Ministry of Electronics and Information Technology
Government of India

INDIA'S TRILLION-DOLLAR DIGITAL OPPORTUNITY

Digital India
Power To Empower

सत्यमेव जयते

Ministry of Electronics & Information Technology (MeitY)
Government of India

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Digital India
Power To Empower

रविशंकर प्रसाद
RAVI SHANKAR PRASAD

सत्यमेव जयते

मंत्री
विधि एवं न्याय
एवं
इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी
भारत सरकार
MINISTER OF
LAW & JUSTICE
and
ELECTRONICS & INFORMATION TECHNOL
GOVERNMENT OF INDIA

MESSAGE

The Digital India Programme is designed to transform India into a knowledge-based economy and a digitally empowered society by ensuring digital services, digital access, digital inclusion, digital empowerment and by bridging the digital divide. Such an objective is sought to be achieved by technology that is affordable, developmental and inclusive.

The programme has transformed the entire digital profile of the country, with 123 crore Aadhaar, 120 crore mobile phones, 49 crore internet subscriptions and a network of 3.12 lakh Common Services Centres. Today, Digital India is transforming the lives of millions of Indians, giving them services in the remotest part of India, creating opportunity by the movement of Common Services Centres in rural parts and BPOs in small towns of India. The extraordinary surge of electronic manufacturing, led by extraordinary mobile manufacturing in India, are creating an eco-system of new opportunity.

I am very happy to note that the vision of our Hon’ble Prime Minister, Shri Narendra Modi, to transform the lives of ordinary Indians with the power of technology has started bearing profound results. The success of Digital India is now finding global resonance.

India is now among the top two countries globally on many dimensions of digital adoption. The gap between the ‘ haves' and ” have nots' is being bridged with access to basic services to all through technological interventions, thus leading to empowerment of citizens. The new digital public platforms have given a significant boost to entrepreneurship as well as improved access to health, education and public utilities.

“India’s Trillion-Dollar Digital Opportunity” is the result of a year-long effort led by Ministry of Electronics and Information Technology (MeitY), based on a research collaboration with McKinsey & Company. It is an outcome of extensive exercise of consultation with the Central government, State governments as well as with private sector stakeholders.

There are three main objectives in this endeavour - to recognize the progress made by India on digital adoption and to identify gaps yet to be filled, to articulate the vision, potential size and drivers of India's digital economy of the future, and to determine what needs to be done to ensure progress toward realising the vision.

The report presents a vision and lays out a roadmap of how India's digital economy can unlock productivity and value through transformative infrastructure, applications and ecosystems. I look forward to continued collaboration between Government and industry in a Team India spirit to build upon the excellent momentum and make India realize its Trillion Dollar Digital Economy potential.

I appreciate the hard work and effort put in by MeitY and McKinsey team for bringing out the report. The journey towards this digital revolution has only begun. I call upon all key stakeholders — government, private sector, civil society — to shape this vision and lay out the roadmap to make India a global digital leader and a role model for the world.

Ravi Shankar Prasad

(Ravi Shankar Prasad)

S S AHLUWALIA
Member of Parliament of Darjeeling
Union Minister of State for Electronics & Information Technology
Government of India

Message

The Digital India Program is designed to transform India into a knowledge-based economy and digitally empowered society by ensuring digital access, digital inclusion, digital empowerment and bridging the digital divide. The program has transformed the entire digital profile of the country.

This can be clearly seen through the proliferation of 123 Crore Aadhaar, 120 Crore mobile phones, nearly 3.12 lakh Common Service Centres (CSCs) etc. Various Initiatives such as UMANG, Digilocker, Government eMarketplace (GeM), National Scholarship Portal, Jeevan Pramaan etc. has enhanced the ease of living of the citizens of the country.

In the last three years, India's Digital India program has transformed into a mass movement and the common man now has a stake in the emerging digital ecosystem in the country. Our government sees this as a major achievement, as one of the major pillars of our vision is that technology can empower people and create jobs.

I appreciate the efforts put in by the officers of MeitY in this endeavour and am happy to note that after more than 12 months of deliberations and hard work, our report' India's trillion-dollar digital opportunity,' has been formulated. This report shines the spotlight on the power of this transformation and charts a path for the next phase of growth. We have undoubtedly unleashed a huge transformation, but I have no doubt that the best is yet to come. I am convinced that India will present a new role model of digital transformation to the world.

(S.S. Ahluwalia)

Office: Electronic Niketan, 6-CGO Complex,New Delhi 110003
Residence: 10, Gurudwara Rakabganj Road, New Delhi 110001
Phone: +91 11 23722826/23720747 | *Fax*: +91 11 23311955
Email: ssamin@gov.in | 2014darjeeling@gmail.com | ssa@10grg.com

सत्यमेव जयते

अजय साहनी, आई.ए.एस.
AJAY SAWHNEY, I.A.S.

सचिव
इलेक्ट्रॉनिकी और सूचना प्रौद्योगिकी मंत्रालय
भारत सरकार
Secretary
Ministry of Electronics &
Information Technology (MeitY)
Government of India

MESSAGE

The Ministry of Electronics and Information Technology (MeitY) is the torchbearer of Digital India, a flagship programme of the Government. The programme envisions the transformation of India into a digitally empowered society and a knowledge economy. India has charted a unique path to digitization that is unmatched anywhere else in the world.

India's Trillion Dollar Digital Opportunity, is a fact-based report that focuses on the power of this transformation, and lays down a roadmap for the next phase of growth. The report is the result of the hard work and analysis by MeitY and our research partners McKinsey & Company. It highlights the fact that India is truly in a lift-off phase of digital adoption, being the 2nd fastest digitizing country amongst a set of seventeen emerging and mature digital economies. Public digital platforms like Aadhaar, BHIM-UPI, GSTN and GeM coupled with private sector innovation have accelerated digital adoption in India.

IT is not just a vertical anymore and is now part and parcel of every domain. The new and emerging technologies are significantly impacting the processes and aspirations in critical sectors like agriculture, education, health etc. Deployment of these technologies has the potential to disrupt as also to change the dynamics and delivery models in these sectors, thereby unleashing a huge wave of innovation that can add immense value.

India's digital transformation has the potential to empower unserved and underserved segments and create $ 1 trillion of economic value in 2025, sustaining 60-65 million jobs. These digital transformations could be government- led business-enabled while others could be government-enabled and business-led. Having identified these actions, the right institutional mechanisms are needed to accelerate implementation.

इलेक्ट्रॉनिक्स निकेतन, 6, सी.जी.ओ. कॉम्पलेक्स, नई दिल्ली–110003 / Electronics Niketan,6, C.G.O. Complex, New Delhi-110003
Tel. : 011-24364041 • Fax : 24363134 • email : secretary@meity.gov.in

I am thankful to all the key contributors to this exercise, including Ministry of Telecom, Ministry of HRD, Ministry of Health & Family Welfare, Ministry of Agriculture and Farmer's Welfare, Ministry of Power, Ministry of Commerce, Ministry of Rural Development, Ministry of Housing and Urban Affairs, Ministry of Finance, Ministry of Roads, Transport and Highways, NITI Aayog and the DBT Mission.

We have consulted with several organizations outside government, including over 90 private sector companies, technology experts, NGOs, academics, Starts ups and industry associations, and I express my gratitude to all of them for their inputs and participation.

I would like to specially acknowledge and thanks the team from McKinsey. Our sincere thanks are also due to Shri Nandan Nilekani who provided valuable guidance to the effort. While the report has benefited greatly from external consultation, inputs and analysis, the conclusions and policy recommendation herein are primarily those of the government.

In line with our mission of providing technical assistance to the Ministries and Departments at the Centre and the States for e-Governance projects, we will take all steps necessary for coordination and extending support to this ambitious venture. We reiterate our full commitment and resolve towards a fast and efficient implementation leading to realization of a truly digital nation.

(Ajay Sawhney)

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Preface

India's digital story is one of an ICT - led development by use of technology that is affordable, inclusive and transformative. The Digital India Programme aims to transform India into a knowledge-based economy and a digitally empowered society.

Through **Aadhaar**, the Government has provided digital identity to 123 crore residents of the country with 99 % coverage of adult population. The combination of Jandhan bank Accounts, mobile phones and digital identity through Aadhaar i.e. JAM Trinity is helping the poor to receive the benefits directly into their bank accounts. A total of Rs. 6.21 lakh crore have been disbursed through Aadhaar based Direct Benefit Transfer (DBT) to beneficiaries of 438 government schemes which, has led to a saving of over Rs. 1.1 lakh crore in the last 4 years by removing fictitious claimants. Increased use of **Digital Payments** in the country has brought about transparency and accountability. Over the past four years, digital payment transactions have grown multifold. BHIM/UPI has grown multi-folds in the span of two years. UPI consumers made over 67 crore transactions with a value of over Rs. 1 lakh crore in the month of January, 2019 alone. Currently, there are 134 banks offering UPI services to their customers.

Digital delivery of services has simplified the way in which the citizens interact with Government to avail various services and has enhanced the ease of living of the citizens. National Scholarship Portal has 1.40 Crore students registered with scholarships worth Rs 5295 Crore disbursed in last 3 years. Jeevan Pramaan has improved the ease of verification of pensioners using Aadhaar digital identity. 2.48 Crore Digital Life Certificates have been submitted since 2014. DigiLocker provides access to over 349 crore certificates in digital format on a single platform. To make governance easily accessible to people UMANG (Unified Mobile Application For New Age Governance) is the platform created by the Government that enables access to 339 various government services to the citizens through their mobile phones, thus expanding the digital outreach of the citizens. There has been a stupendous growth in Electronic Transactions **(e-Transactions)** in various e-Governance services. Over 8,919.94 crore e-Transactions have been recorded since its inception, till 9th December, 2018. **Common Services Centres (CSCs)** are bringing eServices to the doorsteps of people in the rural areas in an affordable manner. There are around 3.12 lakh CSCs across the country, providing over 350 services ranging from education, health, agriculture etc. and generating employment opportunities for rural youth with nearly 10 lakh persons already employed in these centres have generated employment to 12 lakh persons including 54,800 women. CSCs have become centres of digital empowerment with having been actively involved with digital literacy. Under **Pradhan Mantri Gramin Digital Saksharta Abhiyan**, the Government is implementing the world's largest digital literacy programme under which 1.96 crore people in rural backward areas have already been imparted training to become digitally literate and a total of 6 crore will be trained, thus, bridging the digital divide and helping people access benefits of the digital world.

The **BPO** movement for smaller towns aims to create employment opportunities and secure a balanced regional growth by promoting local entrepreneurs; employment to women and differently-abled persons and has a potential to generate around 1.5 lakh employment opportunities. **53,300 seats** are allocated to 184 companies, resulting in setting up of 268 units distributed across **110 locations** of 26 States and 2 UTs. BPOs have started operation at several locations, including Bhaderwah, Budgam, Jammu, Sopore and Srinagar in Jammu and Kashmir, Guwahati, Kohima, Imphal in North-Eastern region, Baddi and Shimla in Himachal Pradesh, Patna and Muzzaffarpur in Bihar, Jaleshwar in Odisha.

The Government is promoting **Electronics Manufacturing** to accelerate the movement towards Make in India, Make for India, and Make for the World. Towards making India a manufacturing hub for electronics and mobile devices, 268 unique mobile and mobile component manufacturing units have been set up in last 4 years, providing direct and indirect employment opportunities to 6.7 lakh citizens.

To create an inclusive, safe and **secure cyber space** for sustainable development, the Cyber Swachhta Kendra (Botnet Clearing and malware analysis centre) has been set up to provide alerts to users for preventing loses of financial and others data.

All these have laid a robust foundation for India to become one of the leaders in digital transformation. Having built a strong foundation of digital infrastructure and expanded digital access and outreach, India is poised to accelerate towards a trillion-dollar digital economy.

'India's Trillion-Dollar Digital Opportunity' is an endeavour of Ministry of Electronics and Information Technology (MeitY), Government of India to present India's Digital Vision and the potential of India to attain $1 trillion of economic value of digital economy by 2025. The report builds on research collaboration with McKinsey & Company. The primary objectives of this study are to recognise progress made by India on digital adoption and to identify gaps yet to be filled; to articulate the vision, potential size, and drivers of India's digital economy of the future; and to determine what needs to be done to ensure progress.

The study has identified the following: (i) India is in a lift –off phase of digital adoption; 2nd fastest pace of digital adoption since 2014-15 covering 17 emerging and mature digital economies, (ii) large scale digital transformation is possible –India can and must prepare for it; public digital platforms like Aadhaar, UPI, have led to this faster digital adoption in India, (iii) a trillion dollar of economic value would be possible by 2025, sustaining 60-65 million jobs and (iv) concerted action by government and businesses is essential to achieve the potential in a 'Team India' spirit.

