkers, integration with point-of-care devices, inventory management, enablement of e-prescriptions and sharing of health records.[170] While e-Sanjeevani has made impressive progress, it lacks integration with certain offline services available on private platforms. A comparison between e-Sanjeevani and private teleconsultation platforms is provided in Table 11.[171] With the evolution of the ABDM, these gaps are likely to be addressed.

Table 11: Comparison of e-Sanjeevani services vis-à-vis private sector teleconsultation platforms		
Services	**e- Sanjeevani**	**Private teleconsultations platforms (e.g., Practo, 1mg, PAGD, Teladoc, Amwell)**
Online	Online Consultations	Online Consultations
	E-health profile	E-health profile
	Express drug delivery	Express drug delivery
		Health Plans
Offline		Appointment Services
		Health Check-Up
		Hospital Referral
		Second Opinion
		In-patient arrangement
		Domestic/Overseas services

[165] Telehealth Innovations Foundation (Intelehealth) and Transform Rural India Foundation (2022, July 27). Impact Report e-Sanjeevani Jharkhand (Draft Copy)

[166] Ministry of Health & Family Welfare (2023). e-Sanjeevani: Improving Accessibility & Equity in Healthcare. Brochure, G20 Health Working Group

[167] ibid

[168] Practo (2022). Understanding COVID-19: Comparing all three waves in India. Practo Insights. Retrieved on February 10, 2023, from https://www.practo.com/company/insights/covid-19-insights.pdf

[169] Ministry of Health & Family Welfare (2022). e-Sanjeevani: National Teleconsultation Service dashboard.

[170] Ministry of Health & Family Welfare (2023). e-Sanjeevani: Improving Accessibility & Equity in Healthcare. Brochure, G20 Health Working Group

[171] Bajpai, N and Wadhwa, M. (2021, July). National Teleconsultation Service in India: eSanjeevani OPD. ICT India Working Paper #53. Centre for Sustainable Development, Columbia University. Retrieved on February 10, 2023, from https://csd.columbia.edu/sites/default/files/content/docs/ICTper cent20India/Papers/ICT_India_Working_Paper_53.pdf

Comparing with Australia's Digital Health Ecosystem

The ABDM shares several features of the Australian digital health ecosystem, particularly with regard to the components of IDs and registries (Table 12). Through automatic assignment using existing Medicare cards, Australia achieved 100 per cent coverage of its Individual Health Identifier within a year of launch. Similarly, by collaborating with the Australian Health Practitioner Regulation Agency (APHRA), the Health Identifiers Service quickly achieved scale for health professional IDs (HPI-I). 'My Health Record', a centralised system that holds personal electronic health summaries of registered citizens, is a key component of the Australian Digital Health Agency. It has near universal coverage of citizens and has also gained widespread acceptance in the healthcare provider ecosystem.[172,173] The agency carries out privacy impact assessments to identify follow up measures and engages in continuous monitoring through consultations with ecosystem partners to provide an interoperable and secure interface. Health data in India are not designed to be held centrally but through a federated architecture. Finally, while ABDM integrates all registries, the systems in Australia are selectively integrated.

Table 12: Comparison of ABDM with Australian digital health ecosystem		
	INDIA	**AUSTRALIA**
Key Agency	National Health Authority (2018)	Australia Digital Health Agency (2016), Health Identifiers Service (2010)
Health ID	Ayushman Bharat Health Account (ABHA) – a 14-digit unique health identifier. (Launched: 2021)	Individual Health Identifier (IHI) – a unique 16-digit number used to identify an individual for health care purposes. (Launched: 2010)
Registry/ National Database of healthcare professionals and ID	Verified professionals receive a unique Healthcare Professional ID, which serves as an identifier within the Healthcare Professionals Registry.	A Healthcare Provider Identifier-Individual (HPI-I) is assigned to healthcare professionals involved in providing patient care. The Healthcare Provider Directory (HPD) is one of the key digital directories supporting digital health in Australia. Healthcare providers can use the HPD to look up details of other health providers using HPI-I.
National Registry of Health Facilities	Each registered health facility on the Health Facility Registry (HFR) is provided a unique 12-character Facility ID. (FID)	The Healthcare Provider Identifier—Organisation (HPI-O) is the 16-digit numerical identifier that uniquely identifies organisations in Australia where healthcare is provided. The HPI-O is linked to the Healthcare Professionals Directory (HPD). Recently, another service, Provider Connect, was launched, which provides a comprehensive overview of healthcare facilities and their services

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[172] Public Hospitals – 95 per cent registered using My Health Records, general practitioners – 99 per cent registered using My Health Records, Pharmacies – 99 per cent registered using My Health Records

[173] Australian Digital Health Agency (2022, December). My Health Record: Statistics and Insights. Retrieved on February 10, 2023, from https://www.digitalhealth.gov.au/sites/default/files/documents/mhr-statistics-december-2022.pdf

Table 12: Comparison of ABDM with Australian Digital Health Ecosystem		
	INDIA	**AUSTRALIA**
Personal Health Record system	ABDM has a federated architecture for enabling storage and sharing of health records through any application (integrated with ABDM) of the patient's choice.	Australia's MyHealth Record system is centrally operated by the Digital Health Agency, although consumers can access their records through apps developed by registered mobile app developers.

Source: National Health Authority and Australian Digital Health Agency

4. UPYOG and DIGIT: Designing for good governance

In 2022, the Ministry of Housing and Urban Affairs (MoHUA) announced the launch of the **Urban Platform for deliverY of Online Governance, or UPYOG** to be implemented as a part of the National Urban Digital Mission (NUDM). UPYOG provides common digital infrastructure for urban e-governance across Indian States and ULBs. Till date, 27 states and Union Territories have signed MoUs (Memorandum of Understanding) for the adoption and implementation of UPYOG.[174]

The NUDM has outlined a flexible implementation plan for UPYOG, based on the needs of implementing states. The design allows for integration of pre-existing e-governance infrastructure of states with UPYOG. States without any existing infrastructure will configure their platform and solutions using open APIs of UPYOG (see Table 13). While UPYOG is still to go live, the DIGIT Urban platform has been adopted as its technical core. DIGIT Core has already been implemented in a few states and is discussed in detail in the following sub-sections.

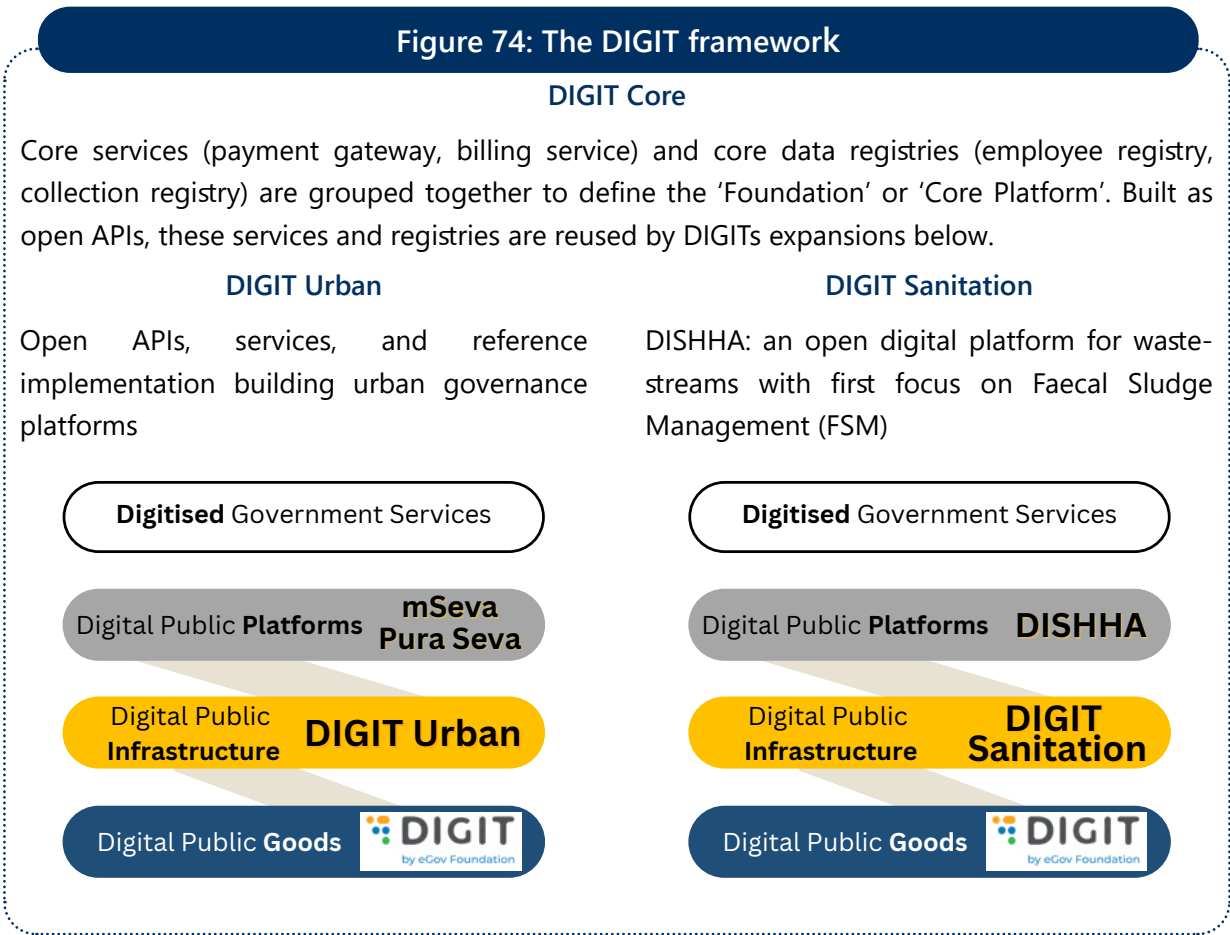| Table 13: UPYOG implementation models		
Greenfield States	**Brownfield States**	**Mature States**
States with little to no existing e-governance systems	States with some existing e-governance systems	States with pre-existing sophisticated e-governance systems
Central government instance: States provided with 'software as a service' with hosting by NUDM	State-created instances: Integration of NUDM platform code with existing systems	Data sharing agreements: States can continue using pre-existing platforms but are expected to share data

Source: NUDM website

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[174] National Urban Digital Mission NUDM-NIUA. (2023, January 26). Signed MoUs with 27 States/UTs across India for implementation of UPYOG [Online post]. LinkedIn. Retrieved on January 30, 2023, from https://www.linkedin.com/posts/national-urban-digital-mission-nudm_niua-nudm-upyog-activity-7024294302360952832-KsQx/?utm_source=share&utm_medium=member_desktop

The DIGIT core and its domain-specific implementation

Digital Infrastructure for Governance, Impact & Transformation, or DIGIT is a set of open-source protocols and code designed to build scalable and interoperable applications centered round urban governance and delivery of public services. Certified as a Digital Public Good by the Digital Public Goods Alliance (DPGA), DIGIT began as one set of code, but has evolved into domain-specific infrastructure over time.[175] DIGIT Core acts as the foundation on which domain-specific open infrastructure is built (see Figure 74)

Figure 74: The DIGIT framework

DIGIT Core

Core services (payment gateway, billing service) and core data registries (employee registry, collection registry) are grouped together to define the 'Foundation' or 'Core Platform'. Built as open APIs, these services and registries are reused by DIGITs expansions below.

DIGIT Urban

Open APIs, services, and reference implementation building urban governance platforms

Digitised Government Services

Digital Public **Platforms** — **mSeva Pura Seva**

Digital Public **Infrastructure** — **DIGIT Urban**

Digital Public **Goods** — DIGIT by eGov Foundation

DIGIT Sanitation

DISHHA: an open digital platform for waste-streams with first focus on Faecal Sludge Management (FSM)

Digitised Government Services

Digital Public **Platforms** — **DISHHA**

Digital Public **Infrastructure** — **DIGIT Sanitation**

Digital Public **Goods** — DIGIT by eGov Foundation

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175 Digital Public Goods Alliance. (n.d.). Digital Public Goods Alliance: Roadmap. Retrieved February 8, 2023, from https://digitalpublicgoods.net/map/

Figure 74: The DIGIT Framework

DIGIT Urban

Built to provide real-time information on the financial health of districts and states, covering expenditure, revenue, and available funds

Digitised Government Services

Digital Public **Platforms**

Digital Public **Infrastructure**

Digital Public **Goods** — DIVOC by eGov Foundation

DIGIT Health

DIVOC: A scalable, modular open-source DPG enables countries to digitally orchestrate large-scale health campaigns

Digitised Government Services

Digital Public **Platforms** — **mGramSeva**

Digital Public **Infrastructure** — **DIGIT iFIX**

Digital Public **Goods** — DIGIT by eGov Foundation

Note: API = Application Programming Interface; DIGIT = Digital Infrastructure for Governance, Impact & Transformation; DISHHA = Digital Infrastructure for Sustainable and Healthy Habitats; DIVOC = Digital Infrastructure for Verifiable Open Credentialing; iFIX = India Fiscal Information Exchange Platform.

Source: ICRIER Policy Brief 3 (2023)

DIGIT's Urban mission is the most mature[176] and is focused on urban local bodies (ULBs) and cantonment boards through customised platforms such as mSeva and PuraSeva; iFIX is a fiscal information exchange platform, currently implemented around villages, and DIGIT Sanitation is in the process of scaling in Odisha. DIVOC's implementation was accelerated by the COVID-19 pandemic, as an application for vaccination certifications in India, Sri Lanka, the Philippines, Indonesia and Jamaica. In survey assessments for mSeva and PuraSeva, employees have reported improvements in their quality of work (87 per cent for mSeva[177] and 96 per cent for PuraSeva) and citizens have also stated improvements in the quality of life (70 per cent for mSeva[178] and 76 per cent for PuraSeva).[179] The adoption of DIGIT is also being

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[176] DIGIT Urban compromises a number of modules that ULBs can design to automate manual workflows for various governance functions. These modules consist of citizen centric services, such as public grievance redressal and trade licence systems; services that can be used by both citizens and ULBs, such as the property tax system under the mSeva app that allows citizens to pay property tax and obtain payment receipts via email and ULBs to monitor tax collection; and modules created solely for ULBs such as the human resource management system.

[177] 60 Decibels & Omidyar Network India. (2022d). eGovernments Foundation Municipal Employees – Punjab Impact Performance Report. Retrieved on January 27, 2023, from https://egov-website-content.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/11/23142134/Municipal-Employees-per centE2per cent80per cent93-Punjab.pdf

[178] 60 Decibels & Omidyar Network India. (2022c). eGovernments Foundation (mSeva) Impact Performance Report. Retrieved January 27, 2023, from https://egov-website-content.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/11/23141537/mSeva-Impact-Performance-Report.pdf

[179] 60 Decibels & Omidyar Network India. (2022a). eGovernments Foundation: Pura Seva Impact Performance Report. Retrieved January 27, 2023, from https://egov-website-content.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/11/23122649/eGovernments-Foundation-Pura-Seva-Impact-Performance-Report.pdf

pushed through independent agencies. For instance, Transerve Technologies has partnered with the Indian Institute for Human Settlements (IIHS) to support a cluster of ULBs in Tamil Nadu for faecal sludge and septage management.[180]

Figure 75: DIGIT adoption across villages, ULBs, states, and countries			
DIGIT Urban	**DIGIT Sanitation**	**DIGIT iFIX**	**DIGIT Health**
• **Punjab (mSeva)** 100 of 169 ULBs • **Uttarakhand** All 92 ULBs • **Andhra Pradesh (PuraSeva)** 112 of 125 ULBs • **Cantonment Boards (eChhawani)** All 62	• **Odisha** 36 of 114 ULBs; • Plans to scale in the entire State • Focus on Faecal Sludge Management (FSM)	• 100 villages in **Punjab** • mGramSeva app • GPWSCs manage revenue and expenses	• DIVOC in **5 nations** • India, Sri Lanka, Phillipines, Indonesia & Jamacia • 2 billion+ COVID-19 vaccination certificates issued • Collaborated with ICMR to generate COVID-19 test certificates in India

Source: Mehra (2022), eGov Foundation website, DIVOC website.

