Digital infrastructure

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This edition of the State of Finance in India report has India's digital economy and its impact as its special theme. The term 'infrastructure' conjures up images of large projects made of steel and concrete, to provide services varying from those offered by dams and power plants to those offered by roads, highways, ports and airports. But in recent years, the term 'digital infrastructure', has attracted much attention. While leveraging the hardware residing in traditional infrastructure, especially telecommunications facilities, the digital infrastructure frame is built largely with 'lighter' hardware and mainly with software that digitizes information and manipulates it to realise desired ends.

The technological components that fall within the ambit of digital infrastructure are in the nature of digital technologies, which have the ability to transform operations in preexisting sectors and industries as well as provide opportunities for the emergence of new sectors and industries. Their deployment therefore alters the way in which production, work, distribution and marketing are organized in a range of areas. In the process, they restructure economic activity in ways that raise productivity and facilitate investment and growth. This also has consequences that can intensify existing sectoral, class and gender inequalities. In some areas, that transformation can be positive. But the case that digitization is only positive and delivers increases in productivity and output through means that are clean and environmentally friendly leaves much that is unsaid. These are some of the issues examined in the report.

India has seen rapid advance of its digital infrastructure framework, assisted in its early growth by the nationwide telecommunications backbone created within the public sector. The National Telecom Policy of 1994 opened the doors to private players as a means of expanding the telecommunications network. Private participation in the wireless telephony area was allowed through auction of parcels of scarce spectrum. Sensing an opportunity, private players made bids of excessively high value based on irrational calculations of profit. When it became clear that these sunk costs could not be easily recouped, some who had established capacity incurred losses and had to exit, and others who held licences but had not installed capacity chose to sell those licences for profit.

Initially, exploiting their oligopolistic position deriving from their control over scarce spectrum, bidders turned operators set call charges at exceptionally high levels. Yet, the regulator did not intervene to rein in prices. Rather, it was argued that ensuring competition by bringing in private players involved a cost that the consumer had to bear. Needless to say, this did not work, because the subscriber base remained low. When repeated auctions of tranches of spectrum were initiated, the number of providers, capacities and competition increased, forcing prices down in the search for a subscriber base. With lower prices, the telecom service providers of that period discovered that they could not operate profitably if they were actually required to pay the amounts they had bid to obtain their licences. At that point, the government lent a helping hand. It allowed incumbent and new operators to migrate to a revenue sharing regime. away from the one based on a specific licence fee, allowing them to turn a profit.

But that was help too little and too late for many operators. The industry went through repeated "shakeouts" that have reduced the number of operators to essentially three—

Airtel, Vodafone-Idea and Reliance Jio. Expansion to acquire and/or retain market share has required large resources, even as competition to woo subscribers has kept the average revenue per user extremely low. The result has been a long-term squeeze on margins. That trend was aggravated by the aggressive price war launched by late entrant Jio, which left the main competitors bleeding and steeped in debt. The result has been consolidation of an oligopoly in which public sector BSNL and MTNL have become marginal players. The trend to concentration was facilitated by repeated changes in the terms and tenure of licencing arrangements, involving implicit or explicit transfers to private firms to keep them in operation. In this way, the government as part of its programme of liberalization and reform not only transferred an industry that was earlier a government monopoly over to the private sector but also facilitated oligopolization of the digital infrastructure space. However, the government still remains crucial in providing both hardware support through public data communication networks and national data centres, which host the information needed for establishing nationwide digital networking, and the software systems such as the digital "unique" identity system Aadhaar and the public Unified Payment Interface (UPI) system.