The report outlines 30 digital themes, which if scaled up nationally, can accelerate India's progress in nine key areas and help create up to $1 trillion of economic value in 2025. The nine areas are -21st-century IT and telecom infrastructure and software services, E-governance for the future, Healthcare for all, Quality education, Energy for all, Next-generation financial services, Doubling farmers' incomes, Make in India/Make for India/Make for the world and Jobs and skills for all. These collectively have the scope to unlock value and empower millions of workers, entrepreneurs, small and large businesses, and consumers in rural and urban parts of the country.

India's Trillion-Dollar Opportunity has been a more than 18 month effort with intensive interactions and extensive consultations with various Central Ministries and Departments, State Governments as well as one-to-one consultations with technology experts, innovators, start-ups, industry associations and academia.

We express our sincere gratitude to Shri Ravi Shankar Prasad, Hon'ble Minister for Electronics & Information Technology and Law & Justice for envisioning the Trillion Dollar potential of India's digital economy and spearheading the entire initiative of India's Digital Vision with his perspective. We are highly obliged to Shri S.S. Ahluwalia, Hon'ble Minister of State for Electronics & Information Technology for his support and inputs. We are especially grateful to Shri Ajay Sawhney, Secretary, MeitY for his perspective, constant support and valuable guidance.

We are grateful to Shri Pankaj Kumar, Additional Secretary, MeitY for the support in this endevour. We also express our sincere gratitude to all the Officers of MeitY and its Organizations for their valuable inputs in the formulation of the report.

We express deep appreciation and recognize the relentless efforts of the team of McKinsey & Company, our research partners, who enabled us to come up with fact-based analyses. McKinsey Senior partner Shri Alok Kshirsagar, Partner Smt. Anu Madgavkar, and Shri Shishir Gupta who led the working team, have contributed immensely to the outcome. While the report has benefited greatly from external consultation, inputs and analyses, the conclusion and policy recommendations herein are solely those of the government.

The report gives the vision and roadmap to unlock the potential and productivity of the digital economy of India. Concerted efforts and collaboration of Team India comprising of key Ministries, State Governments, regulators, IT companies, Large businesses, Investors and Industry Associations, would surely lead to realisation of the Trillion Dollar Digital Economy by 2025.

Chaudhary

Ms. Simmi Chaudhary
Economic Adviser & Group Coordinator
Ministry of Electronics and Information Technology (MeitY)
Government of India

Executive summary

The Digital India programme, launched in July 2015, is a flagship programme of the Government of India with a vision of transforming India into a digitally empowered society and knowledge economy. In line with the Honourable PM Shri Narendra Modi's vision of ensuring that technology is "accessible, affordable, and adds value", the Digital India initiative was aimed at improving the life of the common person. The programme centres on three key vision areas: a) digital infrastructure as a utility to every citizen, b) governance and services on demand, and c) digital empowerment of citizens. The PM said that India may have missed the Industrial Revolution, but it will not miss the information technology revolution.[1] Echoing his sentiments, the Honourable Minister of Electronics and IT, Shri Ravi Shankar Prasad, calls the programme transformational in nature, which will strengthen the youth and future of India.[2]

Three and a half years later, India is in a sharply accelerating "liftoff" phase of its digital journey. Having built a strong foundation of digital infrastructure and expanded internet access through some 560 million subscriptions, India is poised for the next phase of growth — the creation of tremendous economic value and the empowerment of millions of Indians as new digital applications permeate and transform a multitude of activities and types of work at a national scale.[3] Over the last three and a half years, the government has taken up initiatives across many spheres, including e-governance, skills, and digital infrastructure, that have shown significant impact on the way that the nation lives and works. This study is a timely effort to take stock of the digitally enabled change that is under way in India and lay out a vision and road map for the coming years.

Objectives and approach of the research

Conceived by the Ministry of Electronics and Information Technology, Government of India, this research initiative has three objectives:

- to recognise the progress made by India on digital adoption and to identify gaps yet to be filled;
- to articulate the vision, potential size, and drivers of India's digital economy of the future; and
- to determine what needs to be done to ensure progress toward realising the vision.

The initiative is based on a research collaboration with McKinsey & Company. The distinctive feature of this report is that it has followed a collaborative approach, reflecting ideas, examples, and data from a wide range of government, business, and civil society entities. Multiple consultations were conducted with the central government ministries and agencies as well as various state governments. More than 90 organisations across the spectrum of technology thinkers and innovators, established businesses that actively use digital technologies, startups and new-age digital businesses, not-for-profit entities, academia, think tanks, more than 15 central ministries, and a number of state IT ministers and officials were consulted during the year-long effort. A wide ranging literature review was also conducted.

The effort has culminated in a new Country Digital Adoption Index and data set comprising 30 metrics to measure digital adoption in India and other countries, more than 100 examples of pilots, projects, and initiatives under way in India and outside, a quantitative model to estimate the potential value of India's digital economy based on the productivity and savings possible from digital applications, and identification of specific steps needed in order for the identified opportunities to bear fruit.

Summary of key findings

This section briefly summarises the main findings of the research.

- **India is among the top three global economies in number of digital consumers.** With 560 million internet subscriptions in 2018, up from 238.71 million in 2013, India is the second-largest internet subscriptions market in the world.[4] Likewise, India has the second-largest number of instant messaging service users worldwide, behind China, and the most social media users.[5] Aadhaar, India's unique digital identity programme, covers more than 1.2 billion people, the largest system of its type globally.[6]

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[1] *Text of PM's remarks at the launch of Digital India week*, July 1, 2015, narendramodi.in.

[2] "Digital India to empower youth: Prasad", *Economic Times*, July 17, 2015.

[3] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of September 2018.

[4] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of December 2013, September 2018 and March 2018; Analysys Mason, as of January 09, 2019.

- **India has the second-fastest rate of growth of digital adoption in our comparison set.** Seventeen mature and emerging digital economies were considered, including Brazil, China, Indonesia, Russia, South Korea, Sweden, and the United States. India's digital index score has moved from 17 in 2014 to 32 in 2017 (on a scale of 0 to 100), second-fastest rise after Indonesia. India has performed well on e-governance and digital identity, the rate of growth of mobile internet access, and the uptake of digital media by online consumers. For instance, India's monthly mobile data consumption per user, at 8.3 gigabytes (GB) per month, is over 54 times the figure in mid-2016 and higher than countries like China at 5.5 GB per user, and comparable to digital leaders like South Korea at 8-8.5 GB per user.[7]

- **India's digital divide is narrowing fast as less-affluent states leapfrog to catch up with more-affluent states.** Between 2014 and 2018, of the 10 states with highest rate of growth in internet subscriptions, seven had per capita GDP lower than India's average. Among the lower-income states, Uttar Pradesh alone added 36 million internet subscriptions, 12 percent of total incremental internet subscriptions India added during this time period. Similarly, of the top 10 states in terms of gram panchayats covered with Common Services Centres (CSCs), eight have lower GDP per capita than India overall.[8]

- **India can create up to $1 trillion of economic value from the digital economy in 2025, with half of the opportunity originating in new digital ecosystems** that can spring up in diverse sectors of the economy. Currently, India's digital economy generates about $200 billion of economic value annually — 8 percent of India's GVA in 2017–18 — largely from existing digital ecosystem comprising of information technology and business process management (IT-BPM), digital communication services (including telecom), e-commerce, domestic electronics manufacturing, digital payments, and direct subsidy transfers.[9] By 2025, India could create a digital economy of $800 billion to $1 trillion (or value equivalent to 18 to 23 percent of the country's nominal GDP). The existing digital ecosystem could contribute up to $500 billion of economic value, but the potential economic value for India could be as much as double that amount — almost $1 trillion— if digital technologies are used to unlock productivity, savings, and efficiency across more diverse sectors such as agriculture, education, energy, financial services, government services, healthcare, logistics, manufacturing, trade, and transportation.[10] The potential five-fold increase in economic value from India's digital transformation by 2025 would create a rapidly growing market for a host of digital services, platforms, applications, content, and solutions. This represents an attractive opportunity for global and local businesses, startups, and platform-based innovators who will be investing in emerging technologies (for example, artificial intelligence, blockchain, drones, and robotics) customised to India's needs.

- **Thirty digital themes, if scaled up nationally, can accelerate India's progress in nine key areas and help create up to $1 trillion of economic value in 2025.** The 30 themes collectively represent some of the largest system-level digital opportunities and transformations possible, in areas where significant productivity gains, efficiencies, and citizen benefits can be achieved, and where initiatives already under way provide some basis for future growth. These themes have the scope to unlock huge value and empower millions of workers, entrepreneurs, small and large businesses, and consumers in rural and urban parts of the country by providing better access, better quality, and greater transparency of services. The nine goals are described below.

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[5] *Digital in 2018: Global overview*, We Are Social, December 2018.

[6] Aadhaar dashboard, UIDAI, as of April 18, 2018.

[7] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of September 2018, and June 2016.

[8] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of December 2014, and September 2018; *National monthly progress report*, Common Services Centre Scheme, May 2014 and April 2018.

[9] India's fiscal year runs from April to March. Throughout this report, when we say 201X–1Y, we mean the year ending March 201Y. When we say 201X, we mean the year ending in December.

[10] The economic value is estimated as a range, based on the potential output of digital provider sectors (such as IT-BPM and electronics manufacturing) as well as the potential adoption rate of key digital applications in other sectors and the possible value arising as a result, from higher productivity, resources savings, and tapping new factors of production.

A. **21st-century IT infrastructure and software capabilities,** which includes four themes:

   - Equipping the IT-BPM industry with digital technologies of the future, such as artificial intelligence (AI), analytics, automation, cloud, cybersecurity, mobile, and social, so that it could achieve between $205 billion and $250 billion of GVA in 2025, or roughly twice the $117 billion of GVA achieved in 2017–18.
   - Creating state-of-the-art cybersecurity and data protection frameworks.
   - Building capabilities for real-time data visualisation and data analytics within India.
   - Realising the vision of broadband for everyone, comprising a new visual broadband standard and the aspiration of providing affordable high-speed internet to everyone by 2025.

B. **E-governance of the future**, which includes six themes:

   - Scaling up the Government e-Marketplace.
   - Achieving comprehensive Direct Benefit Transfers.
   - Launching Digital Land 2.0 to dematerialise and digitise the transfer, leasing, and tracking of land, aided by an interoperable land records platform.
   - Creating a National Document and Data Exchange to facilitate paperless, instant exchange of documents.
   - Introducing shareable APIs and digital tools for improved urban e-governance in local bodies.
   - Achieving sustainable Common Services Centres in all gram panchayats as a 250,000-strong network of village-level entrepreneurs providing local communities access to commission-based online services, such as farmer advisory and local job-search and placement services.[11]

C. **Healthcare for all**, which includes three themes:

   - Assembling a universal electronic health record (EHR) for every Indian by 2025, along with an Integrated Health Information Platform.
   - Introducing technology-enabled remote healthcare in public and private health centres and hospitals.
   - Offering a universal public health insurance platform to support the National Health Protection Scheme (Ayushman Bharat).

D. **Quality education for all**, which includes two themes:

   - Promoting digital content delivery and learning in schools and higher education centres with HD video-based learning and online open courses.
   - Creating an integrated education content platform, with customisable local-language content and anonymised student-level competency data to enable innovation that can address educational competency gaps, facilitated by a fund of funds set up by the government to shepherd promising ideas from conceptualisation to piloting.

E. **Energy for all**, which includes two themes:

   - Expanding digitally enabled, affordable power access by installing prepaid meters, completely digitising bill payments, and promoting advanced analytics in electricity distribution companies (DISCOMs).
   - Building a smart grid that integrates distributed generation and renewables, and supports distributed, bidirectional flows that enable entities on the grid to be both consumers and producers of energy. This goal also requires the government to support research, proofs of concepts, and scaling up of specific smart grid technologies.

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[11] *National monthly progress report*, Common Services Centre Scheme, November 2017.

F. **Next-generation financial services**, which includes two themes:

- Continuing to scale digital payment solutions and transition to a less-cash economy.
- Introducing flow-based lending and advanced credit underwriting to provide more finance to micro, small, and medium-size enterprises (MSMEs) through data-driven credit evaluations, using information from the Goods and Services Tax Network and other traditional and non-traditional sources of data generated by MSMEs. Flow-based lending could fill 60 to 80 percent of the credit gap faced by MSMEs, which could in turn generate $90 billion to $120 billion of additional economic value in 2025.