Note: ULBs = Urban Local Bodies; Gram Panchayat Water and Sanitation Committees (GPWSCs); DIVOC = Digital Infrastructure for Verifiable Open Credentialing; ICMR = the Indian Council of Medical Research.

DIGIT's design principles configured round solving for inclusion, privacy, innovation and efficiency

As a core DPI, DIGIT's design principles aim to tackle capacity challenges around implementation through modularity that allows innovation and scaling, and offline complements that promote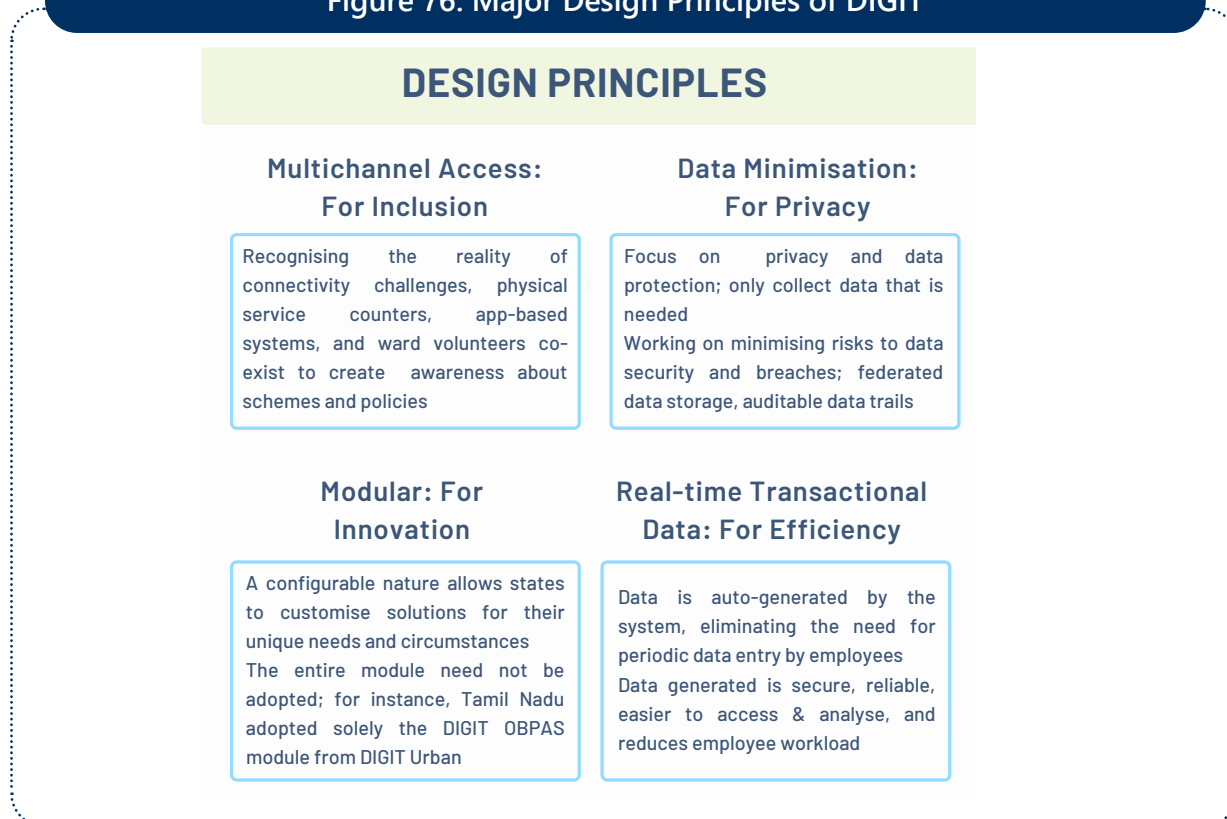 inclusion. The principles of automated data generation and minimised data collection, make the system efficient and secure. These key design principles are summarised in Figure 76 below. The importance of multichannel access is visible in the number of offline complaints lodged by citizens in an online network (refer Figure 77) Ward volunteers help poor citizens who lack access and awareness to lodge complaints in the system. According to one estimate from a district in Andhra Pradesh, one ward volunteer services 50 to 65 households.[181]

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[180] Transerve Technologies partners with Indian Institute for Human Settlements (IIHS) to aid Tamil Nadu Government in Sanitation Management Mission. (2020, September 9). Business News This Week. Retrieved January 27, 2023, from http://businessnewsthisweek.com/business/transerve-technologies-partners-with-indian-institute-for-human-settlements-iihs-to-aid-tamil-nadu-government-in-sanitation-management-mission/

[181] Doctor, G., Vaasanthi, V., & Shree, K. (2022). Public Grievance Redressal for Urban e-Governance in Andhra Pradesh: Insights from Guntur & Visakhapatnam. Retrieved January 27, 2023, from https://egov-website-content.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/11/23151106/CaseStudy_CEPTeGov_PGRforUrbaneGovernanceinAP-1.pdf

Figure 76: Major Design Principles of DIGIT

DESIGN PRINCIPLES

Multichannel Access: For Inclusion

Recognising the reality of connectivity challenges, physical service counters, app-based systems, and ward volunteers co-exist to create awareness about schemes and policies

Data Minimisation: For Privacy

Focus on privacy and data protection; only collect data that is needed
Working on minimising risks to data security and breaches; federated data storage, auditable data trails

Modular: For Innovation

A configurable nature allows states to customise solutions for their unique needs and circumstances
The entire module need not be adopted; for instance, Tamil Nadu adopted solely the DIGIT OBPAS module from DIGIT Urban

Real-time Transactional Data: For Efficiency

Data is auto-generated by the system, eliminating the need for periodic data entry by employees
Data generated is secure, reliable, easier to access & analyse, and reduces employee workload

Source: Authors based on feedback from eGov Foundation

Note: OBPAS = Online Building Plan Approval System.

Figure 77: Categorising complaints received under the Andhra Pradesh Public Grievance Redressal Module
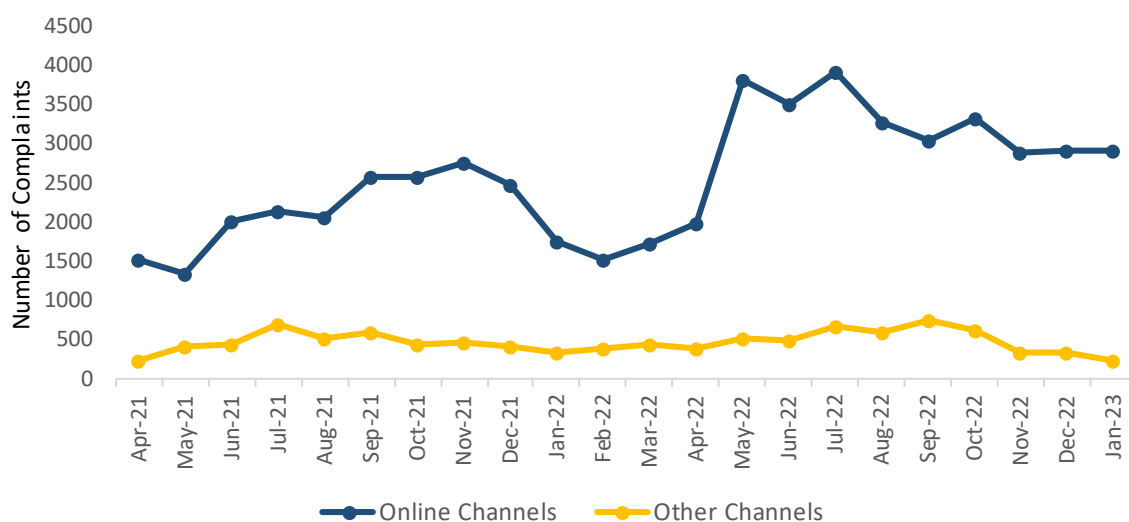
Source: Andhra Pradesh Municipal Corporation Grievance Dashboard

Note: Data for January 2023 is till the 25th. Online channels include grievance referred by minister, portal, Puraseva App, citizen portal, citizen service center, employee app, Swachhta App, website, command communication center, and email; offline channels include phone calls and field sources.

Other design features of DIGIT have also proved successful. DIGIT Urban, deployed as eChhawani by Bharat Electronics Limited (BEL)'s software division under all 62 cantonment boards in the country, combined a pre-existing asset registry with a newly created scheduling engine to create an eChallan and an online booking system for community halls.[182] With data being created in real-time, employees using mSeva reported time savings, efficiency in grievance reporting and resolution, and general improvements in the quality of work.[183] Similarly, employees using PuraSeva reported improvements in grievance management, decreased effort in public engagement, and overall time savings as positive impacts.[184]

Implementation challenges that are beyond the technical design of DIGIT

Despite high quality design principles, the adoption of DIGIT has been limited due to several implementation challenges that are mostly non-technical (refer Figure 78). These can range from the lack of technological capabilities, limited ecosystem partners and inefficiencies in the government procurement process. There is inertia in adoption, both from employees and citizens, given their lack of familiarity and trust in digital systems, especially concerning payments. The ease of use and convenience of these services can be offset by a lack of awareness regarding digital channels available to citizens. The skill gap among users, especially employees of urban local bodies, needs to be addressed. Finding implementation partners and the long-winded selection process by government departments is also a reason for delay. Finally, state and local governments often launch multiple and overlapping services, resulting in uncertainty amongst citizens about the right channel. Integrating government programmes will minimise bottlenecks at the user end. Impact assessments become necessary to identify such challenges that creep into systems that may be technically sound, but practically infeasible. Technical systems must account for local contexts and low-resource settings. To further strengthen DIGIT, eGov Foundation aspires to build in code inspired by the 'once-only policy' – the backbone of interoperability in Estonia's X-Road – where data is requested from the citizen only once. On governance aspects, a desirable design choice would be similar to that of Decidim, a free open-source platform that originated in Barcelona, Spain, that enables changes in rules and systems to be pushed through a participatory process that is secured with encrypted voting.
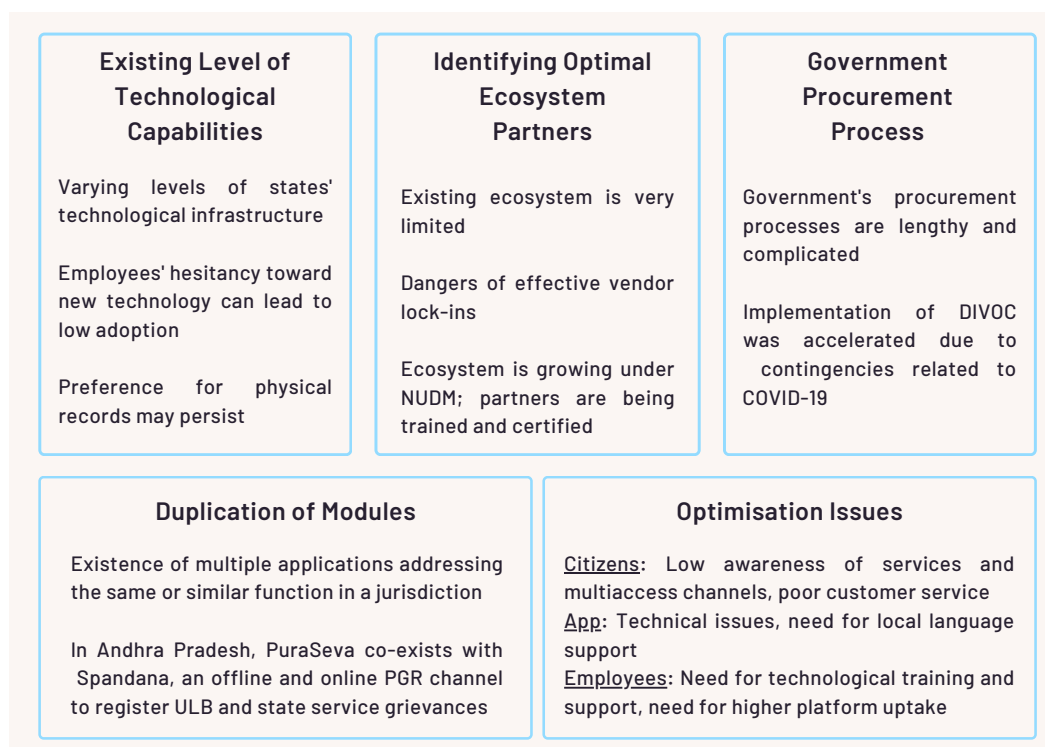
[182] eGov Foundation. (2022b). eChhawani: Online citizen services in cantonment areas. Retrieved on January 27, 2023, from https://egov.org.in/blog/field-stories-punjab-notes-from-amritsar/

[183] 60 Decibels & Omidyar Network India. (2022d). eGovernments Foundation Municipal Employees – Punjab Impact Performance Report. Retrieved on January 27, 2023, from https://egov-website-content.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/11/23142134/Municipal-Employees-per centE2per cent80per cent93-Punjab.pdf

[184] Decibels & Omidyar Network India. (2022b). eGovernments Foundation Municipal Employees: Andhra Pradesh Impact Performance Report. Retrieved on January 27, 2023, from https://egov-website-content.s3.ap-south-1.amazonaws.com/wp-content/uploads/2022/11/23143232/Municipal-Employees_-Andhra-Pradesh-Impact-Performance-Report.pdf

Figure 78: Major implementation challenges of DIGIT

Existing Level of Technological Capabilities

Varying levels of states' technological infrastructure

Employees' hesitancy toward new technology can lead to low adoption

Preference for physical records may persist

Identifying Optimal Ecosystem Partners

Existing ecosystem is very limited

Dangers of effective vendor lock-ins

Ecosystem is growing under NUDM; partners are being trained and certified

Government Procurement Process

Government's procurement processes are lengthy and complicated

Implementation of DIVOC was accelerated due to contingencies related to COVID-19

Duplication of Modules

Existence of multiple applications addressing the same or similar function in a jurisdiction

In Andhra Pradesh, PuraSeva co-exists with Spandana, an offline and online PGR channel to register ULB and state service grievances

Optimisation Issues

<u>Citizens</u>: Low awareness of services and multiaccess channels, poor customer service
<u>App</u>: Technical issues, need for local language support
<u>Employees</u>: Need for technological training and support, need for higher platform uptake

Source: (Doctor et al., 2022), 60 Decibels & Omidyar Network India (2022a), (2022b), (2022c) and (2022d), Sattva (2022), eGov Foundation (2022a), (2022b), (Tyagi & Singh, 2022).