Meanwhile, the low call and data costs and government programmes like Aadhaar and the UPI have resulted in a huge increase in the degree of digitization, albeit with the persistence of a significant digital divide. The number of mobile subscribers in India is estimated by the Telecom Regulatory Authority of India at around 1.15 billion in December 2024, including many people with multiple subscriptions. With smart phone costs in decline, the spread of mobile use has been accompanied by an increase in mobile based internet access. About a billion users are estimated by *Statista* to have accessed the internet via their mobile phones. In the event, internet penetration rate in India is estimated to have risen from about 14 per cent in 2014 to 52 per cent in 2024. Utilisation of the digital infrastructure has also been increasing. As of 2023, the average data consumption per user per month in India was estimated at 24.1 gigabytes, with e-commerce, online education, and higher OTT viewership contributing to the growth in data traffic. This was partly because, even by March 2021, broadband data costs in India had fallen to $0.68 per gigabyte (GB) of data, well below the global average of $4.21.

Externalities

The infrastructure sector is by nature one that contains facilities with large economy-wide externalities. Operations in a host of economic sectors are not just facilitated by the availability of infrastructural facilities such as power plants, roads and ports, but simply would not occur without them. Infrastructural support is therefore seen as crucial for output growth and productivity increase across the economy. In the case of digital infrastructure, its external effects are realized not just by the restructuring of productive activity to benefit from the myriad ways in which the technology can displace labour and increase productivity, but also by altering the ways in which the markets for products, services and labour are organized.

The base that this digital infrastructure provides has been leveraged to digitally offer e-commerce, educational and health services, for example, and launch a host of other means to deliver public services and manage and route payments to public programmes. The evidence points to phenomenal rates of expansion of the sector.

Among the many consequences of the Covid pandemic, one that is widely recognised is the accelerated expansion of, and increased dependence on, certain kinds of information

technology (IT)-enabled services. IT-enabled operations that were earlier restricted to specialised services performed by companies exploiting the benefits of digital communication to undertake remote delivery, were extended across a wide array of digital platforms offering a range of services to individual and business in areas varying from ecommerce to social media, entertainment and care. Some, like ride hailing services such as Uber and Lyft (besides national versions like Ola in India) and delivery services such as Amazon and DoorDash (and Zomato that originated in India and has spread its tentacles abroad), are ubiquitous.

E-commerce is one obvious example, where the transformation of markets, especially retail markets has been remarkable. The market value of the e-commerce industry in India was 125 billion U.S dollars in 2024. And by 2025, the number of annual online shoppers in India was estimated to have increased to approximately 280 million from 205 million in 2022. The expansion was partly the result of the government's decision to allow 100 per cent foreign owned FDI in the sector, triggering the entry of global majors who sense the market potential in the country.

Meanwhile, the 'fintech' business, consisting of firms that use technology as a base for financial innovation leading to new processes, practices and products in financial markets, received a boost. According to the *State of Indian Fintech Report 2024* from Inc42, in 2024 the total value of the fintech market in India was 793 billion. Fintech units cover a wide spectrum of activities, varying from digital payments, to online lending, insurance and wealth management. As of 2024, the lending segment accounted for 51 per cent, the digital payments segment 23 per cent, and Insurance provision 15 per cent. In 2025, India recorded $1.9 trillion worth of digital payment transactions, third only to China ($9.3 trillion) and the US ($3.1 trillion). According to Worldpay's Global Payments Report 2025, digital payments accounted for a 51 per cent share in point-of-sale transactions, followed by debit/credit cards at 28 per cent and cash at 18 per cent.

Many initial entrants started out as providers of payments services for merchants and utilities and their consumers/clients, serving as gateways and debiting consumer accounts against mandates to make periodic payments, by linking with banks and then with other payment methods such as credit cards (PhonePe, GooglePay, Paytm, BillDesk and PayU, for example). Others appeared as aggregators of options for investments in deposits, mutual funds or insurance policies (PolicyBazaar and BankBazaar). But over time, these and other new entities diversified into other sectors, providing innovative services that target new market segments. In the event, the industry came to consist of different kinds of operators. There were, 'enablers', who developed applications and provided 'software as a service' that allowed incumbent financial firms to better their services or offer new services. There were 'distributors' who provided online access to financial products offered by incumbent firms, with additional services such as comparison of the features of alternative products. And, there were 'full carriers' or providers offering complete financial services, such as trading platforms and original financial products. Thus, fintech companies can either facilitate traditional brick-and-mortar operators or disintermediate relationships between clients/customers and those incumbent firms.