G. **Doubling farmers' incomes**, which includes three themes:

- Enabling digital financing and insurance payouts by facilitating consolidated information, credit scoring models, and yield forecasting models using satellite and weather data.
- Introducing precision agriculture using data analytics, with an integrated agricultural data platform across all existing and new data sources (such as the 158.7 million Soil Health Cards dispatched).[12] Based on pilots, this initiative could raise farm productivity by 15 to 20 percent[13].
- Implementing online agricultural marketplaces linked to a unified, nationwide market with a set of institutional market facilitators and common assaying and grading standards. Such e-marketplaces could cover 40 to 60 percent of agricultural produce sold in India, leading to 15 percent farmers' price gains, as demonstrated by pilots.[14] Together, these changes could add $50 billion to $70 billion of economic value in 2025.[15]

H. **Make in digital India, make for India, make for the world**, which includes five themes:

- Facilitating end-to-end supply chains, e-enabled trade, and e-commerce to reach all Indian consumers and producers, link small retailers to digital value chains (such as e-commerce logistics and smart point-of-sale machines in retail stores), and improve inventory handling efficiency, which has shown gains upto 20 percent in pilots in the private sector. Scaling this initiative to reach 60 to 80 percent of India's supply chains could generate additional economic value of $5 billion to $10 billion in 2025.
- Allowing efficient passenger transportation enabled by shared ride-hailing platforms throughout the country.
- Fostering an integrated digital logistics platform to optimise modal mix of freight coupled with e-tolling, dynamic routing, and predictive maintenance of fleets. The potential value is estimated at $20 billion to $25 billion in 2025.
- Encouraging manufacturing automation and internet of things (IoT)–based advanced analytics to improve the competitiveness of the manufacturing sector by investing in AI and IoT incubation centres, resource centres, and test beds for new IoT applications.
- Building vibrant electronic device manufacturing ecosystems encompassing assembly, components, and design for smart phones, LED and LCD televisions and set-top boxes, LED lights, sensors, medical electronic devices, among other goods. Domestic electronics manufacturing could generate economic value of $100 billion to $130 billion in 2025, based on this study's estimates.

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[12] Soil Health Card website, Government of India, as of September 27, 2018.

[13] *Rapid Introduction and Market Development for Urea Deep Placement Technology for Lowland Transplanted Rice*, International Fertilizer Development Center, 2017.

[14] Ramesh Chand, *Doubling farmers' income – rationale, strategy, prospective and action plan*, NITI Aayog, March 2017.

[15] Ibid.

I. **Jobs and skills for all**, which includes three themes:

   - Offering skill building for the future by creating large-scale national partnership for workforce skill upgrades across industries.
   - Creating online talent marketplaces to connect employers with work seekers at all levels, including a jobs data platform to capture labour demand and supply data at a granular local level, leveraging channels such as CSCs and post offices.
   - Promoting digitally enabled jobs allowing people to work from home or remote locations instead of needing to be co-located at the point of service delivery.

- **Higher productivity created by the digital economy can sustain 60-65 million workers in 2025, with substantial redeployment.** Digital technologies fundamentally change work and demand new types of skills and job roles. Of the 60-65 million workers sustained by the digital economy in 2025, an estimated 40-45 million would need to be retrained and redeployed in new jobs. Many positions in areas such as transportation, logistics, education, financial services, and healthcare, will be digitally enabled.

Capturing the potential value of a $1 trillion digital economy will be neither certain nor automatic. Without decisive, significant, and speedy action by the government to work with the business sector to put in place the enablers — policies, platforms, and partnerships — that are required, India would be on a more business-as-usual trajectory and on a path to create economic value of $500 billion to $650 billion from digital themes by 2025, significantly less than the $1 trillion possible in the full potential scenario. These enablers are outlined below and described in more detail in the rest of the report.

A set of five overarching principles will be important for India to secure its place in a digital world that is essentially borderless, with capital, innovation, data, and design capabilities flowing to countries that offer the fewest pain points. To become the digital factory of the world, narrow the trade deficit in digital economy–related imports, and maximise the accumulation of financial and intellectual capital linked to digital innovation, India's government needs to adopt the following principles:

1. **Drastically improve ease of operations and reduce operating costs for digital businesses.** The government is committed to making India one of the 50 easiest countries in which to do business, and this initiative is beginning to show results.[16] The World Bank's ease of doing business rankings for 2018 show India rising an impressive 23 places and coming in at 77th rank. India's leap of 23 ranks in the Ease of Doing Business ranking is significant considering that last year India had improved its rank by 30 places, making India in top 10 jumpers and the only one amongst the large countries.[17] Analysis reveals that between 2003 and 2017, India adopted 37 reforms, nearly half of them in the last four years.

   India needs to build on this momentum and aspire to be among the top 10 countries globally for digital businesses and startups. It must set concrete, time-bound goals; for instance, entrepreneurs should be able to start a business in less than a day (as is the case in New Zealand). Compliance requirements could be purely digital and may require minimal time.

2. **Unlock the flow of domestic capital into digital businesses.** Domestic savings can be a strong complement to the large amounts of foreign direct investment (FDI), foreign institutional investment, and foreign investment driven by high-net-worth individuals (HNI) into India's technology sector. Several steps can expedite this, such as rationalising tax rates to make investing in startups a favourable proposition compared to investing in public markets, coupled with the government's playing a more proactive role in funding the digital-focused startup funds.

3. **Facilitate a booming open-API ecosystem.** The 30 themes outlined earlier, and many more beyond this list that will emerge as technology evolves, all suggest a potential explosion of fintech, agritech, healthtech, edutech, and other tech-based innovation from India. To facilitate innovation, every government digital initiative needs to conform to the

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[16] "Ease of doing business: India jumps 30 notches, breaks into top 100", *Times of India*, October 31, 2017.

[17] *Doing Business 2018*, World Bank, October 31, 2017.

open-API guidelines of the Ministry of Electronics and Information Technology (MeitY). This will ensure that users have the flexibility to employ the underlying raw and processed data per their objective and interest, thus fostering an environment of innovation. In addition, gov.in data could be offered for open use by organisations and companies operating in India, to act as magnet for researchers and innovators to do business in India.

4. **Support Indian digital innovators through government procurement.** The government is a large buyer of services, and it can act as a market maker to create scale for the country's best innovations and technology applications. This would require transparent mechanisms that provide a system for Indian innovators to propose new ideas, processes, and services, and to build products to solve national needs. Open competitions could help to find the best innovation, and winning consortia could be suppliers for, say, 60 percent of the expenditure for that solution for five to seven years.

5. **Unshackle centres of higher education and innovation.** The competitive advantage for a future digital economy lies in developing design, creativity, and innovation skills in the workforce. For this, it would be vital for India to have vibrant higher education institutions that collaborate closely with industry, in innovation clusters and tinkering labs. Strengthen and invest more resources in existing centres of excellence and create a combination of chairs, scholarships, and special funds to invite global leaders to come to India and train talent.

With these principles as the guide, a specific set of actions are required to make progress toward the 30 digital themes identified in this report. Details of the policies, platforms and partnerships are in the report, with a few highlighted here:

- **Supportive policies and regulations.** Many new policies would be needed to accelerate momentum, with alignment required across central and state ministries. For example, India needs a new world-class data-protection law, policies promoting visual broadband access in every home, a policy to govern the use of drones for civilian purposes, a virtual health act, an updated virtual university policy, and a policy on protocol-based sharing of Goods and Services Tax Network (GSTN) data to catalyse flow-based lending.
    - — MeitY set up four committees of industry and academia to draw a road map on how new and emerging technologies could be applied in real world. They have incorporated findings from NITI Aayog's recently released "National Strategy for Artifical Intelligence" as well. To operationalise these recommendations, MeitY is working with Digital India Corporation (DIC) to set up a National Centre for Artificial Intelligence (NCAI) as an apex body for artificial intelligence.

- **Technology platforms and new digital ecosystems.** Public digital platforms are needed in areas such as healthcare, education, labour markets, land markets, and agriculture: for example, an electronic health record and health information platform, an open data platform for agriculture, and a digital land repository. Enabled by these measures, along with open-API frameworks for each, innovators and investors could create tech-enabled business models that meet clients' needs. For example, for precision agriculture to scale, in addition to the open API-based data platform capturing myriad aspects like condition of soil, weather, availability of fertiliser, and so forth, it will also need data aggregators and analytics specialists, sensor-based equipment manufacturers, digital farm financing entities, and digital innovators in farm input companies, food processing companies, and retailers.

- **Team India partnerships and collaborations.** Central and state governments, the private sector, and social-sector organisations can bring complementary assets and capabilities to public-private-social partnerships. Some of these digital transformations could be government-led and business-enabled, while others could be government-enabled and business-led.

Having identified these actions, the government could adopt the right institutional mechanism to push on them. Following are steps to prioritise over the next six to 12 months:

- **Set up sector-specific consultative forums to engage Team India in digital transformation.** These councils would be led by the government with private sector participation for three year terms. A few councils could be set up initially: technology infrastructure (data storage and cybersecurity); healthcare; education and skills training; agriculture (and food processing); and transportation and logistics. Each would include representatives from across the value chain. They could be asked to provide inputs to help each sector's digital strategy evolve and to suggest ways to streamline and simplify regulation and compliance to foster growth of the ecosystem.

- **Public digital platforms are important enablers for the vision** — in areas such as GSTN, education, agriculture, health, land, logistics, future skills and jobs, e-governance app ecosystem, and digital data and document exchange.
- **Create a digital dashboard to measure progress** on existing as well as future initiatives. It would serve as an important barometer of the evolution of India's digital economy and be a tool to review, streamline, and shape future policy.

The rest of this executive summary provides a more detailed overview of the findings of the report.

■ ■ ■

India's digital consumer base is the second largest in the world, and the benefits of technology are being felt by all segments of people

With 1.2 billion mobile subscriptions and 560 million internet subscriptions as of September 2018, India is home to the second-largest mobile consumer base and second-largest internet subscriber base in the world, behind only China.[18] Over 1.2 billion Indians have Aadhaar unique digitally verifiable identities — the largest national roll-out globally.[19] Indian internet users logged 12.3 billion app downloads in 2018, behind only China.[20] India now has 294 million active social media users and 200 million users active on instant-messaging services such as WhatsApp.[21] The time Indian users spent per user on social media, 17 hours per week, exceeds the figure for both the United States and China.[22]

India's pace of digital adoption accelerated rapidly between 2013 and 2018 (Exhibit E1). More than 207 million Indians went online in this period, and smartphone penetration more than quadrupled, from 5.5 per 100 people in 2013 to 26.2 in December 2018.[23] Monthly mobile data consumption per user has grown by more than 54 times since mid 2016, and is now significantly higher than China and comparable to digital leaders like South Korea, while monthly fixed-line data consumption per user more than doubled, from 7.1 GB to 18.3 GB, between 2014 and 2018.[24]

India's rapid pace of digital adoption has been driven by the government's commitment to digitising key aspects of the economy, combined with private-sector innovation and investment to promote internet access and use. The government catalysed the process by establishing a strong national digital foundation — public platforms and infrastructure — and by rolling out a host of digital applications and services. These have created real incentives for citizens to come online.

Government measures include the rapid ramp-up of Aadhaar, the national biometric digital identity programme, and its subsequent linkage to the payment of welfare benefits. Over 1.2 billion Indians now have Aadhaar digital identities, up from 510 million in 2013; nearly 870 million bank accounts were linked to Aadhaar by February 2018, compared with 399 million in April 2017 and just 56 million in January 2014.[25] A suite of open APIs — such as the Unified Payments Interface (UPI) and Bharat Interface for Money (BHIM)/Bharat QR code for payments, DigiLocker for online document access and retrieval, electronic "Know Your Customer" (eKYC) for electronic verification of customers' identities, and the Bharat Bill Payment System — form part of India's strong digital foundation. In future, a range of different

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[18] *Indian telecom services performance indicators,* Telecom Regulatory Authority of India, as of September, 2018; Strategy Analytics, as of December 2018; Digital in 2018: Southern Asia, Eastern Asia, Northern America, We Are Social, December 2018.

[19] Aadhaar dashboard, UIDAI, as of April 18, 2018; *Aadhaar: Inclusive by design*, GSMA, March 2017.

[20] Priori Data, January 2019.

[21] *Digital in 2018: Global overview*, We Are Social, January 2018; "WhatsApp now has 1.5 billion monthly active users, 200 million users in India", *Financial Express*, February 1, 2018.

[22] *Digital in 2018: Southern Asia, Eastern Asia, Northern America*, We Are Social, January 2018.

[23] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of December 2013, and September 2018; Strategy Analytics, as of December 2018.

[24] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of December 2013, and September 2018; Ovum network traffic forecast 2015–20; Ovum total fixed broadband subscription and revenue forecast 2016–21, as of March 22, 2018.

[25] Aadhaar dashboard, as of April 18, 2018; *State of Aadhaar report 2016–17*, IDinsight, May 2017; UIDAI, as of March 4, 2018.

Exhibit E1

India has experienced large-scale digital adoption between 2013 and 2018, triggered by both government action and market forces

GOVERNMENT-LED

1.22 billion
up from 510 million
people with unique biometric digital identities (Aadhaar)

870 million
up from 55.8 million
Aadhaar-linked bank accounts

98 million
up from 6.5 million
daily e-government transactions

292,748 (as of April 2018)
up from 63,000
functional Common Services Centres providing e-services[2]

26.7 billion
up from 249 million
Aadhaar authentication transactions[2]

BUSINESS-LED

560 million
up from 238.7 million
Internet subscriptions

294 million
up from 90 million
Social media users

200 million
up from 30 million
WhatsApp subscribers

176.8 million
up from 40 million
e-commerce users

24.3 billion
up from 2.5 billion
annual digital payment transactions (digital wallets, net banking, or credit or debit card at point of sale)[3]

1 Figures as on 22nd January, 2019.
2 Common Services Centres and Aadhaar authentication transactions data compared to 2014.
3 Digital payments transactions data for January to December 2018 compared to FY 2013–14; all other figures for 2017/2018 compared to 2013.