5. Account Aggregator Framework: Bridging the credit gap

The Account Aggregator Framework or AA Framework is a digital public infrastructure (DPI) that facilitates sharing of financial information between specified regulated entities. Built on the Data Empowerment and Protection Architecture (DEPA), the AA Framework relies on user consent to share data with account aggregators (AAs)[185] that act as consent managers, i.e., a new class of intermediaries that facilitate data sharing based on valid consent from the individual user.[186] AAs are data blind; they can only facilitate encrypted data flows and cannot read, store or analyse users' data.[187] User consent is obtained via a standardised consent artefact.[188]

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[185] Reserve Bank of India. Master Direction- Non-Banking Financial Company - Account Aggregator (Reserve Bank) Directions, 2016. Retrieved February 6, 2023, from https://www.rbi.org.in/Scripts/BS_ViewMasDirections.aspx?id=10598 :-

- Section 3(1)(i): Account Aggregators are licensed by the RBI and are categorised as Non-Banking Financial Companies (NBFCs).
- Section 3(1)(iv): The business of an account aggregator consists of retrieving/collecting a customer's financial information, and presenting this to the customer in a collated/consolidated format.
- 4(1)(a) & 4(1)(b): Account Aggregators are required to be companies and need to obtain a certificate of registration from the Bank to carry out the business of an AA.
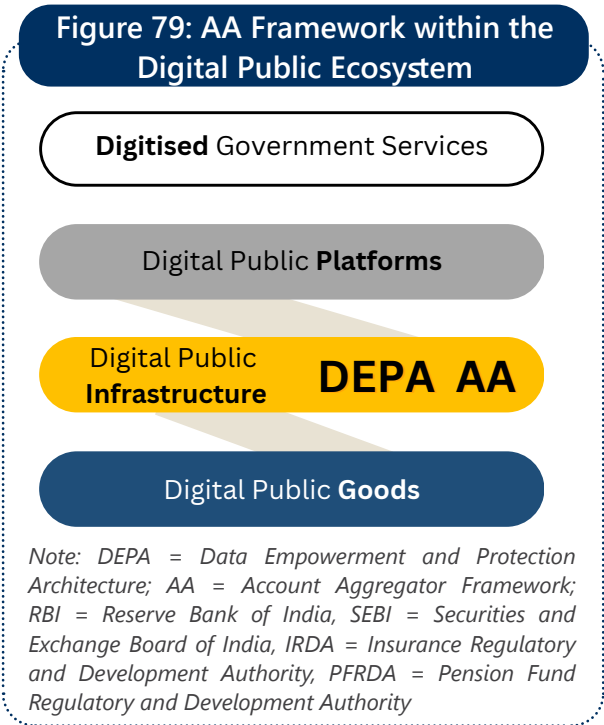
[186] Parsheera, S. (2022). An Analysis of India's New Data Empowerment Architecture. In Emerging Trends in Data Governance (pp 7-23). Centre for Communication Governance at National Law University, Delhi

[187] NITI Aayog. (2020). Data Empowerment and Protection Architecture: Draft for Discussion. Retrieved February 6, 2023, from https://www.niti.gov.in/sites/default/files/2020-09/DEPA-Book.pdf

[188] Reserve Bank of India. Section 6(5), Master Direction- Non-Banking Financial Company - Account Aggregator (Reserve Bank) Directions, 2016. Retrieved February 6, 2023, from https://www.rbi.org.in/Scripts/BS_ViewMasDirections.aspx?id=10598

The AA is also required to provide users with the option to revoke their consent, including towards parts of information mentioned in the consent artefact.[189] The data sharing takes place between financial information users (FIUs) and financial information providers (FIPs) within the AA ecosystem.[190] Reciprocity of data use and data provision is one of DEPAs design principles,[191] wherein institutions in the ecosystem are required to be data users as well as data providers.

The DigiSahamati Foundation or Sahamati is a not-for-profit collective of AAs established to promote adoption of the AA ecosystem. Currently, it formulates and promotes adoption of technical standards, publishes audit guidelines and interoperability standards for members, and monitors member compliance.[192] Sahamati has also created a grievance redressal framework for customer complaints.

Figure 79: AA Framework within the Digital Public Ecosystem

Digitised Government Services

Digital Public **Platforms**

Digital Public **Infrastructure** **DEPA AA**

Digital Public **Goods**

Note: DEPA = Data Empowerment and Protection Architecture; AA = Account Aggregator Framework; RBI = Reserve Bank of India, SEBI = Securities and Exchange Board of India, IRDA = Insurance Regulatory and Development Authority, PFRDA = Pension Fund Regulatory and Development Authority

Source: ICRIER Policy Brief 3 (2023)

Table 14: Account Aggregator Framework facts

Launch Date: September 2021
Master Direction issued by Reserve Bank of India (RBI), Core Technical Specifications and Draft Security Standards by ReBIT
Regulators Involved: RBI, SEBI, IRDA, PFRDA, and Department of Revenue, Ministry of Finance
Product: Digital Public Infrastructure that enables sharing of user financial information with consent
Accounts linked by holders (January 2023): 4.02 million
Consent Requests Fulfilled (January 2023): 3.9 million
Operating AAs (January 2023): 6

Source: Sahamati website

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[189] Reserve Bank of India. Section 6(6), Master Direction- Non-Banking Financial Company - Account Aggregator (Reserve Bank) Directions, 2016. Retrieved February 6, 2023, from https://www.rbi.org.in/Scripts/BS_ViewMasDirections.aspx?id=10598

[190] Sahamati. (n.d.). Retrieved February 6, 2023, from https://sahamati.org.in/

FIPs are institutions like banks or insurance providers that hold user data while FIUs are entities like lending agencies (including banks) that receive consumer financial information through AAs and use it to provide services such as wealth management, insurance, or loans.

[191] NITI Aayog. (2020). Data Empowerment and Protection Architecture: Draft for Discussion. Retrieved February 6, 2023, from https://www.niti.gov.in/sites/default/files/2020-09/DEPA-Book.pdf

[192] NITI Aayog. (2020). Data Empowerment and Protection Architecture: Draft for Discussion. Retrieved February 6, 2023, from https://www.niti.gov.in/sites/default/files/2020-09/DEPA-Book.pdf

Building up the AA Ecosystem

The AA ecosystem is still in its early stages with evolving guidelines and industry practices. Apart from the six operational AAs[193] in the ecosystem, three other entities have received RBI's approval to operate as AAs.[194] Building on the principle of reciprocity, implementation for FIPs and FIUs has been categorised into five stages, viz., live, where it is available for end users; live-enabled where it is in the final stages of production; testing where the service is being tested with at-least one AA; in-development where the service is still being developed; and under-evaluation where the institution has not yet begun developing the service[195] (refer Table 15). Technology service providers (TSP) are intermediate-certified entities that collaborate with FIPs and FIUs to deliver AA products and services. The TSP business model works using a one-time fee with annual updates or the pay-as-you-go model. Their number is steadily rising.

The AA system is yet to become mandatory for any of the ecosystem partners. However, to become an FIU or FIP, the entity must be regulated by at least one of the financial system regulators – RBI, SEBI, IRDA and PFRDA. The commercial arrangements between FIUs and AAs are left to the market. From the latest data available, 4.02 million bank accounts have been linked to AAs and the cumulative count of consent requests successfully fulfilled is 3.9 million.[196] Data for individual account aggregators were not available to fully understand the level of access and competition.

To ensure user privacy, data security and ease of audits, confidential clean rooms are being added to DEPA.[197] The concept draws from data clean rooms, which help execute secure data collaboration between multiple parties by keeping user data private.[198]

For the ecosystem to mature, each FIP must be integrated with all AAs in the market. The type of data sets accessible to FIUs also needs to be broadened and regulatory compliance needs to be strengthened to ensure protection from risks of ecosystem monopolisation either by TSPs or AAs.

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[193] FIP-AA Mapping. (n.d.). Sahamati. Retrieved February 6, 2023, from https://sahamati.org.in/fip-aa-mapping/

Namely Anumati, CAMS, Finvu, NADL, Onemoney, and Yodlee

[194] FIP-AA Mapping. (n.d.). Sahamati. Retrieved February 6, 2023, from https://sahamati.org.in/fip-aa-mapping/ Namely Protean SurakshAA, PhonePe, and Saafe

[195] Status of FIPs & FIUs Implementation in the Account Aggregator Ecosystem. (n.d.). Sahamati. Retrieved February 6, 2023, from https://sahamati.org.in/fip-fiu-in-account-aggregators-ecosystem/

[196] AA Dashboard https://sahamati.org.in/aa-dashboard/

[197] iSPIRIT. (2021, October 14). Confidential Clean Rooms in DEPA. Retrieved February 6, 2023, from https://pn.ispirt.in/confidential-clean-rooms-in-depa/

[198] Kerner, S. M. (n.d.). Definition: data clean room. TechTarget. Retrieved February 6, 2023, from https://www.techtarget.com/searchcustomerexperience/definition/data-clean-room

Table 15: Status of FIP & FIU Implementation in the Account Aggregator Ecosystem				
FINANCIAL INFORMATION PROVIDERS			**FINANCIAL INFORMATION USERS**	
Live – 30			Live – 139	
Banks – 24 RRBs – 2 Insurers – 4				
Live enabled – 1	Testing – 14		Live enabled – 8	Testing – 56
In-development – 12	Under Evaluation – 39		Under Evaluation – 39	Under Evaluation – 49

Note: RRBs = Regional Rural Banks.

Source: Sahamati website

Promoting Financial Inclusion through AAs

One of the primary objectives of the AA framework is to improve access to financial services. According to industry estimates, 50 per cent of the lending disbursed through AAs were to MSMEs. AAs have further improved frictionless lending through digital platforms. According to one industry estimate, 20 per cent of the unsecured loans given by digital platforms were channelled through AAs. For the industry as a whole, follow-through on income verification for loan applications has increased from 7-10 per cent to 35-42 per cent, resulting in credit limits going up by almost 55 per cent. According to industry estimates, the cost of loan processing has declined by 75 per cent from INR440 to below INR100. Besides time savings from reduced documentation, FIUs now have a better and trusted view of customer financial health.

The RBI Innovation Hub and Sahamati also lead the Assisted Account Aggregator Framework that is working towards a simple and secure, *aadhaar*-based AA to improve access to financial services for the unconnected. Targeted beneficiaries include people without smartphones or people with low digital or financial literacy. The working group is tasked with considering the technological and business viability of AA in an assisted mode while ensuring data security and consumer privacy. A proof of concept was proposed to be scheduled at a recent workshop hosted by the RBI Innovation Hub.[199]

Demands in the Future

AAs will need to innovate to enable widespread adoption. While the AA framework allows users direct control over their data, the realities of India's' digital divide cannot be ignored. The lack of digital skills and literacy may result in citizens not being fully capable of giving informed consent to share their data. Some design elements that ought to be introduced to make the system inclusive are support for regional languages, voice support in apps, and simplifying consent management by providing a translation of consent artefacts into layperson's terms. It would also be helpful for AAs to introduce a 'warning system' that informs

[199] RBIH. (2023, January). Fin(Wrap) Issue 4. RBI Innovation Hub. Retrieved on February 6, 2023, from https://rbihub.in/fin-wrap-issue-04

[200] Sanghi, R., & Vir, A. (2020, September 19). OCEN: A Conversation. Tigerfeathers. Retrieved on February 8, 2023, from https://tigerfeathers.substack.com/p/ocen-a-conversation

users when a consent artefact requests for more information than is required by the transaction.

Another key area of action will be the integration of AA with the Open Credit Enablement Network, or OCEN, which is a set of open APIs that can be integrated with a wide range of digital platforms and apps. These open APIs can enable any consumer-facing service provider to 'plug in' lending into their operations and become lending service providers (LSPs).[200] LSPs can use the AA framework to seamlessly obtain user financial data during the credit disbursement process.[201] Created to democratise credit disbursement and enable financial inclusion, OCEN will have to work towards winning consumer and ecosystem trust while guarding against significant ramifications that can come with allowing easy access into the credit disbursement ecosystem. The integration of the data sharing and credit layers can greatly enhance access to finance in underpenetrated segments like retail and MSMEs. Trust in the system and user awareness will be critical to drive adoption.

A Comparison with Singapore

The Singapore Financial Data Exchange (SGFinDex) is digital public infrastructure that resembles the AA framework (refer Table 16 for comparison). It is a centrally managed online consent system that was developed through a joint initiative by the Monetary Authority of Singapore (MAS), the Smart Nation and Digital Government Group (SNDGG), and

financial institutions. SGFinDex enables users to retrieve their personal financial data such as savings, investments and insurance and provides them with a consolidated view to enable better financial planning.[202] Users can use Singpass (Singapore's national digital identity) to verify their identity and retrieve their personal financial information.[203] To enable adoption and spread awareness, SGFinDex has created a detailed set of frequently asked questions targeted at end users that acts as an introductory guide and provides a concise description of significant issues.[204] There is no intermediary such as AAs in this framework; users manage and share data directly with information seekers. The system does not only allow for information sharing but enables users to view all their financial information through a single interface. The AA framework might be considered more useful from the lenders point of view, which can depend entirely on AAs for authentic information, as compared to retrieving information from individual users in SGFinDex. From a user control point of view, AAs, while designed to empower individual users, is currently operationalised through FIUs choosing the AA and users only authenticating through an OTP. In SGFinDex, users have more control over their financial information. There is also a big difference in the institutional set up – while AAs are private entities around which regulations are still evolving, SGFinDex is set up and operated by the government. The ideal model depends on the needs of borrowers and how the ecosystem evolves over time.

[201] What is SGFinDex. (n.d.). SGFinDex. Retrieved on February 6, 2023, from https://www.sgfindex.gov.sg/whatsnew/index.html

[202] What is SGFinDex. (n.d.). Singpass. Retrieved on February 6, 2023, from https://www.singpass.gov.sg/main/sgfindex/

[203] SGFinDex FAQs. (n.d.). Monetary Authority of Singapore. Retrieved on February 6, 2023, from https://www.mas.gov.sg/-/media/mas/fintech/sgfindex/media/sgfindex---frequently-asked-questions-v7.pdf

[204] These issues include, inter alia, an introduction to SGFinDex; a detailed list of ecosystem participants; a setup process of SGFinDex; details on data protection, data breaches and cyber security; data retrievals; and particulars of consent and consent revocation and its effects on end users.

	SINGAPORE	INDIA
Table 16: Account Aggregator Framework contrasted with Singapore's SGFinDex		
Aim	Enables users to retrieve financial data such as savings, insurance and investments across different government agencies and financial institutions in one consolidated view	Established to enable user empowerment by allowing them more control over their own data
How users connect	Users can connect to SGFinDex via participating institutions' own platforms, i.e., either apps or websites of participating banks, insurers, or MyMoneySense for the government	Users can connect to the framework via independent AA applications or websites; these are separate from participating institutions' own platforms
User authentication	Uses Singapore's National Digital Identity (Singpass) for user authentication	Not linked to national digital identity. Users are authenticated in AA apps by entering a unique identifier (for the FIP to discover user accounts) followed by OTP authentication. The unique identifier can be either a mobile number, PAN, or an FIP Customer ID
Consent	Users need to give consent once every 12 months. Consent is revocable.	Consent is requested separately for each instance. Each consent request specifies the purpose, data requested, the time period, and the frequency of data access for the user to review. Consent given can be modified, renewed, or revoked at any time

Source: Sahamati FAQs; Sahamati website; SGFinDex FAQs; What is SGFinDex, SGFinDex website; Singapore Financial Data Exchange (SGFinDex), Monetary Authority of Singapore website; What is SGFinDex, Singpass website

DPI CHECKLIST

A review of DPIs and their end objectives suggest that DPI conception and implementation, focus on aspects that include both technical and non-technical components. Very often, there is disproportionate focus on the technical design, without enough emphasis on the non-technical components of implementation. Based on our analysis in the case study, we propose a DPI checklist with seven steps that follows a project implementation life cycle from identification of the DPI to impact assessment. The components of the checklist are independent actions and decisions, but often overlap and can be inter-related. We explain them in some detail below.