A winning feature of this area is that the revenue model was in most instances clear, consisting either in commissions for serving as intermediaries or a return for directly providing a service such as insurance or stockbroking. This, however, did not mean that all the entrants into the sector, that has seen explosive growth, have been successful. For every

known name such as Paytm, Zerodha or Digit Insurance, there are many that are unheard of and still struggling to plant their feet firmly in the space. Business is already concentrated. Headlines are captured by those who can convince investors to value them highly early in their existence, and some of that funding is used to run expensive advertising that helps pick up a larger list of customers/clients. Even the successful often have limited life -spans. The 'real' growth is not captured by the number of companies or even valuations, as by the volume of business. That volume is perhaps not growing as fast as company numbers or valuations and capitalization. But it is growing, nevertheless.

Besides these factors, government intervention to create supportive software and infrastructure has also played a crucial role. The intervention started in 2009 with the launch of two initiatives to facilitate the fintech boom: the development of the Unified Payments Interface (UPI)—a joint initiative of the National Payments Corporation of India (NPCIL)—and of the biometric authentication and eKYC pathway offered by the Aadhaar initiative, under which a 12 digit identification number was issued to individuals by the Unique Identification Authority of India. The number serves as a proof of identity (with possibility of biometric verification) and address. Then came the government's facilitation of digital financial transactions through the launch of India Stack, which is an initiative aimed at developing a collection of application programme interfaces (APIs), that link the NPCIL's payments interface and the Aadhar database for verification to facilitate financial transactions of various kinds. The first set of uses were in payments systems. Besides use in BHIM, the payments app also developed by NPCIL, the UPI is used by many payments wallets.

Another important fintech protocol developed under India Stack is the Open Credit Enablement Network (OCEN) which consists of a set of APIs that connect various stages of the credit value chain such as lenders, protocol enabled technology service providers, underwriters and borrowers. The information needed to lubricate this process regarding the creditworthiness of the borrower, say, is provided by a Reserve Bank of India-licensed Account Aggregator, which is a non-banking financial company in the business of providing under a contract, the service of retrieving and collating through digital means financial information pertaining to a bank's customers and consolidating, organizing and presenting such information to the customer or any other financial information user as may be specified by the bank. Potential borrowers permit the collection and sharing financial information on their online financial activities. The OCEN protocol is expected to trigger a democratized lending boom that can reach credit to small businesses in a quick and seamless way.

One issue is that the regulatory framework that would govern this sector is still in its nascent stages. In the drive to facilitate an expansion of this sector, regulatory authorities like the RBI, SEBI and IRDA have tilted in favour of forbearance and accommodation, and to an extent even promotion. This is a cause for concern in a sector where risks and/or probability of delinquency are high, especially in the areas like peer-to-peer lending, crowd sourcing and alternative currencies. And then there is the problem of fraud through means such as phishing and planting malware along with identity theft, which makes the digital financial world far more insecure.

Edtech

Digital modes of transacting are rapidly transforming the education and health sectors as well. The edtech industry had experienced rapid growth during the pandemic years when learning from home was the only available alternative. However, as the pandemic waned

and classrooms in the different segments that online providers had been catering to reopened, demand began its return to levels that would be normal. Overall demand was lower than expected, even it if varied considerably between, for example, the K-12 school segment and the test preparation segment.

According to an industry estimate, by early 2020, the cost of customer acquisition rose from an earlier 20-25% of revenues of edtech platforms to 70-80%. However, company valuations were soaring even while losses were mounting. There was no shortage of unicorns with valuations exceeding USD1bn in the sector and Byju's, the dominant player, was a decacorn, valued at more the USD10bn.