SOURCE: Telecom Regulatory Authority of India; Unique Identification Authority of India; We Are Social; *India B2C e-commerce report 2016,* Ecommerce Foundation; Payment system indicators, Reserve Bank of India; Electronic Transaction Aggregation & Analysis Layer; WhatsApp; National monthly progress report, Common Services Centre scheme, November 2017; *Annual report 2016–17,* Ministry of Electronics and IT digitally verifiable identify systems will continue to evolve, in line with the Supreme Court of India's ruling, upholding privacy as a fundamental right of every citizen.

The government also triggered discontinuous growth in digital payments through the launch, in 2014, of the Pradhan Mantri Jan-Dhan Yojana, the national financial-inclusion drive, which opened millions of Aadhaar-authenticated bank accounts linked to mobile phones. Indians have opened some 325 million Jan-Dhan bank accounts, a three fold jump in four years.[26] Other government measures that have promoted digital usage are the November 2016 demonetisation of high-denomination currency notes, the removal of many barriers to digital payments, and the Goods and Services Tax legislation rolled out in July 2017, which is expected to propel nearly 10.3 million businesses onto the digital GSTN platform that records sales and transactions data.[27]

Meanwhile, India's private-sector telecom players — Airtel, Reliance Jio, Vodafone, Idea, and others — have seized on a precipitous drop in technology costs to provide high-speed mobile data services at increasingly affordable prices. Average mobile download speed reflects this trend, climbing from 1.3 Mbps in 2014 to 9.9 Mbps in September, 2018.[28] A sharp fall in mobile data prices has accompanied these technology and infrastructure improvements. Today, one gigabyte of data costs about 0.1 percent of monthly GNI per capita, compared with 9.8 percent in 2013, representing an average annual decline of 68 percent.[29]

Likewise, the large Indian market is spurring global technology giants such as Google, Facebook, Microsoft, and Netflix to create services tailored to India. Google's Android launched the Android One series of low-cost phones and is working with Reliance Jio on a smartphone that would retail for around $30.[30] Facebook supports 12 local languages, and its Express Wi-Fi project is rolling out 20,000 hotspots in partnership with the mobile service provider Airtel.[31] E-commerce players, payment innovators including large commercial banks, and payment disruptors have embraced opportunities presented by India's growing number of connected consumers.

As a result of the rising reach of access and services, the overall data consumption may rise by more than 60 times between 2015-2025, roughly doubling every 18 months during this period, boosting content-creating industries such as media and entertainment. Technology is already affecting the lives of millions of Indians in tangible ways.

Significantly higher banking inclusion, combined with Aadhaar-enabled targeting of beneficiaries, means that welfare payments directly flow into beneficiaries' bank accounts: direct transfers of government payments to consumers' bank accounts in fiscal year 2018 were up more than 26-fold over fiscal year 2014, and Aadhaar-based micro ATM transactions grew 10-fold in value from fiscal 2017 to fiscal 2018.[32]

Many consumers, including those with low incomes, can now open bank accounts or borrow money by using eKYC to verify their identities, rather than having to submit physical documents or visit a distant bank branch. They can use financial services through a network of banking correspondents who carry micro-ATMs to dispense cash, accept deposits, and receive wages under government employment schemes directly into their bank accounts without leakage to middlemen. A rural homemaker living below the poverty line can receive her cooking-gas subsidy directly into her bank account by proving her identity with Aadhaar.

People on the move have also benefited. A migrant worker has been able to activate a new mobile connection in minutes rather than days using Aadhaar eKYC. This will make it easier for him to video chat with his family and inexpensively remit money to them, and enable him to access personalised music, news, and video content in his primary language.

Digital solutions increasingly pervade Indian life. Indians log 50 million video-calling minutes per day

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[26] *Progress report*, Pradhan Mantri Jan-Dhan Yojana, August 28, 2018.

[27] *Role of GST in widening tax base*, answer to Lok Sabha unstarred question no. 2405, March 9, 2018.

[28] Speedtest Global Index by Ookla, November 2018.

[29] Indian telecom services performance indicators, Telecom Regulatory Authority of India, as of September 2018.

[30] *The best of Android and Google with Android Oreo (Go edition) and Android One*, Google, February 22, 2018; "MediaTek, Reliance Jio working on Android Go Oreo smartphones", *Hindu BusinessLine*, January 30, 2018.

[31] Karan Choudhary, "Facebook eyes more likes from Bharat to expand user base", *Business Standard*, October 21, 2016; "Facebook partners with Airtel to roll out Express Wi-Fi to deploy 20,000 hotspots in India", *Financial Express*, May 4, 2017.

[32] Direct Benefits Transfer website, as of April 18, 2018; *State of Aadhaar report 2017–18, IDinsight, May 2018*.

on WhatsApp, and approximately 65 percent of Indians shared their videos through mobile as compared to 53 percent globally during 2013.[33] More and more microentrepreneurs and self-employed (independent) workers can link to organised, digitally enabled value chains such as cab-hailing apps, job marketplaces, and e-commerce firms, gaining access to better income-earning opportunities.

The wave of digital transformation has also empowered women, a hitherto underserved segment, in many ways. These include helping women find opportunities for gainful employment, one of the key areas where they lag behind their counterparts in peer countries. The business-process outsourcing (BPO) industry in India employs some 4 million workers, about 30 percent of them women.[34] A three-year awareness programme in rural India on opportunities in the BPO industry enhanced women's enrolment in BPO training programmes and increased school enrolment among young girls by 3 to 5 percent.[35] Likewise, 54,800 women have become village-level entrepreneurs at government-run Common Services Centres, providing digital services to the local population.[36] Technology is also empowering women by enabling them to move into jobs previously considered unconventional for them. In fiscal 2016, the BabaJob portal recorded a sevenfold increase in demand from employers for female cab drivers and a more than 150 percent increase in women's applications for driver jobs.[37]

In urban centres, shoppers now enjoy more choice and convenience. Consumers in smaller Tier 2 and Tier 3 cities, which do not have retail infrastructure comparable to that of large metro areas, account for more than half of the new e-commerce purchases in India.[38] A host of e-services are also becoming available to consumers in semi-urban and rural parts of India through the spread of CSCs, the physical centres that deliver e-services. In 2018, India had 292,748 functional CSCs, up from 63,000 in 2014.[39] The extensive reach of CSCs means that consumers can avoid travelling long distances for services such as Aadhaar enrolment, passport application or renewal, Permanent Account Number (PAN) card application, banking, and, increasingly, new services such as medical consultation and educational opportunities.

India's digital surge is evident even against global peers, and the digital divide within India is narrowing

To objectively take stock of the extent of India's digital transformation, this study compares where the country stands relative to other emerging and mature digital

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[33] "Indians make 50 mn minutes of WhatsApp video calls daily", *The Times of India*, May 8, 2017.
Indian Consumers Love to Share Mobile Videos, Reveals Vuclip Survey, BusinessWire India, July 31, 2013.

[34] World Bank. 2016. *World Development Report 2016: Digital Dividends*. Washington,DC: World Bank.

[35] Ibid.

[36] MeitY, as of April 2018.

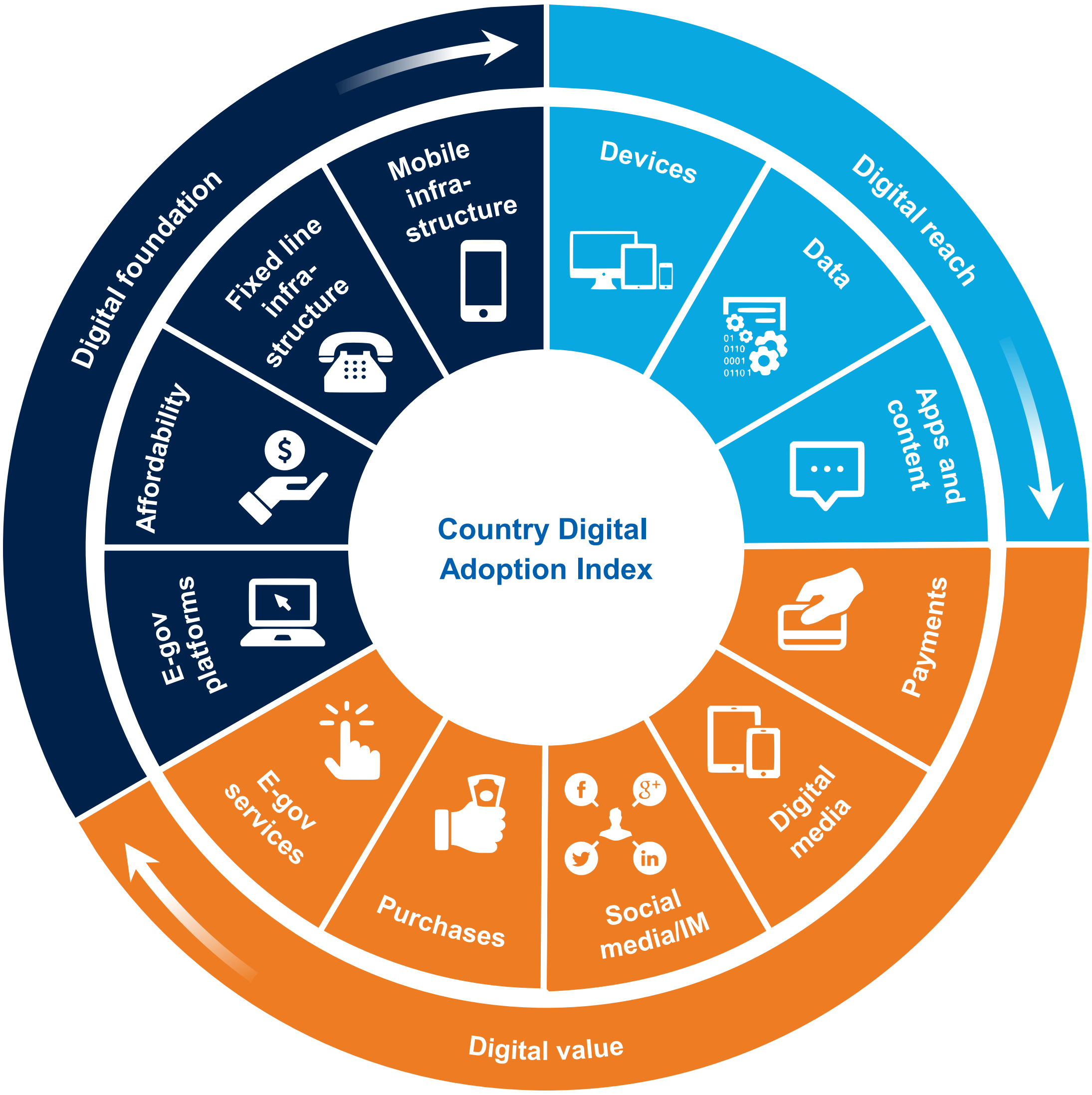
[37] "More women taking up odd jobs; opt to be cab drivers, guards", *The Economic Times*, June 5, 2016.

[38] "Rasul Bailay, Shambhavi Anand, How e-commerce companies like Amazon, Flipkart help stores locate new spending cities", *The Economic Times*, September 1, 2017.

[39] *National monthly progress report*, Common Services Centre Scheme, April 2018; *Annual report*, Ministry of Electronics and Information Technology, 2016–17.

EXHIBIT E2

Country Digital Adoption Index takes a 360-degree view of digital adoption


Country Digital Adoption Index
Digital foundation
Mobile infra-structure
Fixed line infra-structure
Affordability
E-gov platforms
Digital reach
Devices
Data
01
0110
0001
01101
Apps and content
Digital value
Payments
Digital media
Social media/IM
Purchases
E-gov services

DIGITAL FOUNDATION
The availability of digital infrastructure and platforms

DIGITAL REACH
The penetration of digital devices, data, and content

DIGITAL VALUE
The adoption of various digital use cases

Analysis of data of 30 indicators across 17 countries for 2013–14 to 2017–18

economies, and how the different states of India compare with one another. For this, the analysis creates a digital index based on the framework of three pillars of the digital economy (Exhibit E2): digital foundation (for example, spectrum availability, internet download speed, internet affordability, and e government platforms and services offered), digital reach (such as the size of the mobile and internet user bases, availability of local-content websites, and data consumption per user), and digital value (including utilisation levels of use cases across e-government services, digital media, e-commerce, and digital payments).