Figure 80: The DPI checklist
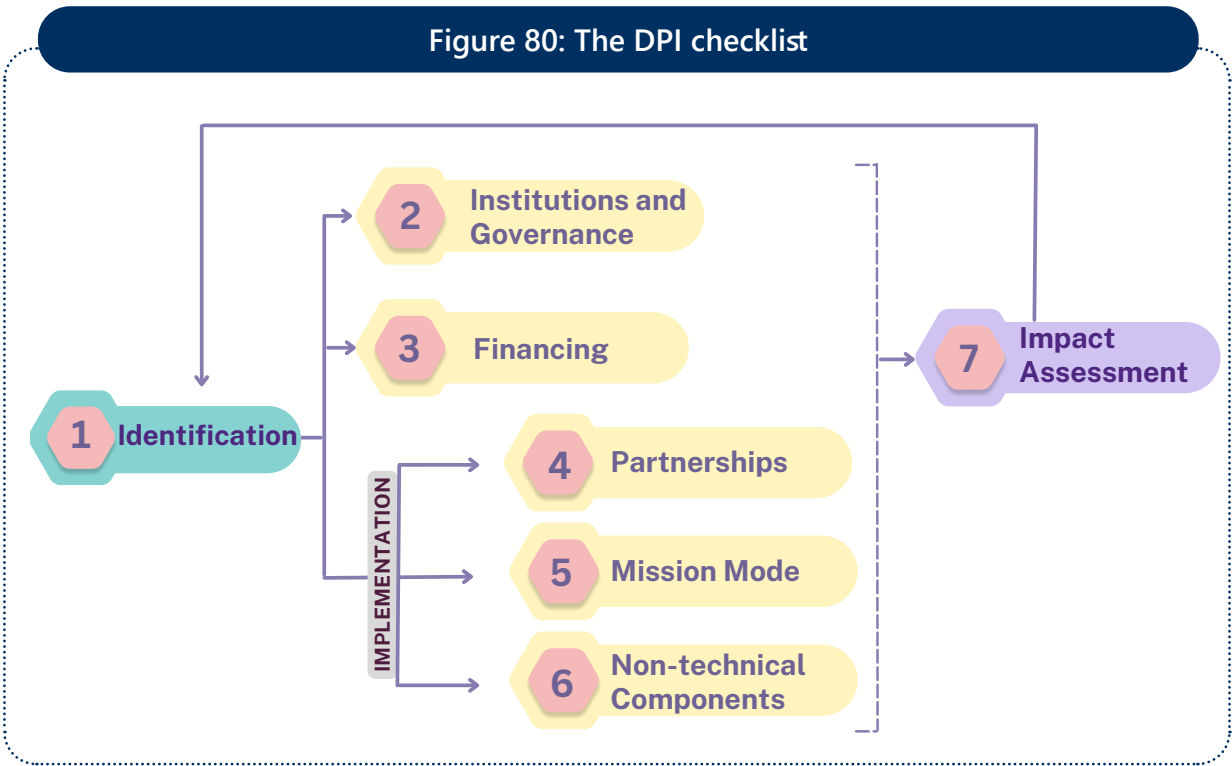
Source: Authors

1) Identification

DPIs are designed to achieve policy outcomes around a particular problem statement. The open and modular nature allows for different components of DPIs or DPIs as a whole to be adopted by countries. However, it is not necessary that DPIs are the only solution to overcome a stated policy issue. A filtering framework can help determine the need for a DPI-based solution, given the available digital infrastructure and resources. If a DPI ought to be used, the nature and scope of the DPI must be clearly identified.

2) Institutions and Governance

Before building and implementing DPIs, it is important to consider the institutions that will build and regulate them as well as the governance framework that will be adopted by the DPI, once it is implemented. This aspect deals with the important question of who owns the DPI. A strong governance

framework is necessary to protect the DPI and its outcomes from the arbitrary influence of select stakeholders. Principles of accountability and transparency embedded in the governance frameworks of DPIs helps build trust and ensure that implementation of the DPI will lead to meaningful outcomes.

3) Financing

Flowing from the ownership and governance design comes the question of financing DPIs. DPIs require high-risk and large-scale financing. Accordingly, actors that can contribute towards building and financing DPIs include the government, private sector in collaboration with the public sector, philanthropic and not-for-profit entities.[205] Creating DPIs is a long-term effort and requires patient capital.[206] Naturally, funders may influence the vision and priorities of DPIs through the development and implementation stages.[207] It is crucial to ensure that the DPIs are designed to maximise gains to the ecosystem and steps should be taken to minimise the influence of funding partners over the DPI design and implementation.

4) Partnerships

The customisation, implementation and deployment of DPIs requires an ecosystem of partners. The lack of ecosystem players can limit the scale and diminish the potential benefits from the implementation of DPIs. Interoperable systems thrive on a strong vendor and participant network. However, a lack of ecosystem players may leave the implementation agency with few alternatives and limit competition. Developing a large diverse pool of partners is crucial to ensure effective implementation. This also means building capacity and capabilities of ecosystem partners along with that of the implementation agency.

5) Mission Mode

DPIs such as aadhaar and UPI with government backing, have traditionally been delivered using 'mission mode' implementation. These DPIs have a clearly defined scope, specific objectives, and a focus on scale and implementation. Many interventions during and after the Covid-19 pandemic were also guided through mission mode implementation programmes. In contrast, some DPIs may be rolled out like most other government schemes, and grow organically without explicit push. The choice of mission mode must be evaluated and a resource kit should be created, describing the essentials of mission mode implementation programmes. Regardless of the modes of implementation, DPIs and DPPs should not compromise on trust for scale. Minimising harm and ensuring effective implementation should be the core priority.

6) Non-technical Components

DPIs and DPPs require more than technology to succeed. Access to connectivity and digital literacy are key for DPI adoption. Until meaningful connectivity is attained at the national-level, DPIs should solve for the problem of divides. For example, DIGIT's offline support through ward volunteers to register citizen

[205] Matthan, R., & Ramann, S. (2022, October 26). Financing digital public infrastructure: The India story. ORF: Digital Frontiers. Retrieved on February 11, 2023, from https://www.orfonline.org/expert-speak/financing-digital-public-infrastructure/

[206] Tyagi, N. (2022). Workshop 2: India to the World: Leading the Agenda on Inclusion through Public Digital Platforms. India Internet Governance Forum 2022, India. Retrieved on February 11, 2023, from https://www.youtube.com/watch?v=9tg6ILfDnY8&feature=youtu.be&ab_channel=IIGF-IndiaInternetGovernanceForum

[207] Singh, A. (2022). Workshop 2: India to the World: Leading the Agenda on Inclusion through Public Digital Platforms. India Internet Governance Forum 2022, India. Retrieved on February 11, 2023, from https://www.youtube.com/watch?v=9tg6ILfDnY8&feature=youtu.be&ab_channel=IIGF-IndiaInternetGovernanceForum

complaints makes the overall system inclusive. This also overlaps with the point on building secure partnerships. Creating awareness on use of DPIs, security and privacy norms, etc. are also important in building scale and preventing the misuse of DPIs.

7) Impact Assessment

Following implementation, it is essential to conduct impact assessments of DPIs. A detailed impact assessment along the lines of the previous six components of the DPI checklist would provide a clear understanding of all components and their effects, and whether the DPI has made progress in achieving its objectives. An impact assessment can help identify gaps in implementation, issues that remain unaddressed, or discover adverse effects that can be remedied by the DPI going forward. This impact assessment should be a periodic exercise and will help DPIs establish accountability, improve service delivery, and gain trust. Impact assessments should in fact be built into the design of the DPI.

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partners-with-indian-institute-for-human-settlements-iihs-to-aid-tamil-nadu-government-in-sanitation-management-mission/

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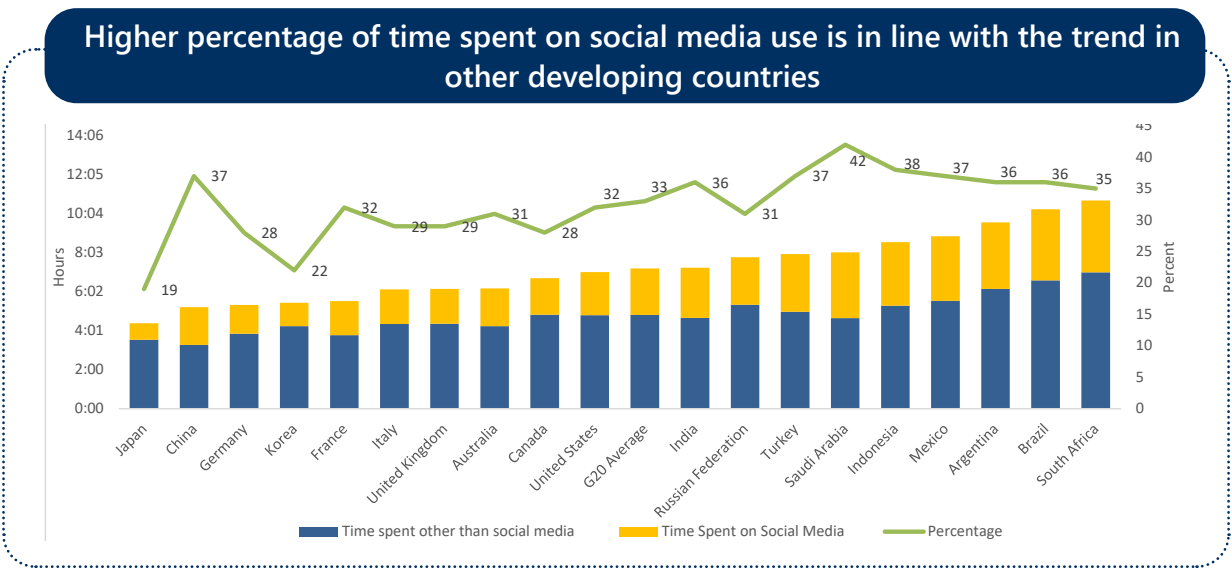
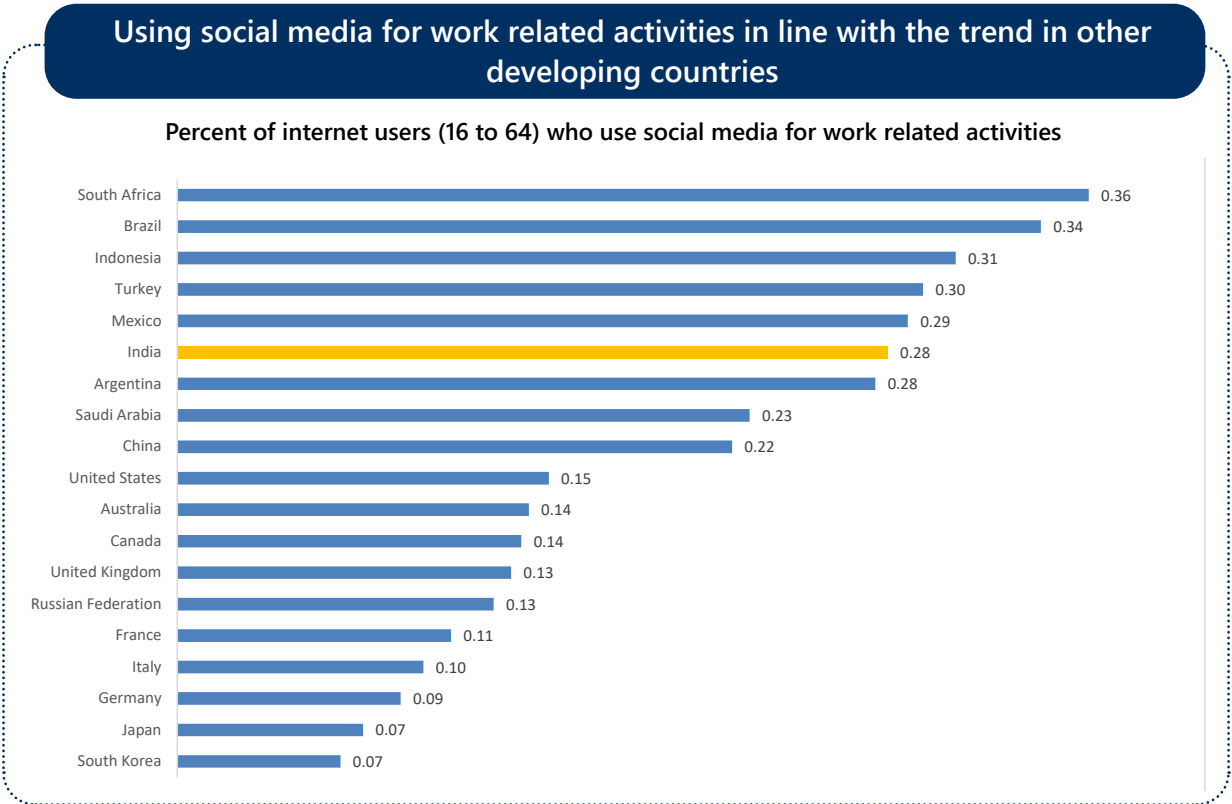YUVAi. Youth for Unnati & Vikas With AI. (n.d.). Ministry of Electronics Information Technology. Retrieved on January 31, 2023 from https://innovateindia.mygov.in/yuvai/

Appendix 1A

Higher percentage of time spent on social media use is in line with the trend in other developing countries

Source: Digital 2022; Global Overview Report Hootsuite

Appendix 1B

Using social media for work related activities in line with the trend in other developing countries

Percent of internet users (16 to 64) who use social media for work related activities

| Country	Value
South Africa	0.36
Brazil	0.34
Indonesia	0.31
Turkey	0.30
Mexico	0.29
India	0.28
Argentina	0.28
Saudi Arabia	0.23
China	0.22
United States	0.15
Australia	0.14
Canada	0.14
United Kingdom	0.13
Russian Federation	0.13
France	0.11
Italy	0.10
Germany	0.09
Japan	0.07
South Korea	0.07