That former market leader, Byju's, is now as good as closed. That experience has revealed many fundamental weaknesses of the industry. Excessive optimism about market demand on the part of both new entrants and incumbents is the norm, leading to lack of due diligence as investors prioritise gaining a foothold and expand presence in a promising industry. The business model is focused on market reach rather than the substance or quality of the content offered. Following sharp interest rate increases from late 2022 onwards, a major crutch of the edtech industry disappeared. Overstaffing and excess capacity could no more be sustained. Layoffs and retrenchment followed. In areas such as test preparation, for admissions to institutions that hold out a promise of lucrative post-certification jobs and for entry into the prestigious central government services, young or new start-ups are still following the same strategy. They compete for access to expensive, full-page advertising space in the front jackets of national newspapers. Others that have established themselves have turned more circumspect with respect to splurging on advertising, but the cost of past profligacy must still be met. Meanwhile, the quality of the actual pedagogy provided through such courses remains an area of concern, with wide variations and no clear standards.

Healthtech

The use of the broadband network and various kinds of smart devices to access health facilities received a boost during the Covid era, when physically availing health services by sections other than those looking to be treated for Covid infections became a problem. Patients wanting to avail health services began experimenting with virtual access. Doctors too found it difficult to pursue their profession and turned to healthtech as a solution. The result has been an explosion of entry into the healthtech startup space.

The healthtech sector consists of multiple segments. While technology aided diagnostics and treatment equipment has been a major niche, the more recent thrust is in IT-enabled delivery in areas such as telemedicine, e-pharmacy, fitness and wellness, healthcare IT and analytics, and personal health management. While the market has seen entry into all these segments, telemedicine and e-pharmacy services lead the shift.

According to an estimate made by Inc42, the size of the Indian healthtech Industry as of 2022 was $10.6 billion. That amounts to little more than a quarter of the overall healthcare market. This points to the rapid growth of Indian healthtech. Initially healthtech startups focused on information management solutions for hospitals. But more recently technology has been leveraged for telemedicine, pharma e-commerce, and diagnosis and surgery.

An interesting feature of the healthtech explosion is that most entrants have been startups looking to achieve scale by obtaining funding from private equity firms and/or venture

capitalist firms. These firms were the ones willing to take the risks of initiating the digital transition in different segments of the health care business. Established business groups seem to enter through acquisitions, as happened in the pharma e-commerce sector with Reliance acquiring Netmeds in August 2020 and Tata Digital acquiring 1mg in June 2021.

Social media

Besides commercial ventures and government operations, digital proliferation has affected the private space as well, not least through social media. DataReportal estimates the number of Indian users of social media at 491 million users, which is second only to China's 1.1 trillion. However, given India's large population that figure reflects a still low penetration rate compared to many other countries in the Asia Pacific. At 33.7 per cent, India's penetration rate is 27th in rank, behind many smaller countries like Laos, Nepal, Sri Lanka and Bangladesh. According to a Statista survey of 25,891 respondents in India in 2025 on "Most common social media activities", "sent private messages" and "liked posts by other users or followed people" are the top two answers among Indian consumers.

As the use of India's digital infrastructure increases, misuse and the spread of false information are rife, as are also fears of censorship and surveillance.

Data protection and surveillance

There are, of course, concerns world-wide on the implications of allowing profit-hungry digital platform managers to determine what can and cannot flow through their channels and access privileged information stemming from that flow. There are major threats to privacy, which has been breached in multiple ways. And trolls and purveyors of hate speech have been treated with a light touch. The case for some form of regulation to protect the individual has many votaries.

But the Information Technology (Intermediaries Guidelines) Rules, 2011 of the Indian government seem to be more directed at state surveillance of social media traffic rather than driven by individual privacy concerns and platform abuse. The rules sought to specify the responsibilities of an "intermediary", defined as "any person who on behalf of another person receives, stores or transmits that record or provides any service with respect to that record and includes telecom service providers, network service providers, internet service providers, web-hosting service providers, search engines, online payment sites, online-auction sites, online-market places and cyber cafes."