Country Digital Adoption Index assesses 17 countries using 30 metrics across the three pillars of the digital economy (Exhibit E3). India's overall score in 2017 was 32 on a scale of 0 to 100, where 100 represents the highest theoretical value (computed as the combined value assuming the score of the best-performing country on each of the 30 metrics). India's score is well below those of the digital leader economies of South Korea and Sweden (with digital scores above 70) and the mature digital economies of United Kingdom, Singapore, Australia, the United States, Japan, Canada, Russia, and Germany (whose scores fall between 60 and 70), close to that of emerging digital leaders Brazil, China and South Africa (which score between 40 and 50). India's position is relatively strong on several indicators of digital foundation, such as biometric ID, e-government services, and 4G network coverage, but there is substantial scope for India to catch up on digital reach, given its internet penetration rate of 40 percent of the population, and on digital value, on which India's score for usage of digital payments and e-commerce penetration is lower than those of many peer countries.[40]

Overall, however, India has the second-highest momentum, or rate of growth, among all countries over the past four years. According to Exhibit 3, its digital score rose by 90 percent, from 17 in 2014 to 32 in 2017. The rate of growth is very high across all pillars: on 14 of the indicators, India's annual growth rate over the last four years exceeded that of the other fast-growing digital economies (China, Germany, and Indonesia). The indicators include 4G coverage, smartphone users, mobile broadband subscribers, download speed, e-commerce, cashless consumer transactions, and online government services.

Going deeper, the gap in India's overall digital adoption relative to other countries can be explained by disparities within India. The degree of digital adoption within India is uneven, with some states and union territories having moved faster than others. To assess the pace of digital adoption within India, the study examined the growth in internet subscribers and digital access to unserved populations through the CSC network.

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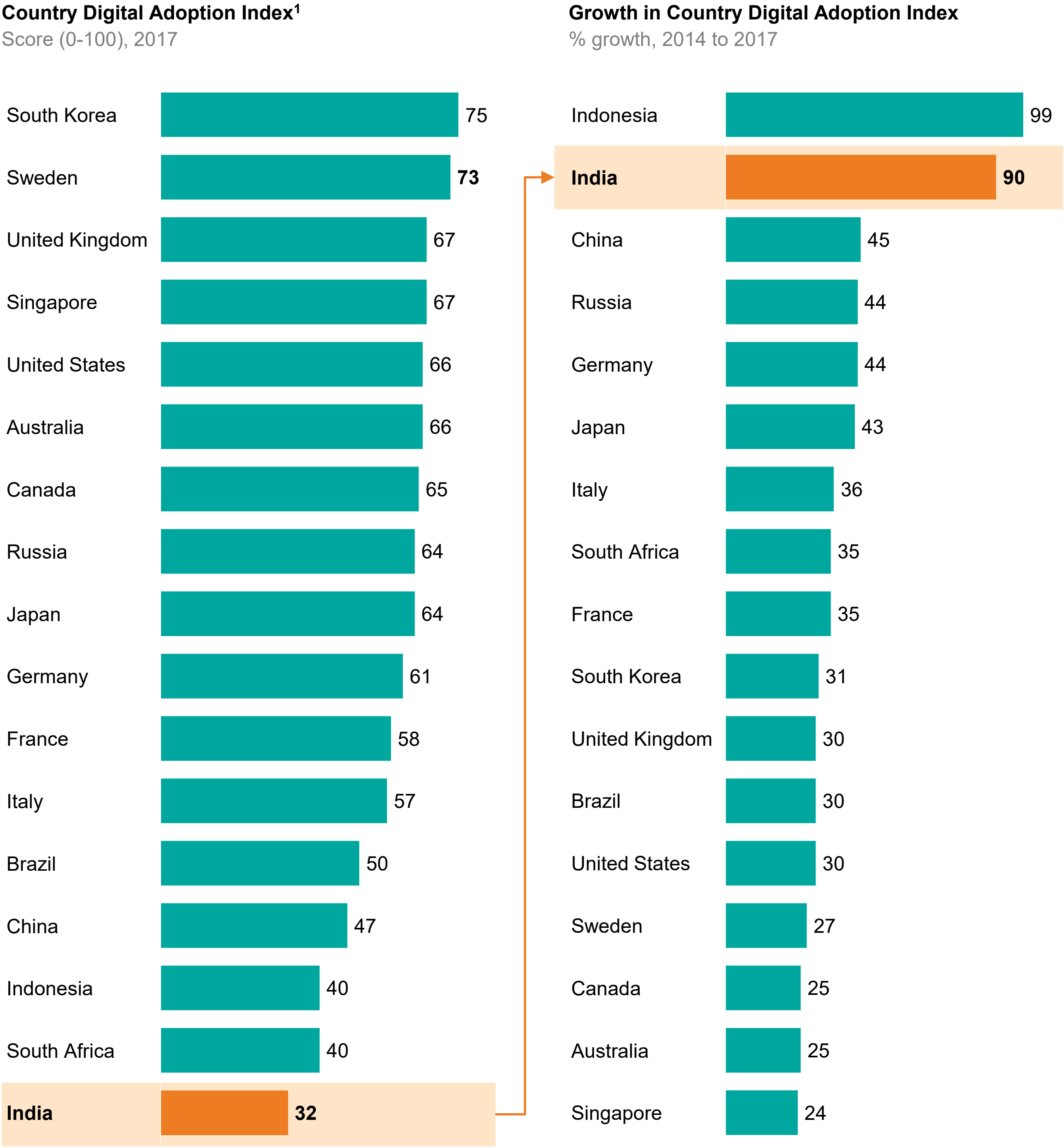
[40] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of September 2018.

EXHIBIT E3

India, coming off a low base, is the second-fastest digital adopter among 17 major digital economies



1 MGI's Country Digital Adoption Index represents the level of adoption of digital applications by individuals, businesses, and governments across 17 major digital economies. The holistic framework is estimated based on 30 metrics divided between three pillars: digital foundation (eg, spectrum availability, download speed), digital reach (eg, size of mobile and internet user bases, data consumption per user), and digital value (eg, utilization levels of use cases in digital payments or e-commerce). Principal component analysis was conducted to estimate the relative importance of the three pillars: 0.37 for digital foundation, 0.33 for digital reach and 0.30 for digital value. Within each pillar, each element is assigned equal value, with indicators normalized into a standard scale of 0–100 (0 indicating lowest possible value). A simple average of the normalized values was then used to calculate the index.

SOURCE: Akamai State of the Internet Report Q1 2014, Q1 2017; Analysys Mason; Euromonitor International consumer finance and retailing overviews, 2017 editions; International Telecommunication Union; UN e-Government Survey; Strategy Analytics; Open Signal; Ovum; We Are Social; Digital Adoption Index, World Bank

Digital penetration and GDP per capita or affluence are strongly correlated. States in the top third of GDP per capita levels, such as Haryana, Maharashtra, and Tamil Nadu, together with the small, highly urbanised states and union territories of Chandigarh, Delhi and Goa have the highest internet penetration, ranging between 28 percent in Uttarakhand to more than 170 percent in Delhi. Similarly, states in the bottom third of GDP per capita, such as Bihar, Jharkhand, Madhya Pradesh, and Uttar Pradesh, are among states with the lowest penetration rates, for example 22 percent in Bihar and 22 percent in Jharkhand. State-level analysis reveals that all states have grown their internet subscriber basis by a minimum of 12 percent annually between 2014 and 2018, while states with relatively lower internet penetration rates to begin with, such as Uttar Pradesh, Madhya Pradesh, and Bihar, have grown their subscriber base distinctly faster, at 24 to 26 percent over the same period.

India has the potential to create a $1 trillion digital economy by 2025, benefiting all sectors and people

India's government aspires to provide its people with ubiquitous and affordable internet and digital access, reaching unserved and underserved segments of people and facilitating new digital ecosystems that can remedy problems across a range of economic and social sectors and activities. Doing this could enable India to establish a vibrant digital economy that creates up to $1 trillion in economic value by 2025 and paves the way for the country to become a digital factory for the rest of the world (Exhibit E4). The potential five-fold growth in economic value from India's digital transformation by 2025 would create a rapidly growing market for a host of digital services, platforms, applications, content, and solutions. This represents an attractive opportunity for global and local businesses, startups, and platform-based innovators who will be investing in emerging technologies (for example, artificial intelligence, blockchain, drones, and robotics) customised to India's needs.

Based on a study of global digital applications as well as promising applications implemented in India, this report identifies transformative digital themes that could achieve national scale by 2025 and help advance the developmental priorities of the country. The study identifies 30 digital themes for India, aligned to nine pressing national areas (Exhibit E5). Each of these has the potential to raise productivity, unlock efficiency, remove barriers to growth, and improve the quality of life for millions. While these digital interventions alone are not sufficient to meet India's goals, they can certainly help accelerate progress if implemented at scale. The themes, grouped by national areas, are described briefly here and in more detail in the full report.

A. **21st-century technology and telecom infrastructure and services.** A strong and vibrant technology and telecom sector is a critical foundation for an emerging digital economy. Four themes would be important to achieve this:

   - An IT-BPM industry that is equipped for the digital technologies of the future, undertakes significant retraining of its workforce in digital technologies, and supports end-to-end customer journeys for clients in both international and domestic markets.
   - A state-of-the-art cybersecurity and data protection framework so that India emerges as one of the most secure cyberspaces globally, thereby fostering innovation.
   - Real-time data visualisation and data analytics capabilities built on the premise of a universal open API ecosystem.
   - The aspiration of visual broadband for everyone — a new visual broadband standard and aspiration of providing affordable high-speed internet to everyone by 2025.

B. **E-governance for the future.** Six digital themes can help make government-to-citizen (G2C) and government-to-business (G2B) services more accessible and effective, and reduce the cost of doing business in India:

   - Adoption of the Government e-Marketplace by the central and state governments, public-sector units, and nondepartmental enterprises, and GeM's comprehensive coverage of end-to-end digital processes.
   - Digital Land 2.0 to dematerialise and digitise the transfer, leasing, and tracking of land aided by an interoperable land records platform.

EXHIBIT E4

Aspiration for Digital India

DIGITAL FOUNDATION

A strong national digital foundation …

- Universal coverage of digital identity, authentication, and consent framework
- World-class environment for cybersecurity and data protection
- Digitised data assimilated from open API framework with utilities developed using deep analytics and real-time visualisation
- Largest global base of skilled workers in new digital and emerging technologies

DIGITAL REACH

… to connect unserved and underserved people …

- Affordable, high-speed internet to every household through fibre and 5G with more than 1 billion internet users and two-way data speed of 20 Mbps
- Strong local-language content
- Universal digital literacy

… and solve problems

- Dematerialised, digitised, disintermediated processes to empower consumers and businesses in
  - G2B and G2C interactions
  - Land and property markets
  - Financial and credit markets
  - Skill and job markets
- New digital platforms and delivery models in agriculture, education, transportation, and other services

DIGITAL VALUE

Creating a $1 trillion digital economy…

- Digital and data-backed innovation to boost productivity in manufacturing, agriculture, and services sectors
- Vibrant IT-BPM, telecom, e-commerce, and electronics sectors
- Explosion of new digital startups
- More workers in the formalised, digitised sector via tech platforms and value chains

… and India to emerge as the "digital factory" for the world

- Global leader in digital identity and public digital platforms, and data utilities
- Hub of innovation in fintech, edutech, healthtech, agritech, and other areas of technology innovation
- A data analytics engine for the world
- Global supplier of digitally skilled workers

SOURCE: Ministry of Electronics and Information Technology, Government of India

EXHIBIT E5

Thirty digital themes will pave the way to Digital India 2025

DIGITAL FOUNDATION

A 21st-century IT infrastructure and software capabilities

1 A vibrant IT/BPM industry with significant reskilling of its workforce in digital technologies of the future

2 State-of-the-art cybersecurity, robust laws and policies for secure and safe collection, and storage of personal data

3 Real-time data visualisation and deep analytics to track national projects and provide open data platforms for innovation

DIGITAL REACH

4 Ubiquitous coverage of broad-based, affordable, high-speed internet connectivity through a combination of fibre to the home (FTTH) and wireless technology

DIGITAL VALUE

C Healthcare for all

11 Universal electronic health record for every Indian capturing and making available clinical encounters, to achieve a rapid, accurate, and affordable healthcare value chain (across drug discovery, diagnostics, delivery, and financing)

12 Tech-enabled health delivery with e-health centres, tele-consultation, tele-diagnostics, analytics-based protocols, remote monitoring, feedback to patients and caregivers

13 Universal health insurance platform for rapid, mass, low-cost customer onboarding, provider, and claims interface for national health protection schemes

D Quality education for the future

14 Integrated digital education platform with customisable local-language content created as an open societal platform for teachers, learners, education providers, and all stakeholders

15 Digital content delivery and learning in schools and higher education institutes through online lessons, video, simulations, continuous assessment, and adaptive learning systems, supported by trained teachers

E Energy for all

16 Digitally enabled power access to every household while improving the financial condition of DISCOMs

17 Grid automation and optimisation using digital technologies to integrate renewable energy sources and improve grid reliability

F Next-generation financial services

18 Digital payment solutions across the full spectrum of government, business, and consumer payments in all states of India to transition to a less-cash economy

19 Flow-based lending and advanced credit underwriting for MSMEs using GSTN and other data for pricing and credit risk management