Source: Digital 2022; Global Overview Report Hootsuite

Appendix 2

Cultural norms may have a role in gender disparity among social media users

Gender discrimination in social institutions (SIGI) vs parity in social media use (2019)
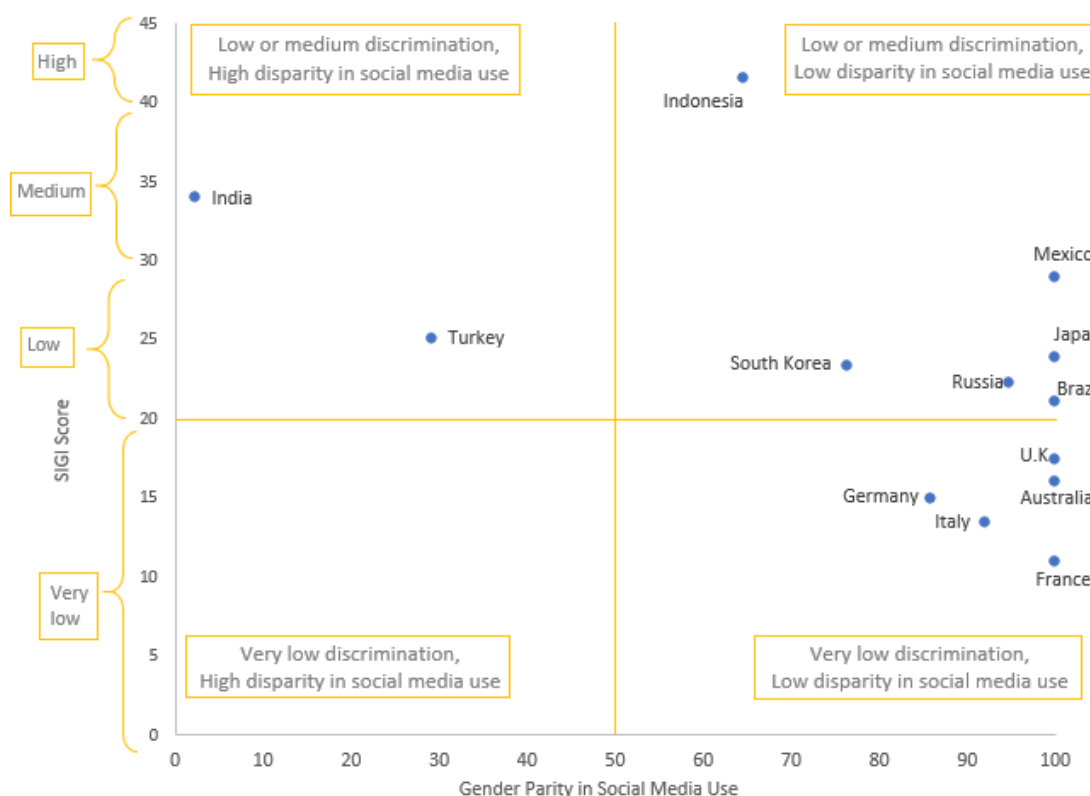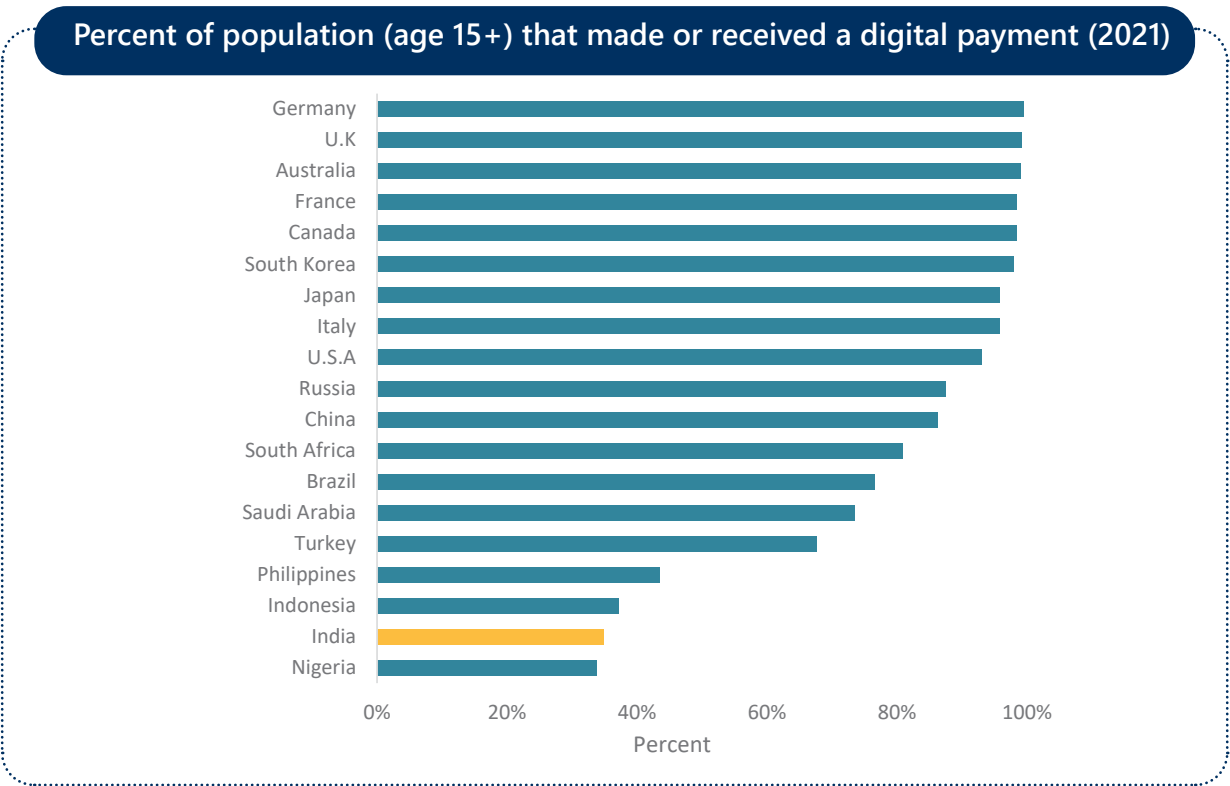

Source: GMSA MCI, 2022; OECD, SIGI 2019 Global Report.

SIGI: The OECD Development Centre's Social Institutions and Gender Index (SIGI) measures discrimination against women in social institutions across 180 countries. By taking into account laws, social norms and practices, the SIGI captures the underlying drivers of gender inequality with the aim to provide the data necessary for transformative policy-change. The SIGI includes 27 variables combined into 16 indicators and 4 dimensions. Higher SIGI Scores mean more inequality.

The SIGI ranges from 0%, indicating no discrimination, to 100%, indicating absolute discrimination. The SIGI score presents a summary measure of the institutional gaps between women and men in a given country. A value of zero represents the goal to achieve the elimination of all forms of gender discrimination, and the distance from zero indicates the extent of gender discrimination. In other words, the SIGI score for a given country simply reflects the percentage of parity this country has left to achieve.

But the report classifies Distribution of the 120 countries ranked in the SIGI 2019 according to their level of gender-based discrimination in social institutions: very low (SIGI < 20%), low (20% < SIGI < 30%), medium (30% < SIGI < 40%), high (40% < SIGI < 50%) and very high (SIGI > 50%).
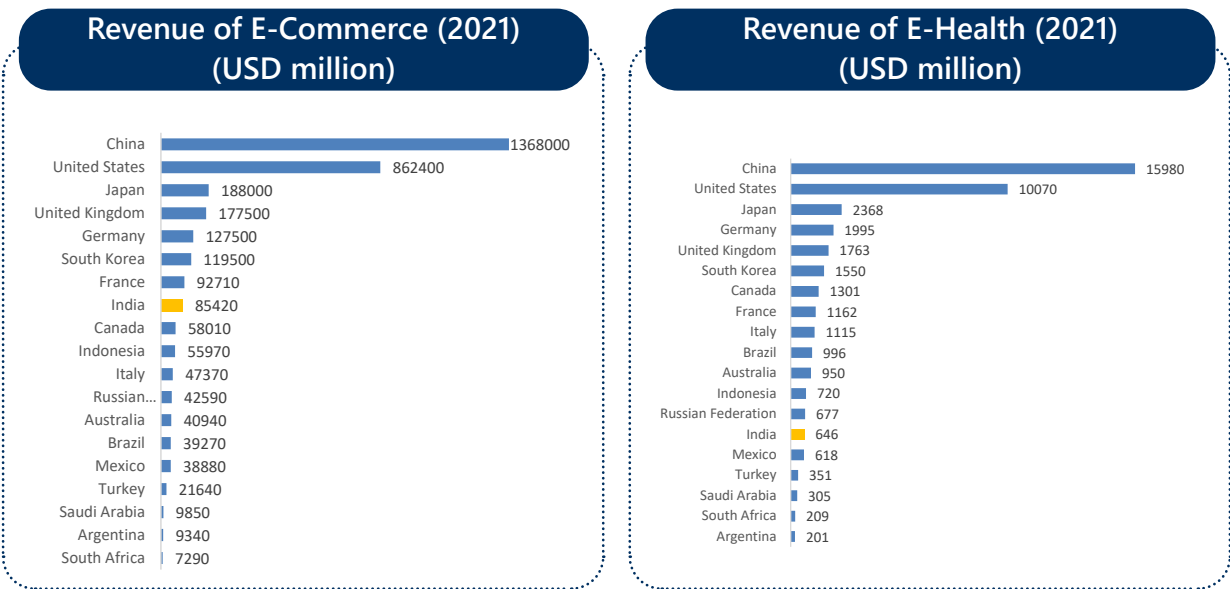
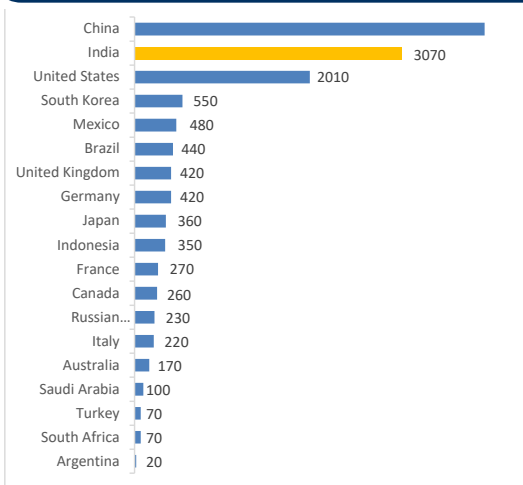*GSMA: The 2019 indicator has been used from the 2020 to make it at par with the SIGI 2019 index.*
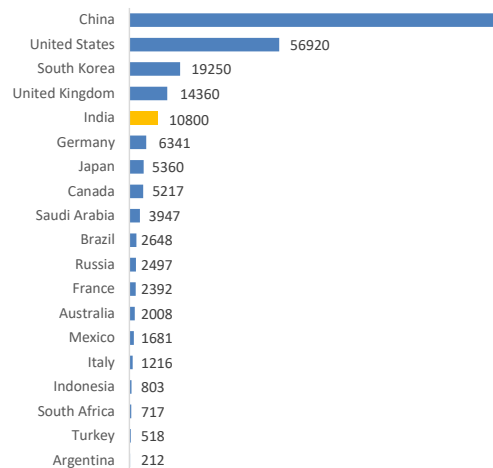
Appendix 3

Percent of population (age 15+) that made or received a digital payment (2021)

Country	Percent
Germany	
U.K	
Australia	
France	
Canada	
South Korea	
Japan	
Italy	
U.S.A	
Russia	
China	
South Africa	
Brazil	
Saudi Arabia	
Turkey	
Philippines	
Indonesia	
India	
Nigeria	

Percent

Source: World Bank Findex Database (2021)

Appendix 4

Revenue of E-Commerce (2021) (USD million)

Country	Value
China	1368000
United States	862400
Japan	188000
United Kingdom	177500
Germany	127500
South Korea	119500
France	92710
India	85420
Canada	58010
Indonesia	55970
Italy	47370
Russian...	42590
Australia	40940
Brazil	39270
Mexico	38880
Turkey	21640
Saudi Arabia	9850
Argentina	9340
South Africa	7290

Revenue of E-Health (2021) (USD million)

Country	Value
China	15980
United States	10070
Japan	2368
Germany	1995
United Kingdom	1763
South Korea	1550
Canada	1301
France	1162
Italy	1115
Brazil	996
Australia	950
Indonesia	720
Russian Federation	677
India	646
Mexico	618
Turkey	351
Saudi Arabia	305
South Africa	209
Argentina	201

Revenue of Online Learning Platforms (2021) (USD million)

Country	Value
China	
India	3070
United States	2010
South Korea	550
Mexico	480
Brazil	440
United Kingdom	420
Germany	420
Japan	360
Indonesia	350
France	270
Canada	260
Russian...	230
Italy	220
Australia	170
Saudi Arabia	100
Turkey	70
South Africa	70
Argentina	20

Revenue of Online Food Delivery (2021) (USD million)

Country	Value
China	
United States	56920
South Korea	19250
United Kingdom	14360
India	10800
Germany	6341
Japan	5360
Canada	5217
Saudi Arabia	3947
Brazil	2648
Russia	2497
France	2392
Australia	2008
Mexico	1681
Italy	1216
Indonesia	803
South Africa	717
Turkey	518
Argentina	212

Source: Statista (2021)

Appendix 5

Device affordability and internet penetration in India have improved significantly in the past five years
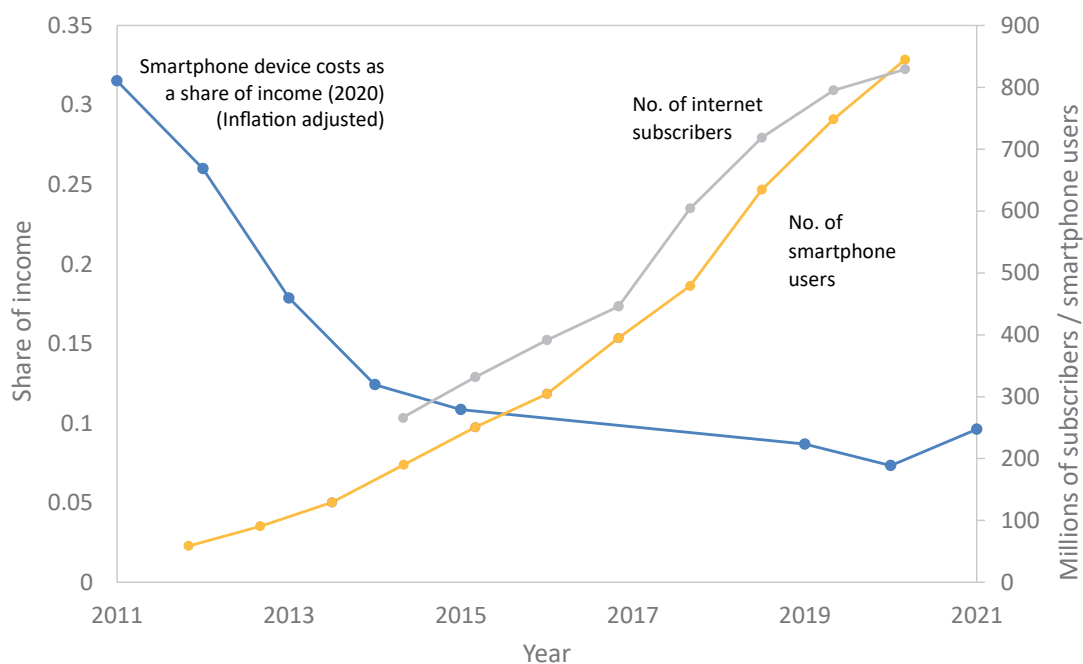
Source: Smartphone device costs and income are inflation adjusted. Internet subscribers are from TRAI Performance Indicator Reports. Smartphone users was from Statista Key Market Indicators. Smartphone device costs data was taken from Statista, and originally from IDC. CPI is from World Bank, exchange rates from RBI, and income per capita at current prices from MoSPI.