The rules are ostensibly geared to preventing intermediaries from transmitting material that "threatens the unity, integrity, defence, security or sovereignty of India, friendly relations with foreign States, or public order, or causes incitement to the commission of any cognizable offence or prevents investigation of any offence or is insulting any foreign States". The regulation also applies to material that "is defamatory, obscene, pornographic, paedophilic, invasive of another's privacy, including bodily privacy, insulting or harassing on the basis of gender, libellous, racially or ethnically objectionable, relating to or encouraging money laundering or gambling, or otherwise inconsistent with or contrary to the laws of India"

The passage of the Digital Personal Data Protection (DPDP) Act brought to a close a long process that began with a draft Personal Data Protection Bill included in the 2018 report of the B. N. Srikrishna Committee, which was mandated to review the status of data protection in India and make recommendations on the personal data protection rules and procedures.

The law is extremely problematic—even dangerous—for a number of reasons. At one level, it dilutes the regulation of recognised "data fiduciaries" such as private companies and exempts the government from even the restrictions applicable to data fiduciaries, largely at the expense of the privacy of individuals. Moreover, the agency monitoring the activity of data fiduciaries and implementing the Act is to be constituted solely by the government, which raises questions on the independence and efficacy of the data protection board. There is reason to believe that the DPDPA will be used under vague grounds of 'national security' and 'public order'. On the other hand, for-profit players including big platform companies have greater freedom in storing and using data for commercial purposes, while individuals (data principals) will have very limited control over the collection, storage and use of information about them. The data regime allows cross-border data flow through foreign technology firms.

At the same time, the formulation of the Act suggests that the government intends to use the smoke screen of privacy to establish its total control over information, data and tracking. It also involves the effective destruction of the Right to Information Act, which is widely recognised as being essential for democratic functioning and accountability. The DPDP Act has directly amended the RTI Act in a way that makes it infructuous and totally ineffective, through Section 44 of the DPDPA, which states: "8. (1) Notwithstanding anything contained in this Act, there shall be no obligation to give any citizen,— (j) information which relates to personal information ~~the disclosure of which has no relationship to any public activity or interest, or which would cause unwarranted invasion of the privacy of the individual unless the Central Public Information Officer or the State Public Information Officer or the appellate authority, as the case may be, is satisfied that the larger public interest justifies the disclosure of such information. *Proviso*-Provided that the information which cannot be denied to the Parliament or a State Legislature shall not be denied to any person."~~

These important deletions that remove the public interest dimension of the RTI Act mean that nobody can seek any information related to any "person" which means any name, or any means by which a person can be identified. The consequences are clear: ss a result of this, the RTI would allow citizens to only have access to government propaganda and be unable to probe any features that would pin accountability, or expose corruption or even honest mistakes in government functioning at all levels. Data fiduciaries include anyone who has a social media account or spread information (data) een if only through online messages. Without the protection and facilitation of the RTI Act, the DPDP Act becomes a comprehensively draconian framework for all users of information, by defining personal information and all those connected with it in a way that enables the State to target those attempting to use information in holding power to account and enables it to impose entirely disproportionate penalties up to Rs. 250 crores through a Government Appointed Centralised Board.

The perception that the rules and their modification can lead to censorship, invasion of privacy, surveillance and suppression of dissent seem warranted, and there are real concerns that this can lead to suppression of not just crucial information necessary for controlling corruption and ensuring basic accountability of governments, but also impact on journalism, research and other activities essential for a just society.