B	E-governance of the future
5	Government e-Marketplace adopted by all government departments/agencies, with comprehensive coverage of buyers, sellers, and service providers, and end-to-end digital enablement from tendering to payment and fulfilment
6	Digital Land 2.0 to accelerate property market transactions enabled by record verification and interoperable platform for all land record–related documents
7	National document and data exchange (using digital locker) to facilitate exchange of documents/data and enable straight-through verification/compliance for multiple individual and business needs (e.g., eKYC, employment, and utilities)
8	Digital technologies to improve urban e-governance for local bodies and satisfied citizens to address challenges of congestion, security, and utility management
9	Comprehensive Direct Benefit Transfers to eliminate losses and inefficiencies in disbursement of benefits and subsidies across wages, food, fertiliser, cooking gas, power, and other areas
10	Profitable digital service provider ecosystem (CSC in every gram panchayat) by expanding range and volume of G2C and B2C goods/services delivered (e.g., e-commerce, insurance, education, health, and agriculture)

G	Doubling farmers' income
20	Digital financing and insurance payouts (credit, insurance, payments, risk management) using data from digitised land records, crop-cutting experiments, satellite images, fertiliser DBT, digital sales, and sensors
21	Precision agriculture know-how sharing through multiple channels based on multiple existing and new data sources (soil health cards, weather data, farm/tractor-based sensors)
22	Online agricultural marketplaces leveraging wholesale markets and buyer-seller platforms, providing farmers and traders with timely information on local prices, e-warehousing receipts, and transaction guarantee through direct and e-enabled channels

H	Make in digital India, make for India, make for the world
23	End-to-end digital supply chain, e-enabled trade and ecommerce across manufacturers, SME vendors, and wholesale/retail trade, with transition to GSTN, online inventory management, and growth of ecommerce
25	Integrated logistics platform to fully integrate and share information on transportation of physical goods
24	Efficient transportation through digital platforms for passenger transportation such as cab-hailing, and similar sharing-economy applications
26	IoT-based advanced analytics and automation to improve manufacturing processes with plant availability, yield, and throughput, and save costs through asset management
27	Boost electronics manufacturing and exports from India by facilitating financing, investment in R&D, and building best-in-class infrastructure

I	Jobs and skills for the future
28	Building skills with updated curriculum (across multiple use cases such as remote ops and advanced analytics) rolled out in all colleges and ITIs in partnership with industry, leveraging digital technology (MOOCs and AR/VR)
29	Online talent marketplaces to provide employers, job seekers, and skills trainers with an array of content, job market information, and supply and demand matching platforms for a variety of occupations
30	Digitally enabled jobs through investment in the next wave of BPO in small towns and semi-urban India, the sharing economy, on-demand workers, and new digital value chains in healthcare, agriculture, and other services

SOURCE: Public and private-sector consultations

- A national document and data exchange (using digital locker) to facilitate the exchange of documents and data and enable straight-through verification and compliance.
- Improved urban e-governance in local bodies to address challenges such as water and electricity management, congestion, governance, and security using digital platforms such as the Unified Mobile Application for New-age Governance (UMANG).
- Comprehensive Direct Benefit Transfers to eliminate leakage (fraud, theft, and extortion) and inefficiencies in the disbursement of food, fertiliser, cooking gas, and power subsidies.
- A profitable digital service centre ecosystem with a Common Services Centre in every gram panchayat to expand the range and volume of G2C and B2C goods and services delivered by these centres.

C. **Healthcare for all.** Technology is making significant advances in healthcare delivery. According to experts, over the next decade, it may become mandatory for doctors to use tech solution software to provide second opinions about procedures for patients. In the not-so-distant future, a software platform could emerge as the biggest provider of healthcare, creating a bedless hospital, much as Airbnb has emerged as the biggest hotel chain without owning any rooms. To achieve significant improvement in access to quality healthcare services and better health outcomes, three digital themes can help:

- A universal, interoperable, and mobile-compatible electronic health record (EHR) for every Indian by 2025, along with an Integrated Health Information Platform.
- Technology-enabled remote healthcare in public and private health centres and hospitals.
- A universal public health insurance platform to support the national health-protection scheme, Ayushman Bharat.

D. **Quality education for the future.** Over the years, India has invested heavily to improve access to education, and this has increased enrolment. However, learning outcomes have stagnated. Digital content and channels provide a powerful opportunity to bridge the last remaining gaps in access and, equally importantly, to improve learning outcomes significantly. The critical national priority of improved learning outcomes across all educational institutions could be accelerated through two digital themes:

- Digital content delivery and learning in schools and higher education centres with HD video-based learning and online open courses.
- An integrated education content platform, with customisable local-language content and anonymised student-level competency data to enable innovation that can address educational competency gaps, facilitated by an education innovation fund.

E. **Energy for all.** Historically, India's power sector has focused on improving access, but a new set of reforms such as the Integrated Power Development Scheme are promoting the use of IT to improve distribution and transmission. These digital reforms will expand focus from access to consumer-level reliability and quality of power supply. Energy for all includes two themes:

- Digitally enabled, affordable power access through installing prepaid meters, complete digitisation of bill payments, and advanced analytics in DISCOMs.
- A smart grid that integrates distributed generation, renewables, and bidirectional flows to enable entities on the grid to be both consumers and producers of energy. As part of this effort, government should support research, proofs of concepts, and scaling up of specific smart grid technologies.

F. **Next-generation financial services.** India has approximately sixty million micro, small, and medium-size enterprises, most of which are in the informal sector.[41] They primarily depend on cash transactions and their own sources of finance for growth. The reach of formal, modern financial services to all sectors of the economy can be promoted by two digital themes:

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[41] *Annual Report 2017–18*, Ministry of MSMEs, Government of India.

- The embrace of digital payments by governments, businesses, and consumers across all states and rural and urban parts of India.

- Flow-based lending and advanced credit underwriting for micro, small, and medium-size enterprises using data from the GSTN and other sources to undertake credit scoring, risk-based pricing, and portfolio credit risk management.

G. **Doubling farmers' incomes.** The $1 trillion digital economy could remain a dream if it does not have a significant impact on agriculture, which accounts for about 18 percent of the country's GDP and employs about 45 percent of its workforce.[42] Raising farmers' incomes and boosting their income security, one of the highest priorities for the government, can be aided by three digital themes:

- Digital financing and insurance payouts enabled by consolidating information and facilitating credit-scoring and yield-forecasting models using satellite and weather data.

- Precision agriculture using data analytics approaches, with an integrated data platform across all available and new sources, such as the 158.7 million Soil Health Cards dispatched.[43]

- Online agricultural marketplaces linked on a one-India market, a set of institutional market facilitators, and common universally available assaying and grading standards.

H. **Make in digital India, make for India, make for the world.** To establish a vibrant economy, India needs to improve its productivity and global competitiveness in manufacturing and associated value chains like trade and logistics. Five themes are critical for this:

- Digital end-to-end supply chain, e-enabled trade, and e-commerce that reaches all Indian consumers and producers across the country, links small retailers into digital value chains, and improves inventory-handling efficiency. Private-sector pilots of these measures have shown productivity gains of more than 20 percent.

- Efficient passenger transportation enabled by shared ride-hailing platforms throughout the country for better utilisation of vehicles, less congestion, and reduced pollution.

- An integrated digital logistics platform to standardise and digitise documentation, optimise modal mix of freight, and employ e-tolling, dynamic routing, and predictive maintenance of fleets.

- AI and IoT incubation centres, resource centres, and automation and IoT-based advanced analytics test beds to improve the competitiveness of the manufacturing sector.

- Vibrant electronic-device manufacturing ecosystems encompassing design, components, and assembly of smartphones, LED and LCD televisions and set-top boxes, LED lights, sensors, medical electronic devices, among other products.

I. **Jobs and skills for the future.** To make full use of India's demographic dividend and create opportunities for the workforce, three digital themes can help:

- Skill building for the future by creating a large-scale national partnership for workforce skill upgrading across industries.

- Online talent marketplaces to connect employers with work seekers at all levels, including a jobs data platform to capture labour demand and supply data at a granular local level, leveraging channels like CSCs and post offices.

- Digitally-enabled jobs to allow people to work from home or from remote geographic locations to instead of needing to be co-located at the point of work delivery. The government could encourage this by outsourcing government/private data processing work to semi-urban and rural BPOs and recognising and enabling independent skilled professionals to engage in project-based employment through freelancing portals.

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[42] National Accounts Statistics, Central Statistical Organization, Ministry of Statistics and Programme Implementation; *Report on fifth annual employment-unemployment survey*, Ministry of Labour and Employment, 2015–16.

[43] Soil Health Card website, Government of India, as of September 27, 2018.

These 30 digital themes are not futuristic or improbable — most are already being demonstrated in pilot programmes and initiatives by the private sector and government in India, and many promising models can be scaled up to achieve greater impact. This report catalogues a host of such initiatives undertaken by the government, the private sector, and non-governmental organisations.

Accelerated implementation and adoption of these digital themes is essential if India is to become a $1 trillion digital economy by 2025. The analysis of about 50 digital applications globally reveals that digital adoption could vary from as low as 20 percent of the addressable set to as high as 80 percent over a seven- to eight-year horizon. The speed with which enterprises adopt an application depends on a welter of reasons, including whether an at-scale use case already exists, whether users have experience employing digital tools and see value in that specific use case, and whether the requisite policy/regulatory push is already in place or likely to emerge in the near future. Based on these broad criteria, sized themes were classified into three groups based on potential adoption rates — 20 to 40 percent, 40 to 60 percent, and 60 to 80 percent (Exhibit E6).

By 2025, India could create a digital economy of $800 billion to $1 trillion (or value equivalent to 18 to 23 percent of the country's nominal GDP).[44] The economic value is estimated as a range, based on the potential value of digital provider sectors (such as IT-BPM and electronics manufacturing) as well as the potential adoption rate of key digital applications in other sectors and the possible value arising as a result, from higher productivity, resources savings, and tapping new factors of production. India's digital economy in 2017–18 was about $200 billion (or 8 percent of nominal GDP) and mainly comprised of IT-BPM, digital communication services (including telecom), electronics manufacturing, e-commerce, digital payments and Direct Benefit Transfer of subsidies. The digital economy of the future could span all sectors of the economy (Exhibit E7). While almost half of the $1 trillion of potential value in 2025 could come from growth in existing ecosystem (digital payments, e-commerce, electronics manufacturing, IT-BPM, digital communication services and DBT), the rest could be generated by new digital ecosystems in sectors such as agriculture, education, financial services, energy, healthcare, and logistics. It is difficult to predict how value will be distributed across digital innovators, incumbent businesses, small and medium-size enterprises, independent workers, and consumers in many sectors of the economy, but the overall pie available will be sizable. It is interesting to note that this detailed bottom-up aggregation of how digital applications create value of up to a $1 trillion is strikingly close to some recent studies that have tried to estimate the digital economy using a dynamic regression-based approach (refer to Box 5). It is estimated there would be an increase in internet subscribers from about 40 percent of the population in December 2017 to about 65-70 percent by 2025, representing 9 percent annual growth. A 10 percent increase in internet penetration results in a 3.9 percent increase in per capita GDP. Applying this ratio to the 9 percent growth of internet subscribers, per capita GDP increases by $600 to $650 during this period. With an estimated population base of approximately 1.4 billion by 2025, this translates into incremental value creation of $850 billion to $900 billion, similar to $1 trillion estimated from the more bottom-up manner.