Statista estimates of smartphone users in 2021 of 844.84 million in 2021 is significantly higher than estimates from others sources such as Newzoo (492.78 million). The primary purpose of this chart is to show the increasing trend in smartphone users alongside the fall in device prices.
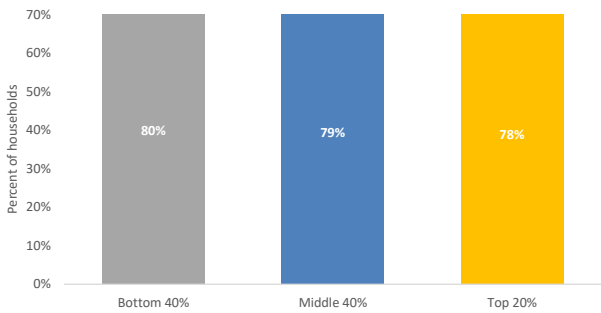
Appendix 6

Low-income households are less likely to use digital payments. Amongst those who do, low income households are similarly likely to use payment apps but less likely to use debit cards, credit cards or bank apps.
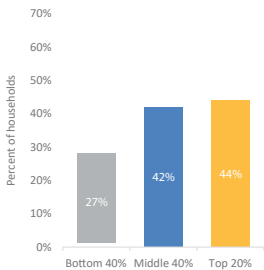
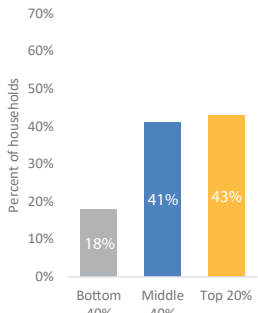**Percent of households using digital payments by income group**

Income Groups

- Top 20% — 49%
- Middle 40% — 34%
- Bottom 40% — 24%

Paytm, PhonePe type apps

Percent of households

- Bottom 40% — 80%
- Middle 40% — 79%
- Top 20% — 78%
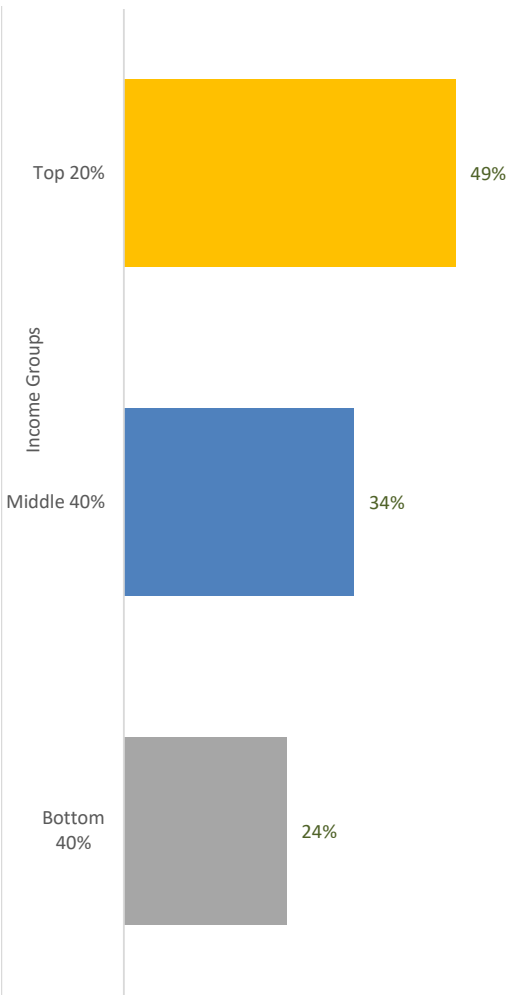
Online shopping using credit or debit card

Percent of households

- Bottom 40% — 27%
- Middle 40% — 42%
- Top 20% — 44%

Use Bank App

Percent of households

- Bottom 40% — 18%
- Middle 40% — 41%
- Top 20% — 43%

Source: NPCI, 2020. Digital Payments Adoption in India

Appendix 7: Web Presence of Businesses


Percent of businesses with web presence
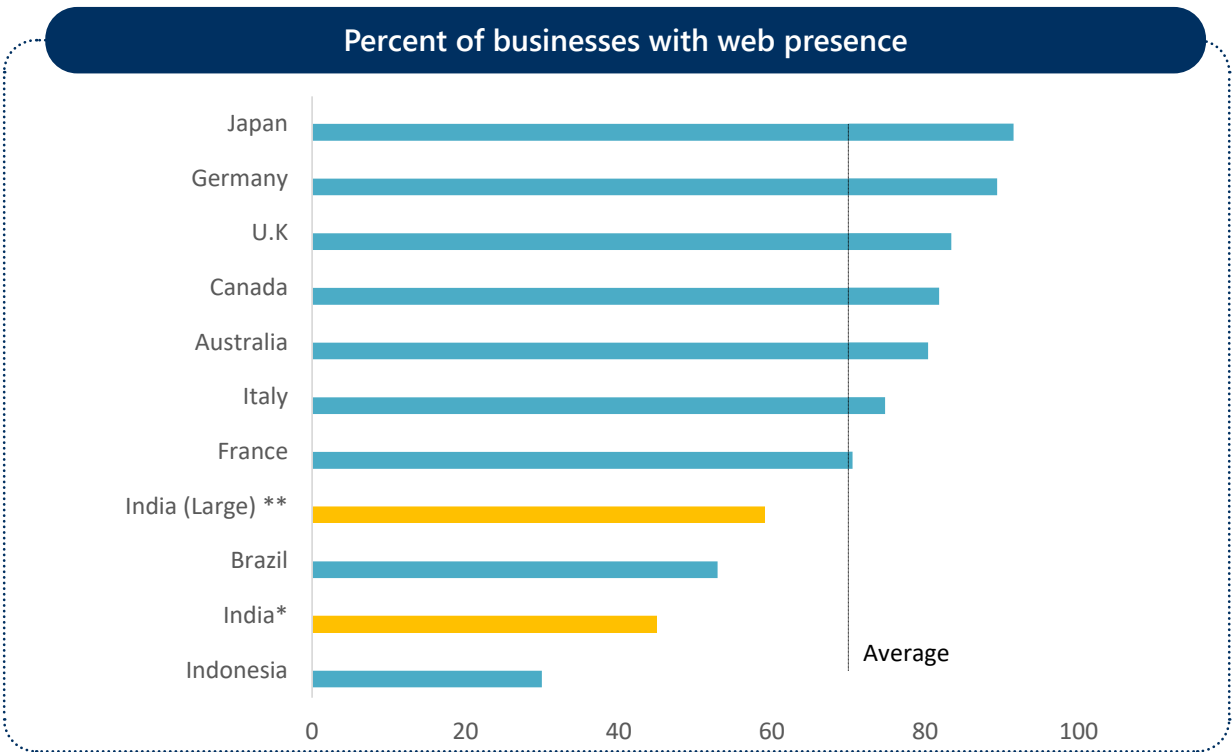
Source: OECD digital toolkit 2020 and 2021. IMRB Kantar ITOPS 2021 for India.

Share of businesses with a web presence includes operating a website or home page, or having presence on another entity's website over which the business has control. The sample is firms with 10 people or more. The value for India, however, is for percent of businesses with a website. The Indian sample consists only of firms outside the household with a fixed structure (electric meter connection and separate brick and mortar structure for the business).

* The value for India is for businesses with either a website or social media presence. ** The value for India (Large) is for businesses with a website, for firms with 250+ employees in 2021. The vertical line represents the average of the countries represented.

Appendix 8: Web Presence of Businesses

Percentage of businesses with websites

Source: OECD.stat, IMRB

Percentage of businesses using social media
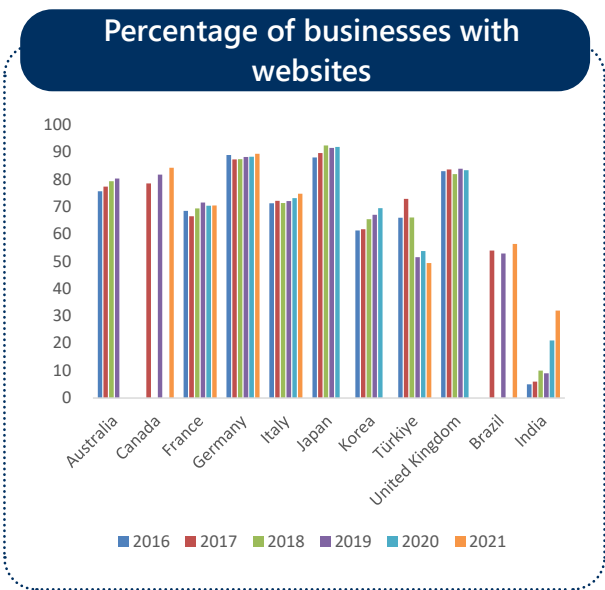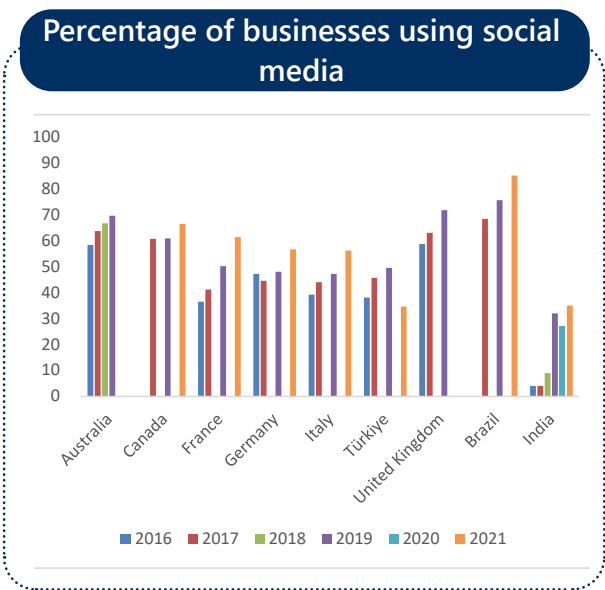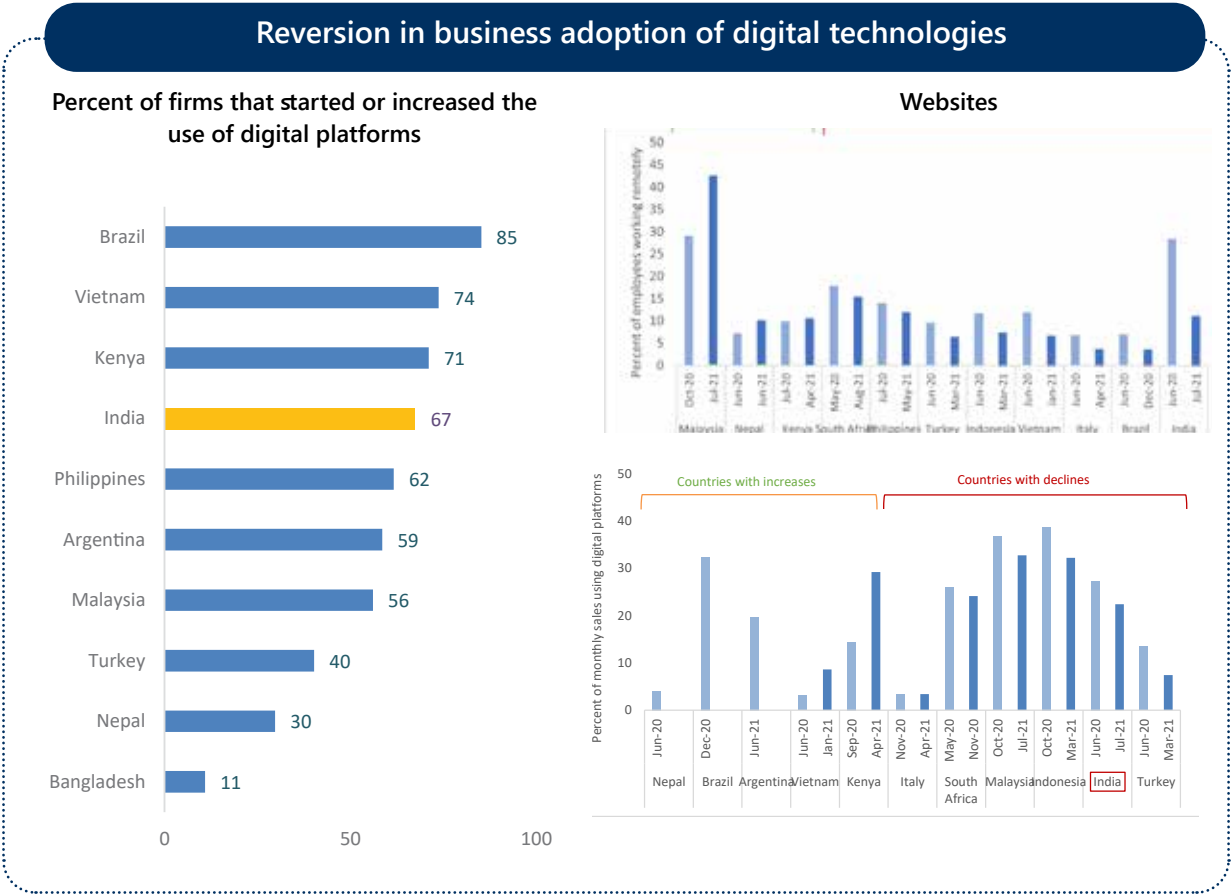
Source: OECD.stat, IMRB