Transforming the labour market

A corollary of the digital explosion is the growth of digital labour and digitally-enabled labour. Not only has work to be performed to generate the software and applications that facilitate the digital economy, but a growing proportion of the workforce engages in the provision of digitally enabled services or is mobilised and allocated through digital platforms, in areas such as taxi services (Uber and Ola), delivery services (Zomato and Dunzo) or personal services delivered at home (Urban Company). Many of these are identified by the ILO as "location-based platforms" since task need to be performed at specified locations. A parallel process has been the emergence and growth of online digital labour platforms, which get tasks performed by workers serving as freelance and microtask executors, or taking up competitive programming assignments. The new high growth sector is microtask crowdsourcing platforms such as Amazon Mechanical Turk (AMT) and Clickwork that allow work providers to directly access a large number of potential online workers and allocate to them tasks to be performed and delivered online without outsourcing the work to a corporate intermediary. These digital labour platforms have attracted a lot of attention and are presented by some as defining the future of work. But such a transition would be hampered in activities where successful outsourcing would require close supervision for ensuring quality of workers chosen, training to homogenise execution of repetitive tasks according to protocols specified, and monitoring to ensure volume, timeliness and quality of output. Digital labour platforms rely on algorithms that interpret background evidence and data emerging from past work performed to rate and choose workers, allocate them tasks and weed out those whose performance has been poor or whose work has been rejected for not meeting quality parameters. It is likely that these platforms are mainly used for sourcing workers at the lower levels of the skills range required to undertake work in areas varying from data entry and clerical services to software development. According to the ILO *World Employment and Social Outlook 2021*, globally the field of software development and technology dominates worker accessed through digital labour platforms, accounting for an estimated 39 per cent of the total in 2018 and 45 per cent in 2020. In 2020, 40 per cent of the demand for such workers came from clients based in the United States, followed by the United Kingdom, Australia and Canada. India accounted for 8 per cent of the demand.

These requests are substantially serviced by workers in the developing countries (especially Bangladesh, India, Pakistan, the Philippines and Ukraine), with India leading the pack and accounting for about a fifth of the total. As during the software services outsourcing boom of the 1990s, India has been an important contributor to the digitally enabled global workforce, with software development and technology workers accounting for a substantial share of its contribution. Demand for such online workers increased during the pandemic, being 50 per cent higher than at the beginning of the pandemic. Interestingly, women accounted for only 21 per cent Indian online workers, as compared with 39 per cent in Ukraine and 41 per cent in the US. In all three countries, women accounted for a larger share of the work in writing and translation, as compared with other occupations.

As digitally enabled and allocated work grows, there is evidence that average working conditions have been adversely affected. The ILO finds inadequacies in areas covering regularity of work and income, terms, social protection, skills utilisation, freedom of association and the right to collective bargaining. This is especially true of digitally mobilised and allocated work, whether by corporate intermediaries or by those demanding the services. Such workers, still largely identified as independent contractors rather than employees, are generally not legally recognised as workers in the digital economy. They are

contractors finding work through “digital platforms”. Only those involved in developing, maintaining and improving the applications that form the core of these digital platforms are digital workers in this ecosystem. Like workers remotely providing services such as customer care, medical transcription or translation through digital connections transmitting voice, print, image and video mediated information, these contractors on digital platforms are digitally enabled workers rather than digital workers *per se*. While ride hailing and delivery services are centrally coordinated, the rise of digital labour platforms has paved the way for more decentralised transactions with direct contracts between clients and providers.

The pandemic accentuated the disruption of the place-bound nature of work as workers had to be required to work from home. This led to the “offshoring” of work from the office to the home and the honing of the means needed to allocate, monitor and coordinate the work of dispersed employees. Going forward, the share of those working from home is likely to rise, increasing the volume of digitally enabled work within individual organisations. That can in turn change the nature of contracts between employers and their employees even within individual firms, with more flexible terms and commitments and more online-enabled monitoring as well.

These processes only extend the tendencies that have been operative in the past in India’s digital and digitally enabled economy. There have been a number of phases through which India’s digital service economy has traversed. The first was the growth of offshored provision of software services such as coding, exemplified by the role that Indian software firms provided in addressing the Y2K problem. The second was the rapid expansion of the business process outsourcing sector, offering a range of business services through a hierarchy of call and data centres in terms of scale and sophistication of services offered. The third was the expansion of aggregator services of various kinds, leading to the establishment of major digital platforms that concentrate business in their hands, manage large volumes of business, but maintain a relatively small workforce as all of the actual service providers are treated as independent contractors. And a fourth is the engagement of workers from India by digital labour platforms.

Implications

In sum, as India’s digital infrastructure begins to extend to and transform sectors and spaces across the economy, the initial euphoria over the benefits the technology can bring has been moderated by fears of the inequalising, divisive and freedom-constraining effects it is beginning to have. Regulation by the State does not seem to be the answer as of now, because that regulation is itself a cause of many of the adverse consequences and fears being expressed.