Beyond economic value, millions of digital professionals as well as workers in small and medium-size enterprises and in the farm sector can gain access to better income-earning opportunities. The $1 trillion economy could support 60 to 65 million workers in 2025 based on expected trends in labour productivity by sector (Exhibit E8). Some 40-45 million workers will need substantial retraining and redeployment, as a result of significant change in the nature of their work due to automation or other disruptive digital applications such as Direct Benefit Transfer of subsidies and online trading of agricultural produce. Those analyses help estimate the extent to which firms are likely to introduce efficiency-enhancing digital improvements that free up labour time and the impact of entire industry value chains' being disintermediated as a result of mass-scale digital adoption that fundamentally reshapes the nature of work in that sector. If correctly harnessed, new digital ecosystems — technology-enabled business models that lead to better job and skill matching, better sharing and utilisation of assets and know-how, and improved access to digital services to underserved parts of the

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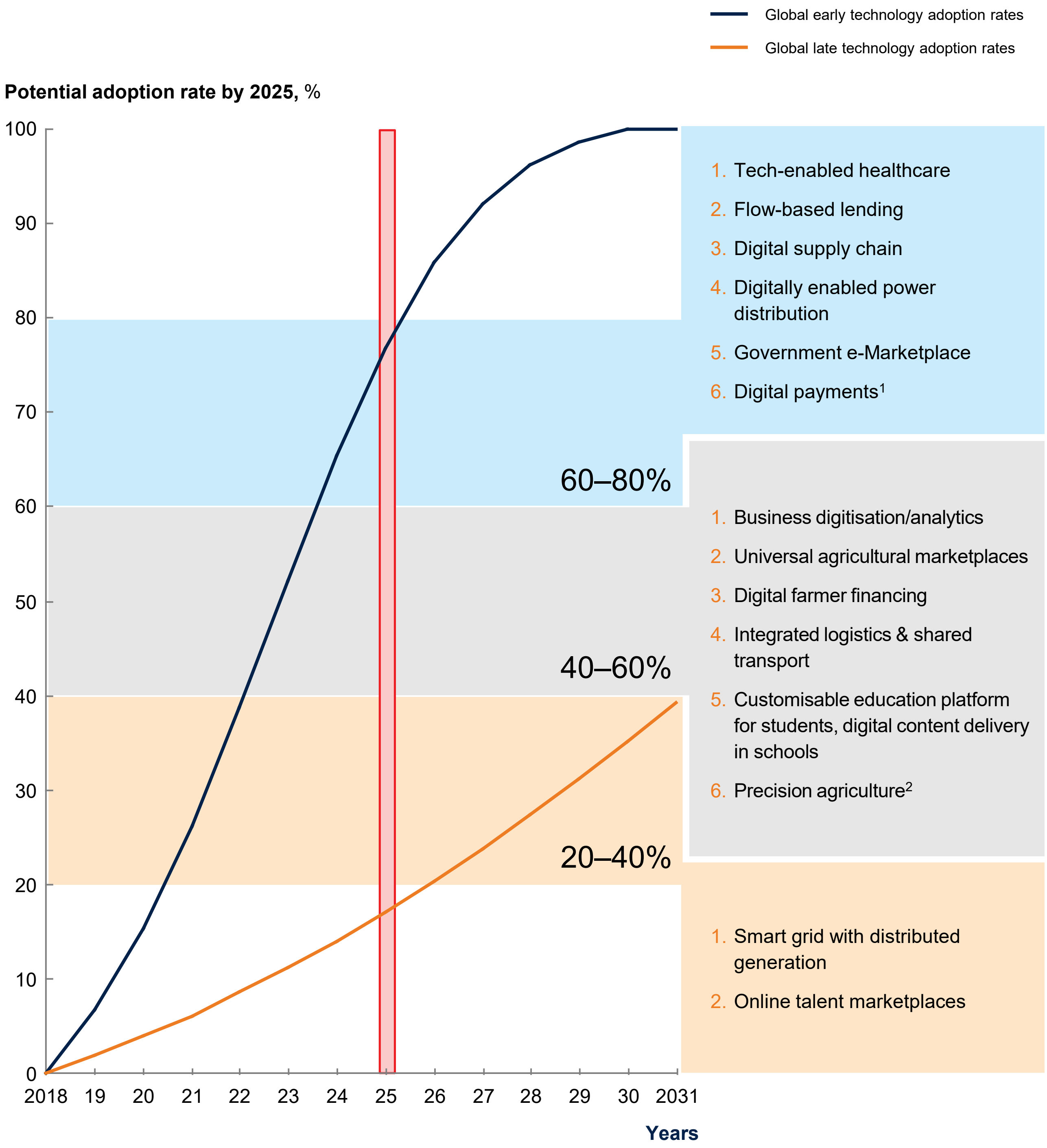
[44] Multiple factors pose challenges in measuring the size of the digital economy — overall methodological questions on how GDP is accounted for and the fact that quality improvements and nonmarket production do not play a role in it; the highly fragmented nature of digital interactions and practical difficulties of capturing them; and the rapidly falling cost of technology and its implications for valuation of output from technology providers. In this report, therefore, we refer to all estimates of the size of the digital economy as "economic value" rather than "GDP" or "GVA".

EXHIBIT E6

The value realisation is contingent on digital applications permeating deep in most of the sectors of the economy by 2025



1 Value of retail transactions that will be intermediated through digital.

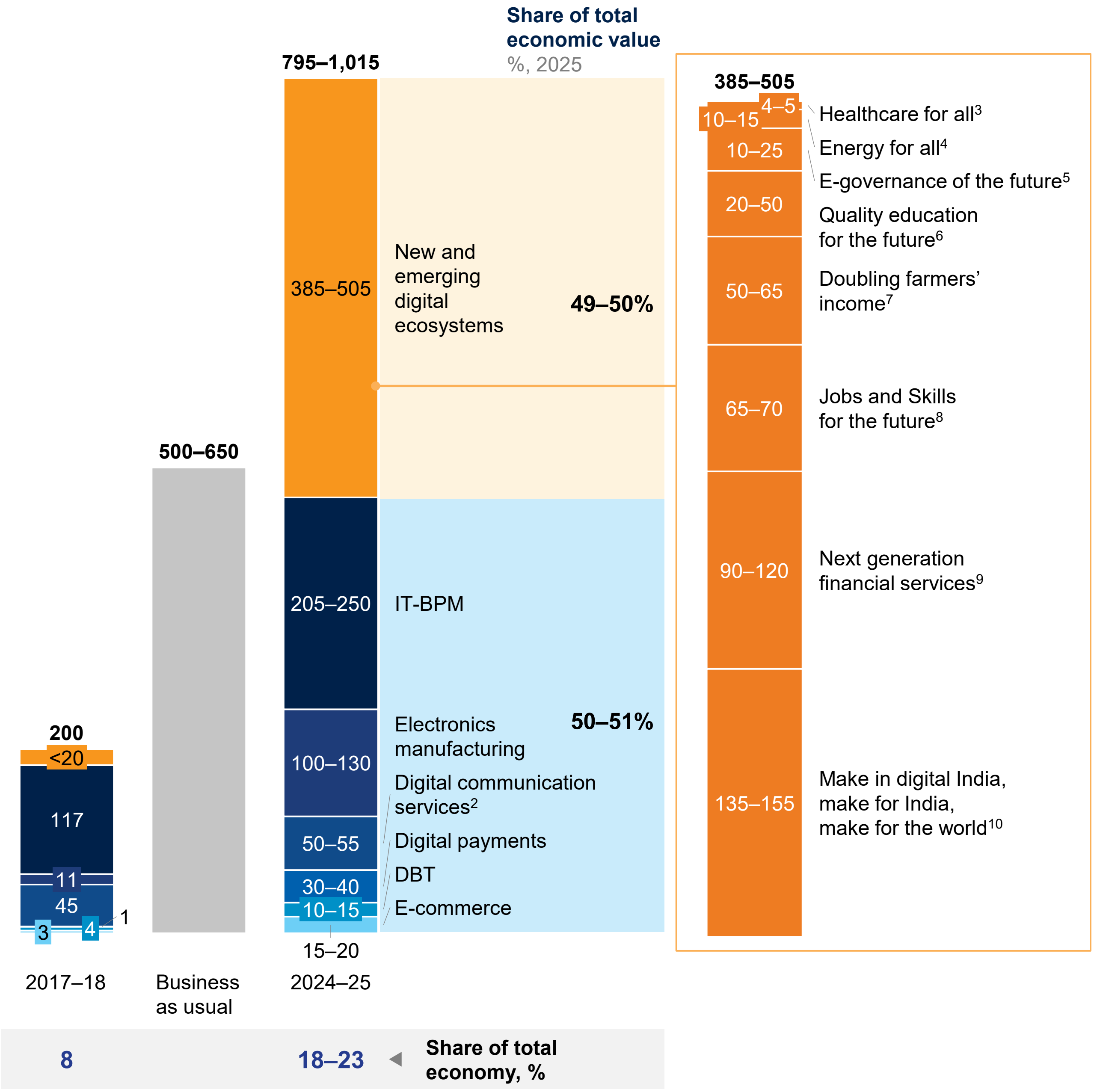
2 Assumed to vary with size of the landholding. Adoption rate of 20–40% is assumed for landholdings of less than 1 hectare, 40–60% for landholdings of 1–4 hectares, and 60–80% for landholdings of more than 4 hectares.

SOURCE: *A future that works: Automation, employment, and productivity,* McKinsey Global Institute, January 2017

EXHIBIT E7

India’s digital economy could contribute 18–23% of overall economic activity by 2025, with more than half the potential coming from scaling up new and emerging digital ecosystems

Size of India’s digital economy, $ billion, nominal

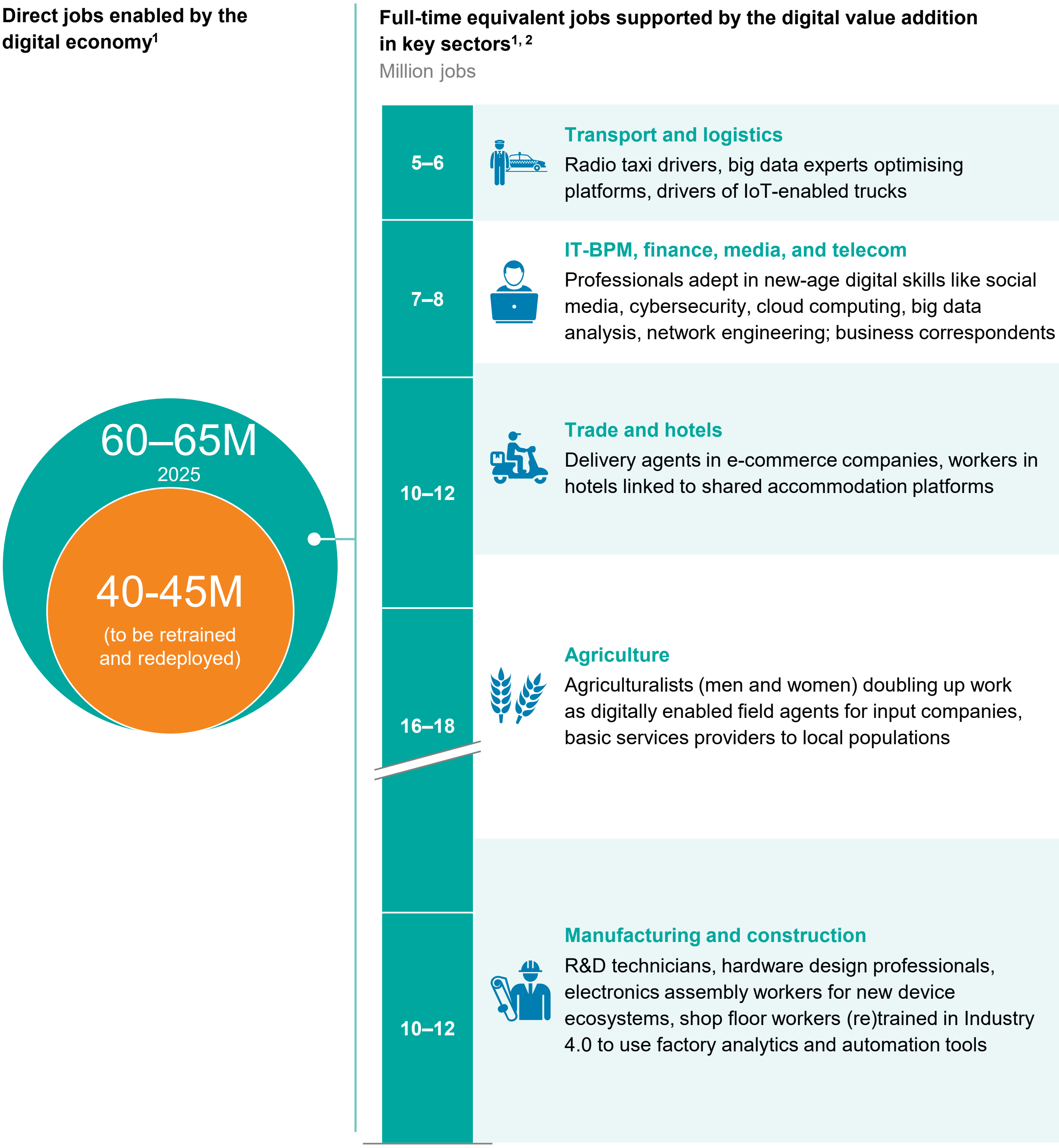


1 Figures may not sum to 100% because of rounding.
2 Estimation for 2025 includes value addition from visual broadband services, plus digital media and entertainment.
3 Tech enabled healthcare.
4 Digitally enabled power distribution and smart grid with distributed generation.
5 Government e-Marketplace and DBT.
6 Customisable education platform for students, digital content delivery in schools.
7 Digital farmer financing, precision agriculture, and universal agricultural marketplace.
8 Online talent platforms.
9 Flow based lending.
10 End-to-end digital supply chain, efficient transport and logistics, and business digitisation and IoT.