Appendix 9

Divides by size in internet access have narrowed over time but divides in its use have widened with larger firms having more rapid increases in adoption recently. Online selling, online marketing, websites saw rapid rises during the pandemic, generally more so for larger firms and those in the services sector.
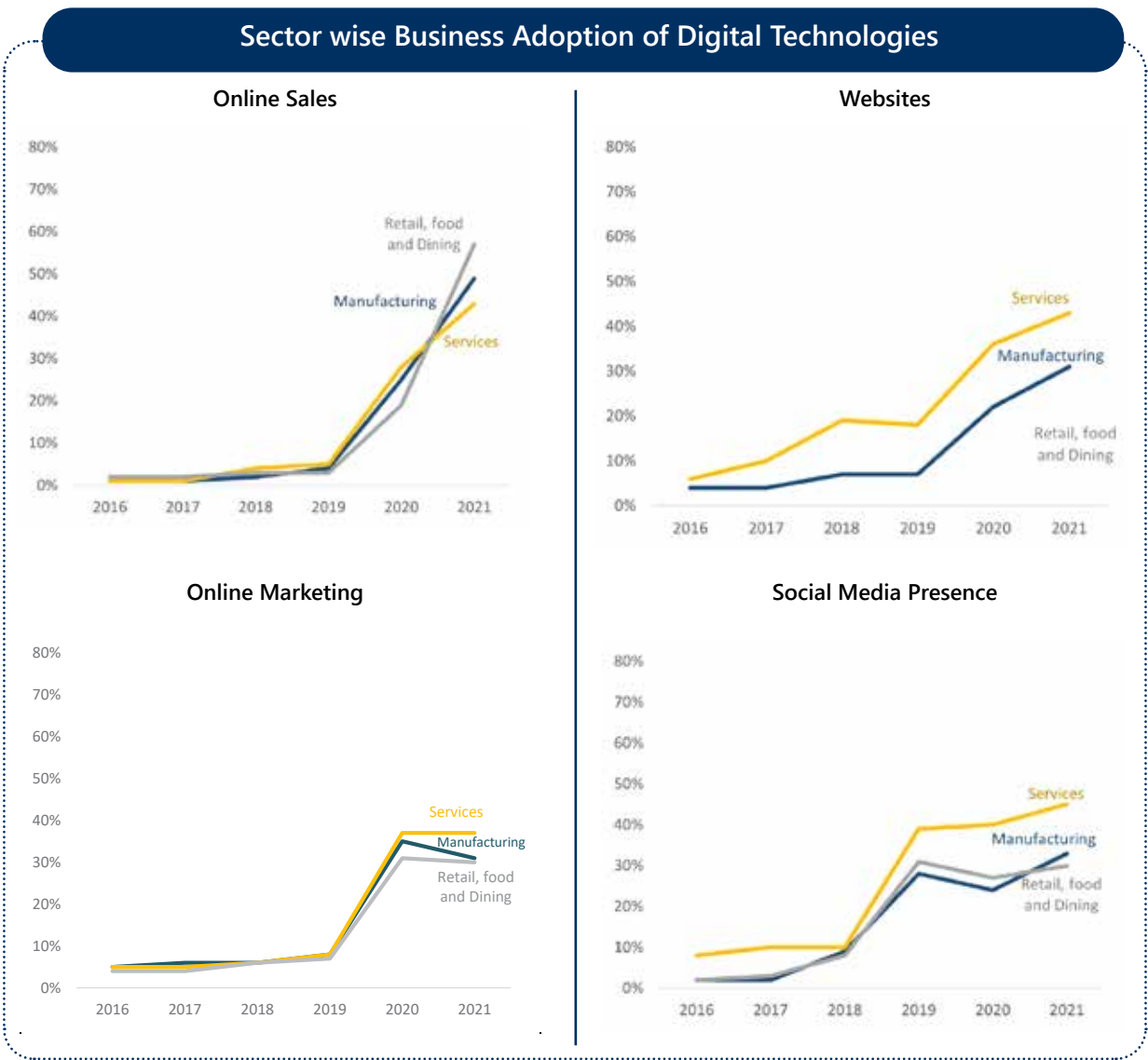
Social media presence: having a business page on social media sites. Source: IMRB, ITOPS 2021. Sample consists only of firms outside the household with a fixed structure (electric meter connection and separate brick and mortar structure for the business).
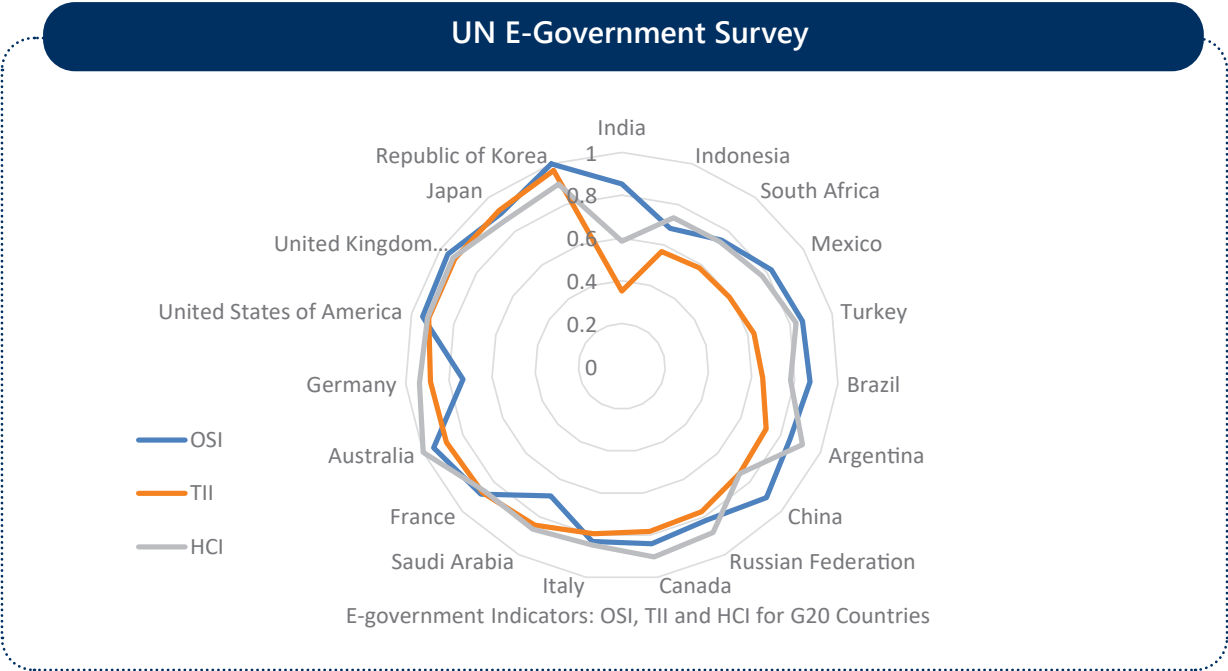
Appendix 10

Reversion in business adoption of digital technologies

Percent of firms that started or increased the use of digital platforms

Country	Value
Brazil	85
Vietnam	74
Kenya	71
India	67
Philippines	62
Argentina	59
Malaysia	56
Turkey	40
Nepal	30
Bangladesh	11

Websites

Latest available data for each country: Brazil (Dec 2020), Vietnam (Jan 2021), Kenya (April 2021), India (July 2021), Philippines (May 2021), Argentina (June 2021), Malaysia (July 2021), Turkey (March 2021), Nepal (June 2020).

Countries are ordered from left to right in terms of percent change between the two time periods. India has the largest decline in average percent of employees working remotely and the second largest decline in average percent of monthly sales using digital platforms.

Source: World Bank Business Pulse Surveys. Only formal firms are included in the sampling frame and these indicators does not include micro firms (>5 workers).

While the pandemic pushed adoption of digital technologies by businesses, there are signs of reversion in terms of the intensity of use in India as well as other countries.
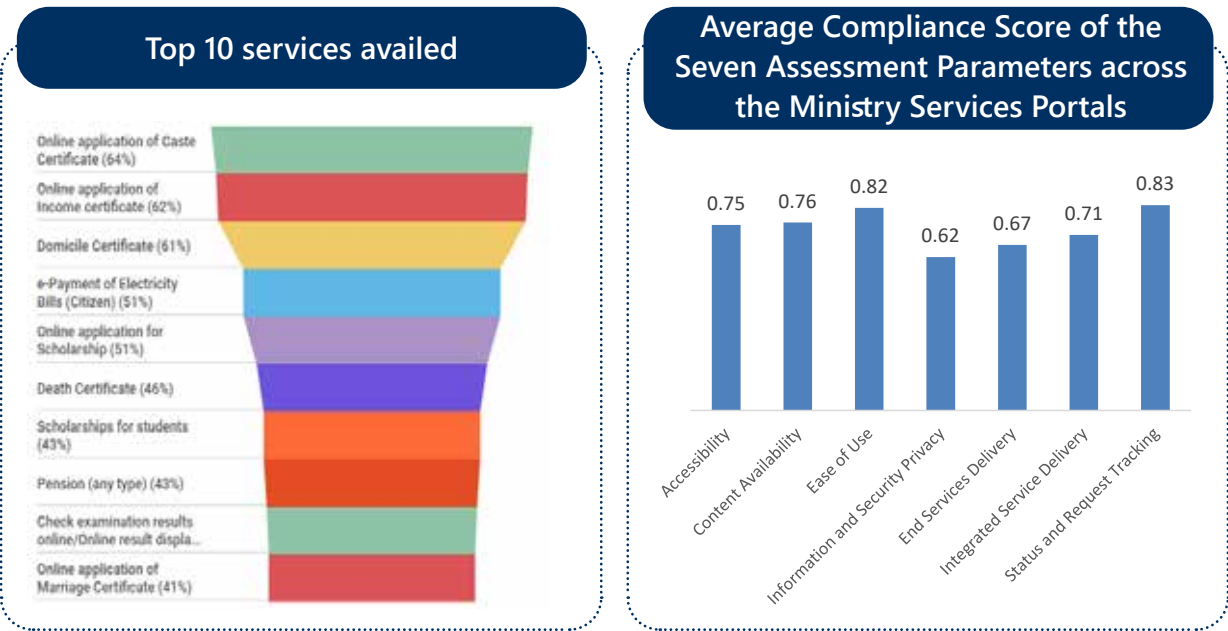
Appendix 11

UN E-Government Survey

E-government Indicators: OSI, TII and HCI for G20 Countries

Legend: OSI, TII, HCI

Source: UN E-Government Survey 2020

India, although has performed poorly in terms of Infrastructure, represented by TII, and Human Capital represented by HII, it fares well in terms of online service index (OSI) which indicates good adoption of online government services.
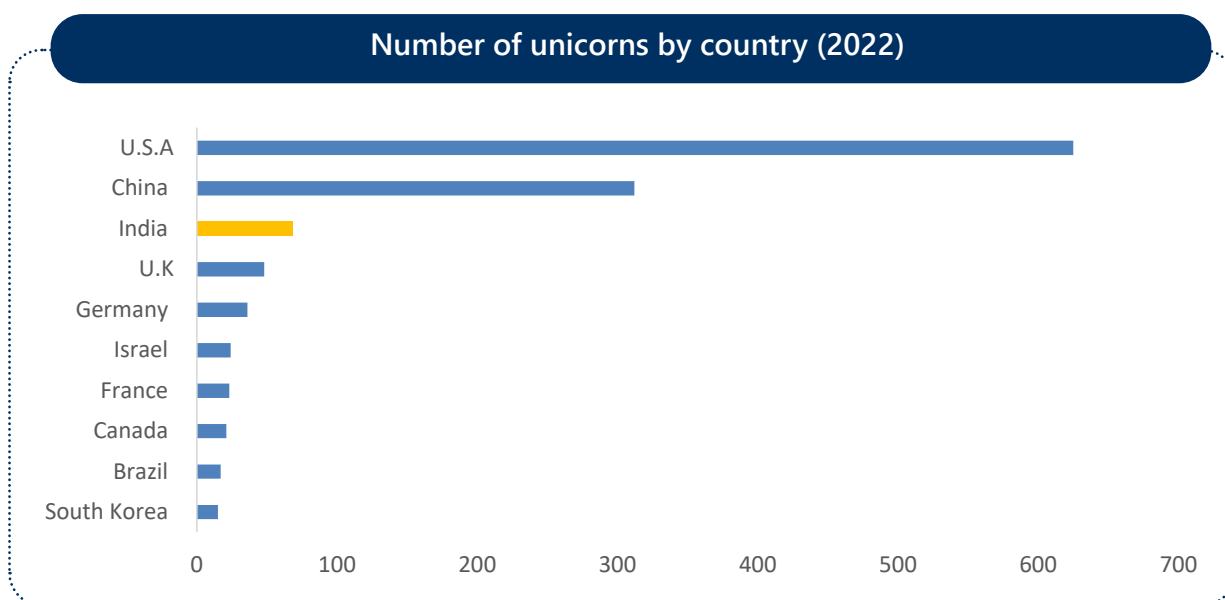
Appendix 12

Top 10 services availed

- Online application of Caste Certificate (64%)
- Online application of Income certificate (62%)
- Domicile Certificate (61%)
- e-Payment of Electricity Bills (Citizen) (51%)
- Online application for Scholarship (51%)
- Death Certificate (46%)
- Scholarships for students (43%)
- Pension (any type) (43%)
- Check examination results online/Online result displa...
- Online application of Marriage Certificate (41%)

Average Compliance Score of the Seven Assessment Parameters across the Ministry Services Portals

Parameter	Score
Accessibility	0.75
Content Availability	0.76
Ease of Use	0.82
Information and Security Privacy	0.62
End Services Delivery	0.67
Integrated Service Delivery	0.71
Status and Request Tracking	0.83

Source: NeSDA, 2021

EGov services caters to basic requirements like online application and access of certificates, which require low skills and are adopted due to ease of use of government portals. High performance in areas like ease of use, content availability and status and request tracking contribute to high rank of OSI.

Appendix 13

Number of unicorns by country (2022)

Horizontal bar chart showing number of unicorns by country: U.S.A (~625), China (~315), India (~70), U.K (~45), Germany (~35), Israel (~25), France (~25), Canada (~22), Brazil (~18), South Korea (~15). X-axis ranges from 0 to 700.

Source: Times of India (Original Source: HURUN). Number of new unicorns-startups, valued at $1 billion or more as of mid-2022.
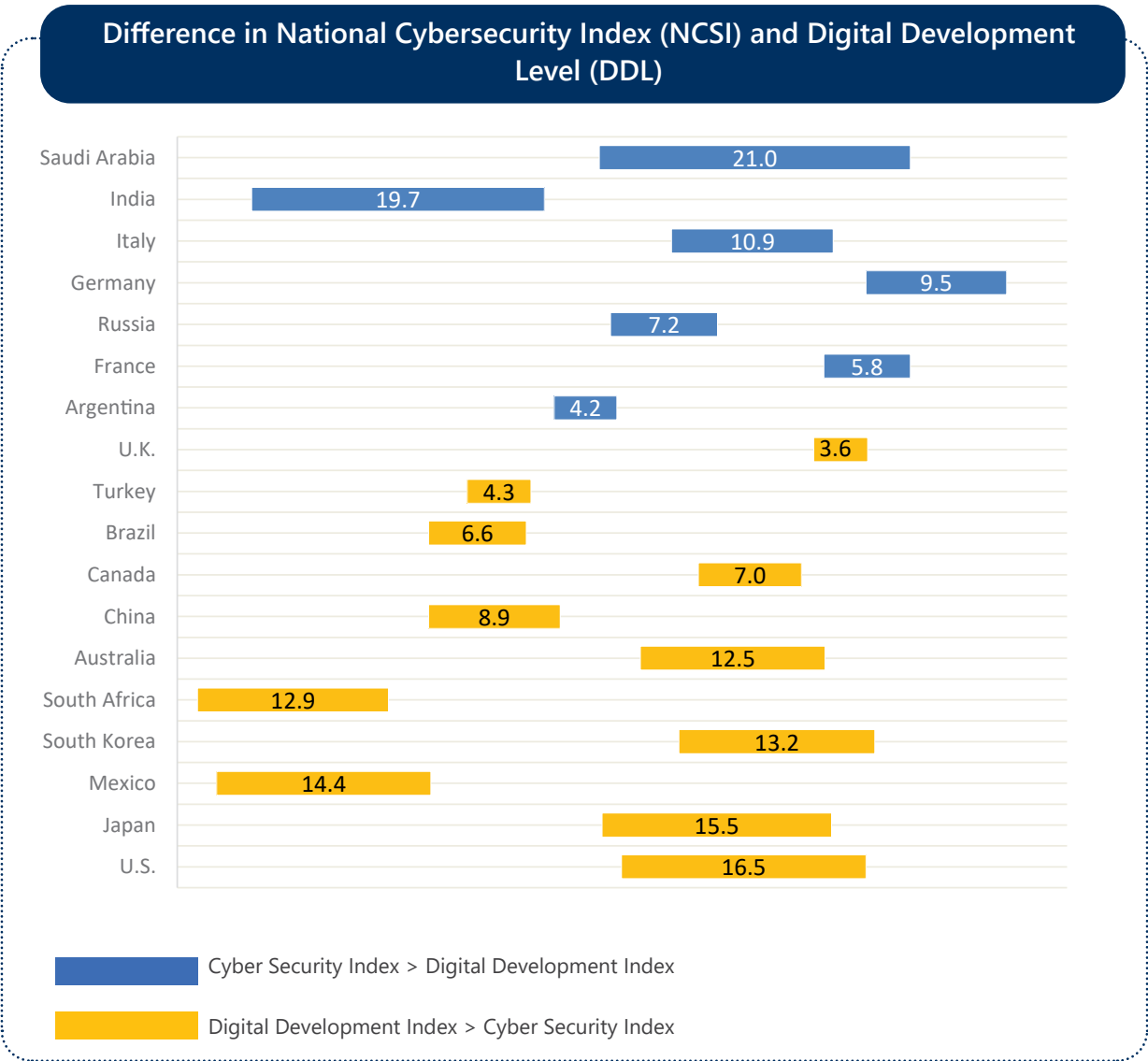
*From April to December 2022, VC and PE (private equity) funding to India's startup ecosystem fell nearly 50% year on year to $29.2 billion. Between April and December 2021, PE/VC investors invested approximately $58.9 billion in the country's startup ecosystem, making it the world's third-largest. https://www.moneycontrol.com/news/business/new-unicorns-halve-in-2022-as-startup-ecosystem-faces-funding-winter-9764811.html *

The number of late-stage investments (Series C onwards), when unicorns typically get minted, has decreased significantly in 2022, as some of the nation's most active late-stage investors have scaled back their capital allocation. According to Tracxn, compared to $43 billion in 2021, late-stage investments to India's startup ecosystem fell to just under $25 billion in 2022. However, it should be noted that three of India's largest funding rounds—VerSe Innovation ($805 million), the parent company of DailyHunt, Byju ($800 million), and Swiggy ($700 million)—took place in the first three months of the year. Late-stage PE/VC funding decreased from nearly $38 billion in 2021 to $14.9 billion in 2022, with the first three months of 2022 excluded. https://www.moneycontrol.com/news/business/new-unicorns-halve-in-2022-as-startup-ecosystem-faces-funding-winter-9764811.html

In India, the amount of funding received through venture capital and private equity flow has risen from ₹4 billion to ₹1,327 billion in the last two decades (Nuthalapati & Singh, 2019).

https://www.niti.gov.in/sites/default/files/2022-07/India-Innovation-Index-2021-Web-Version_21_7_22.pdf

Appendix 14

Difference in National Cybersecurity Index (NCSI) and Digital Development Level (DDL)

Country	Value
Saudi Arabia	21.0
India	19.7
Italy	10.9
Germany	9.5
Russia	7.2
France	5.8
Argentina	4.2
U.K.	3.6
Turkey	4.3
Brazil	6.6
Canada	7.0
China	8.9
Australia	12.5
South Africa	12.9
South Korea	13.2
Mexico	14.4
Japan	15.5
U.S.	16.5

Legend:
- Cyber Security Index > Digital Development Index
- Digital Development Index > Cyber Security Index

Source: National Cybersecurity Index

The bars show difference between the NCSI (National Cybersecurity Index) score and DDL (Digital Development Level). A positive result shows that the country's cyber security development is in accordance with, or ahead of, its digital development. A negative result shows, that the country's digital society is more advanced than the national cyber security area.

- *India has a positive difference, indicating that its cyber security development is in accordance with or ahead of, its digital development.*
- *Negative differences suggest that the country's digital development is more advanced than cyber security area.*

The DDL is calculated according to the ICT Development Index (IDI) and Networked Readiness Index (NRI)

Appendix 15

Number of data breaches in Q1 2021
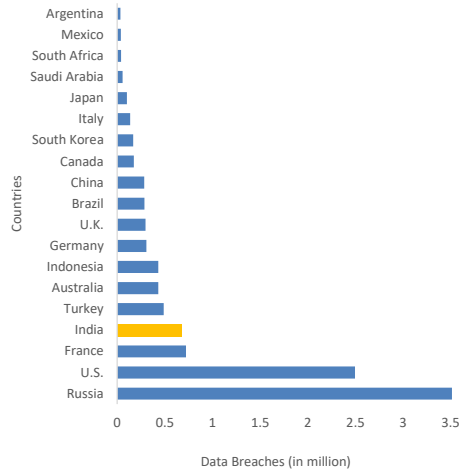
Source: Surfshark, 2022

As per the Surfshark website, in the domain of information security, data breach is defined as a phenomenon in which data is accessed or held by some third party including a person or a company. Data is accessed, viewed and potentially stolen by unauthorized third parties. For the purpose of the analysis, it meant that the intruder copied and leaked user data such as names, surnames, email addresses, passwords and so on. It also includes instances like telephone phishing attacks seeking to lure out credit card details, attacking exposed accounts and so on.

Number of cybercrimes related to data theft
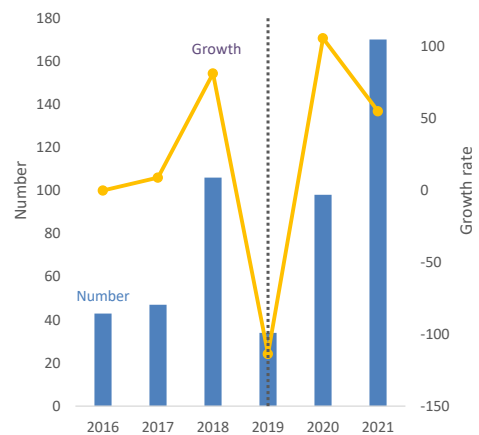
Source: Statista; NCRB (India); EY; FICCI; 2016 to 2021.

The statistics on cybercrimes are collected under the following heads:

i) Offences registered under the Information Technology Act, 2000.

ii) Offences under the IPC related to cyber crimes

iii) Offences under the Special and Local Laws (SLL) related to cyber crimes

Inflection in growth rates and number both in 2019. trends bounce back very quickly within 3 years. Both growth rates and actual numbers

Appendix 16

Women per lakh that have been victims of Cybercrimes against women (2021)
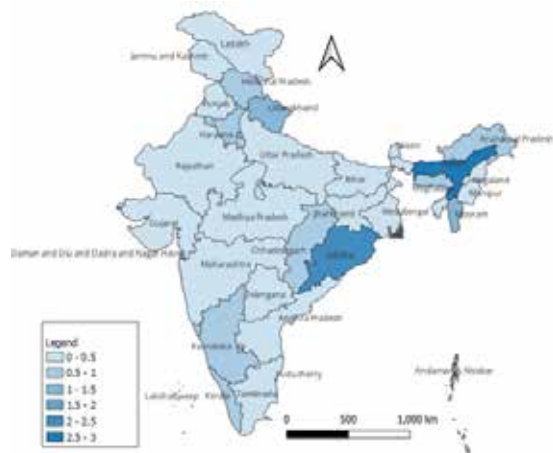
Source: NCRB

Children per lakh that have been victims of cyber-crimes against children (2021)
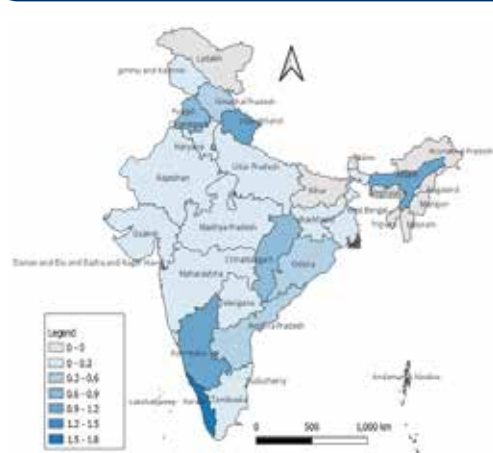
Appendix 17

Rising vulnerability to cyberattacks in the healthcare sector (2020-22)

Time Period: June 2020 - June 2022

Country	Value
US	240
France	34
Italy	15
Canada	14
Germany	13
India	11
Brazil	11
Australia	10
Japan	9
UK	7
South Africa	3
Turkey	2
Mexico	2
South Korea	1
China	1
Russia	1

Data on Argentina, Indonesia, EU and Saudi Arabia was not available.

Source: Cyber Incident Tracer (CIT) of Cyber Peace Institute. https://cit.cyberpeaceinstitute.org/explore

Appendix 18

State wise access to computer facilities in schools (2022)

Percent of government schools with functional computer facilities
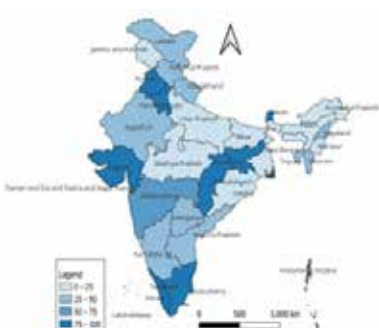
Percent of government aided schools with functional computer facilities
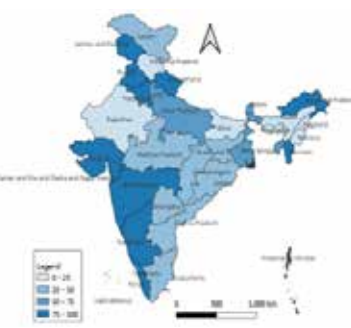
Percent of private unaided schools with functional computer facilities
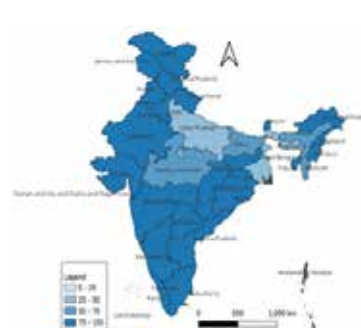
Source: UDISE+ 2020-21 Report.

Appendix 19

State wise adoption of digital technologies in police stations (2022)

Percent of police stations using search & query of CCTNS
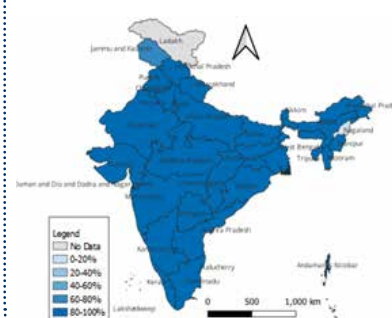
Percent of Police Stations generating reports through CCTNS
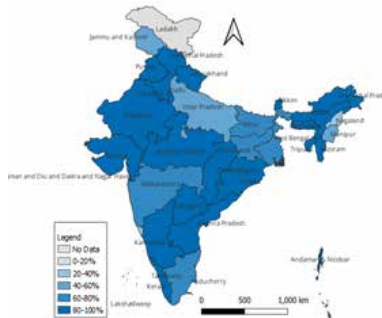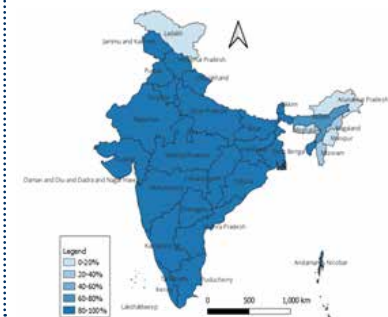
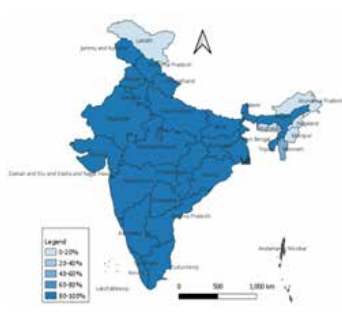**Percent of Police Stations generating reports through CCTNS**
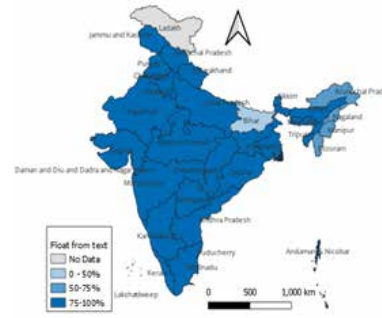
Source: CCTNS Pragati Dashboard, 2022

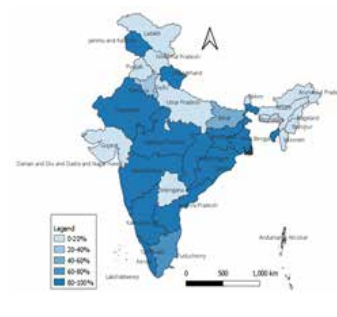## State wise adoption of digital technologies in Sub-Registrar's Offices (Land Records) (2022)

Percent of villages where computerization of land records is complete

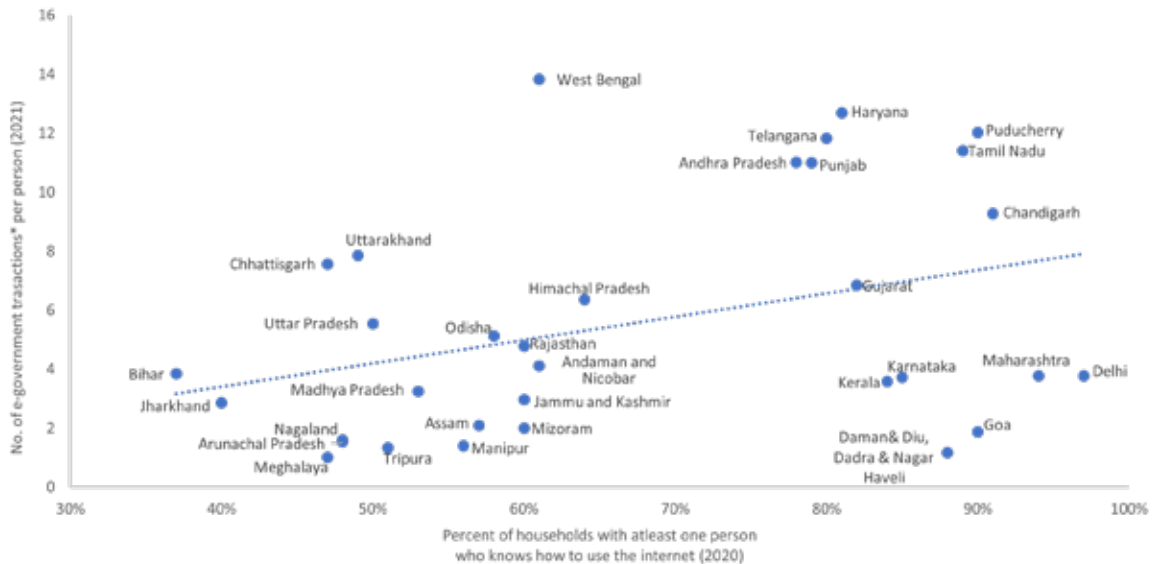**Percent of Record of Rights Distributed through CSCs, Kiosks, online etc.**

Percent of Sub-Registrar's Offices that have Online Payment

Source: Digital India Land Records Modernization Programme (DILRMP-MIS 2.0) Database, 2022

Appendix 20

Digital literacy and e-government transactions per person

Source: e-Taal Dashboards, NeSDA 2019 Report, IMRB Kantar 2020 ICUBE report

Transactions between Jan 1, 2021 and Jan 1, 2022, performed through e-Governance applications, including national-level mission mode projects (MMPs) under the National e-Governance Plan (NeGP) as aggregated and reported on the e-Taal platform (Electronic Transaction Aggregation & Analysis Layer).

IPCIDE Team
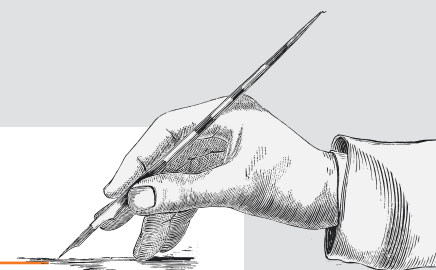
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