SOURCE: *India energy security scenarios, 2047,* Government of India; US Energy Information Administration; *Public Procurement Observations in India (English). Washington, D.C.: World Bank Group*; Planning Commission, Government of India; *A labour market that works,* McKinsey Global Institute, 2015; Prabhat Barnwal, *Curbing leakage in public programs: evidence from India’s Direct Benefit Transfer policy,* Michigan State University, 2018; *Economic survey, 2015–16,* Ministry of Finance, Government of India; *A future that works,* McKinsey Global Institute, 2017; Montenegro and Patrinos, *Comparable estimates of returns to schooling around the world,* World Bank, 2014

EXHIBIT E8

The value created by the digital economy of the future could support 60-65 million jobs by 2025



Direct jobs enabled by the digital economy[1]

Full-time equivalent jobs supported by the digital value addition in key sectors[1, 2]

Million jobs

Million jobs	Sector	Jobs
5–6	**Transport and logistics**	Radio taxi drivers, big data experts optimising platforms, drivers of IoT-enabled trucks
7–8	**IT-BPM, finance, media, and telecom**	Professionals adept in new-age digital skills like social media, cybersecurity, cloud computing, big data analysis, network engineering; business correspondents
10–12	**Trade and hotels**	Delivery agents in e-commerce companies, workers in hotels linked to shared accommodation platforms
16–18	**Agriculture**	Agriculturalists (men and women) doubling up work as digitally enabled field agents for input companies, basic services providers to local populations
10–12	**Manufacturing and construction**	R&D technicians, hardware design professionals, electronics assembly workers for new device ecosystems, shop floor workers (re)trained in Industry 4.0 to use factory analytics and automation tools

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1 Estimate based on estimated labour productivity in 2025 of each broad sector; assumes that workers remain in the same sector where value is created (though in reality, they may shift to other sectors depending on demand); includes some 40-45 million workers who would need to be retrained and redeployed as labour-displacing technology fundamentally transforms their current work.

2 Other sectors like public administration and defence, mining and quarrying and construction explain the difference

SOURCE: *A future that works: Automation, employment, and productivity,* McKinsey Global Institute, January 2017

country — could create 15 million to 20 million digitally enabled jobs; a significant number of them would be part-time positions that provide workers with the flexibility and autonomy that many of them desire.[45]

What is needed to realise this vision

Achieving a $1 trillion digital economy is not a certainty. Several prerequisites must be met, and the right governance and execution enablers need to be put in place in order to move toward that goal. The challenge is even steeper when it comes to building new and emerging digital ecosystems such as flow-based lending, technology-enabled healthcare delivery, and digital platforms to provide new-age skills and match job seekers with work opportunities, since profitable business models for these digital themes have yet to be fully developed and rolled out at scale; also, the policy and regulatory environment for some of these areas is uncertain at this point. To realise this vision, government must work with the private sector and build a collaborative working model to spur innovation and investment. Without such a commitment, backed by accountability for speedy execution, India could only generate economic value of $500 billion to $650 billion by 2025, as the share of new ecosystems depending on government policies, platforms, and partnerships would not be realised in full measure.[46] These are outlined in the sections below and described in some detail in the rest of the report.

First, it is vital to frame some overarching principles for the government, based on recognising that the digital world is essentially borderless, with capital, innovation, data, and design capabilities flowing into countries that offer the fewest pain points. If India is not well positioned in the global digital diffusion race, it could face a widening "digital deficit" in balance of trade, capital, and intellectual property. In this light, the government could adopt the following overarching principles to boost India's digital economy and mitigate the risks of a digital deficit.

1. **Significantly improve the ease of operations and reduce the cost of operations for digital businesses.** The government is committed to making India one of the 50 easiest countries in which to do business, and that effort is beginning to show impact. The World Bank's 'Ease of Doing Business' rankings for 2019 show India rising an impressive 23 places and coming in at 77th rank. India's leap of 23 ranks in the Ease of Doing Business ranking is significant considering that last year India had improved its rank by 30 places, making India in top 10 jumpers and the only one amongst the large countries. Last year's report noted that India has adopted 37 reforms since 2003, nearly half of them between 2014-2018.[47] India needs to build on this momentum and aspire to be among the top 10 countries globally for digital businesses and startups. It must set concrete, time-bound goals to achieve this objective; for instance, entrepreneurs must be able to start a business in less than a day (as is the case in New Zealand), or something close it. Thus giving a boost to the overall digital ecosystem.[48]

   Digital businesses provide a useful test bed for the government to streamline, standardise, and digitise compliance processes and procedures. The government can also work with business entities to develop market-friendly regulations, standards, and platforms within specific domains, as the Reserve Bank of India has done for payments processing by setting up the National Payment Corporation of India with the involvement of private- and public-sector banks as stakeholders.

2. **Unlock the flow of domestic capital into digital businesses.** Domestic savings can be a strong complement to the large amounts of FDI, foreign institutional investment, and foreign HNI-driven investment in India's technology sector. The flow of domestic capital into digital businesses enables the assets and wealth created by businesses to be retained in the country and ploughed back into the digital economy. Increased financial support from the government through credible, transparent vehicles (such as the Yozma initiative by Israel, or Singapore's scheme in which government funding matches venture capital funding for startups) is one step that could give impetus to domestic digital ventures.[49]

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[45] Independent work: Choice, necessity and the gig economy, MGI, October 2016.

[46] Ibid.

[47] *Doing Business 2018*, World Bank, October 31, 2017.

[48] Startup definition, Department of Industrial Policy and Promotion, Government of India, as of April 16, 2018.

[49] "What makes Israel's innovation ecosystem so successful", Forbes, January 9, 2017; Startup SG Equity scheme, as of April 16, 2018.

Government-backed investment could be up to 15 to 20 percent of those of a venture capital fund, and be raised for digital businesses in specific sectors. Another step to consider is rationalising tax rates to attract more early-stage financing for startups; current tax structures make investing in startups less attractive than investing in public markets. The government could also allow certain types of nonprofit private or corporate foundations to invest directly or indirectly as angel or seed investors — in developed markets, such foundations have been important sources of patient capital for technology innovations that require long gestation periods.

3. **Facilitate a booming open API ecosystem.** The 30 themes outlined earlier, and many more that will emerge as technology evolves, all suggest a potential explosion of fintech, agritech, healthtech, edutech, and other tech-based innovation in India. To facilitate innovation, every government digital initiative needs to conform to the MeitY open API guidelines. This will ensure that people have the flexibility to use the underlying raw and processed data per their objective and interest, thus fostering an environment of innovation. In addition, data on the central government's portal, gov.in, must be restricted to open use by only Indian organisations and companies, to act as a magnet for researchers and innovators to migrate to India. Promising examples already exist which leverage open APIs to create solutions to benefit the end user. For example, using rainfall data of 13 districts in Andhra Pradesh collected over the past 45 years, Microsoft, in collaboration with ICRISAT, has developed an application which advises farmers on the best time to sow crops, ideal fertiliser mix, etc. This has shown to increase productivity by 30 percent for the 175 farmers selected for the pilot. Likewise, e-Governments Foundation has developed open source, interoperable technology solutions to connect urban governments with citizens. This has resulted in an increase of 72 percent in property tax revenue collection of Delhi between 2008–9 and 2013–14.

4. **Support Indian digital innovators through procurement.** The government is a large potential buyer of services and can act as a market maker to create scale for the best innovations and technology applications coming out of the country. It can do so directly (for example, by procuring telemedicine services from the private sector for its primary health network) or indirectly (such as by purchasing all goods and services on the Government e-Marketplace platform, which encourages vendors to become digitally enabled). Transparent mechanisms would be required to provide an open system for Indian innovators to propose ideas and build products to solve problems of national importance. These could take the form of technology and product purchasing councils, with open competitions to find the best innovation to serve a national need. The top two consortia could win, say, 60 percent of the expenditure on that solution for a period of five to seven years.

5. **Unshackle centres of higher education and innovation.** Competitive advantage in the digital economy of the future will lie in developing its workforce's skills in design, creativity, and innovation. For this, it will be vital for India to have vibrant higher education institutions that collaborate closely with industry in innovation clusters and tinkering labs. Countries such as China and Singapore have invested in making their higher education institutions among the top 100 in the world.[50] Locations where world-class innovators gather and thrive, such as Singapore, Tel Aviv, Seoul, and the San Francisco Bay Area, are essential to the digital economy.[51] India needs to strengthen and invest more resources in existing centres of excellence and create a combination of chairs, scholarships, and special funds to invite global leaders to come to India and train talent. It also needs to develop more manufacturing and services clusters that serve as centres of the digital economy, supporting new digital jobs in the process. For this, a significant fraction of local revenue must be ploughed back into the city to improve physical and social capital.

As an example of the approach for creating centres of excellence, MeitY set up four committees of industry and academia to draw a road map showing how new and emerging technologies could be applied in real world. They have incorporated findings from the recently released NITI Aayog's "National Strategy for Artificial Intelligence" as well. To operationalise these recommendations, MeitY is working with Digital India Corporation (DIC) to set up a National Centre for Artificial Intelligence (NCAI) as an apex body for artificial intelligence.

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[50] Ellie Bothwell, Jack Grove, World University Rankings 2018: results announced, Times Higher Education, September 5, 2017.

[51] *Tech cities 2017*, Savills World Research, February 13, 2017.

With these overarching principles as the guide, specific steps are required to capture the potential of each of the 30 digital themes. Discussions with over 90 organisations, more than 15 central government ministries, and extensive consultations with state IT ministers and officials — all actively deploying digital technologies — have helped identify specific prerequisites for success for each digital theme, which are typically policies, platforms, or partnerships. Without stakeholders taking action to address barriers and put the enablers in place, full economic value will not be realised. Several areas need to see concerted efforts and new mechanisms for collaboration between government and businesses (Exhibit E9). These are outlined briefly below and presented in detail in Section 2 of this report:

- **Adopting supportive policies and regulations.** New policies and guiding frameworks will be required in several areas. They include, for example, clarified data encryption and governance standards, a clear data-protection policy that meets international standards, active participation in global IoT standard-setting bodies, and the creation of a data interoperability committee for the IoT and beyond. Policies that create legal recognition and incentives will be required for participation in the national document exchange and the national digital land repository, with conclusive titling. Multiple stakeholders need to establish policies to clarify the roles of government and private-sector parties to facilitate remote healthcare and virtual learning and teaching. A clear policy governing the civilian use of drones, and policies supporting the manufacture of a wide variety of electronics, such as LED devices and set-top boxes, are some other examples. In addition, the overall regulatory stance would need to balance risk mitigation with encouraging innovation to solve problems. The government can provide the right environment for private-sector innovation through policy labs, regulatory sandboxes, incubation centres, and other test beds for new fintech and IoT-based applications, for example. Enabling private-sector innovation is critical to achieving Digital India goals.

- **Initiating new digital platforms and ecosystem enablers.** API-based, public, societal platforms can play a critical role in triggering and enabling solutions from startups and digital innovators. India will need to create several such catalytic platforms to accelerate capturing the value of the digital economy. Platforms that facilitate digital authentication and data integration of MSMEs, open-data platforms that integrate agriculture data from diverse sources, and a labour market information system to aggregate data on skilled job seekers and job vacancies are important examples, as is an interoperable land records platform that dynamically mirrors on-the-ground realities with land records. All such platforms would need to be created on an open API basis, allowing innovators to create digital apps and solutions that plug into the underlying data in the platform. In addition, necessary digital infrastructure elements include cybersecurity information-sharing platforms, digital dashboards that help monitor national priorities, and improved versions of the Government e-Marketplace platform to support vendor participation.

- **Team India partnerships and collaborations.** Central and state governments, the private sector, and social-sector organisations can bring complementary assets and capabilities to public-private-social partnerships. One example is building digital infrastructure and training healthcare workers in primary health centres. Some of these digital transformations could be government-led and business-enabled, while others could be government-enabled and business-led.

Beyond a blueprint for the enabling steps required, the right governance architecture is an important element of the road map. Some recommendations follow:

- **Set up sector-specific consultative forums to engage Team India in digital transformation.** These councils would be led by the government with private sector participation for, say, three-year terms. A few councils could be set up initially: technology infrastructure (data storage and cybersecurity); healthcare; education and skills training; agriculture (and food processing); and transportation and logistics. Each would include representatives from across the value chain.

EXHIBIT E9

Examples of actions required

Priority areas	Data platforms with open APIs	Public-private partnership opportunities	Government initiatives (with private sector inputs or execution)
A 21st century IT and telecom infrastructure and services	▪ Facilitate a booming open-API ecosystem by ensuring that every government digital initiative needs to conform to open-API guidelines ▪ Strengthen National Knowledge Network as a backbone to catalyse rapid spread of domain networks	▪ Establish a future-skill platform, in partnership with the private sector, to train and retrain IT workforce in new and emerging technologies like AI, IoT, data analytics ▪ Create PPP framework to bring affordable 'visual broadband' to every home leveraging BharatNet 2 ▪ Set up an expert technical group to lay out India's future architecture and roadmap for next-gen broadband infrastructure	▪ Finalise personal data protection framework with statutory backing to protect personal data privacy while encouraging innovation through appropriate consent frameworks ▪ Introduce regulations to remove obstacles to broadband rollout (e.g., right of way) and declare fibre as critical national infrastructure ▪ Create nodal cybersecurity body to streamline and consolidate multiple existing agencies
B E-governance for the future	▪ Design interoperable land records platform to link and "mirror" data on record of rights, mutations and cadastral maps, enabling a move towards eventual conclusive titling ▪ Host a set of shareable APIs and digital tools that urban local bodies can use with minimum customisation ▪ Push national document and data exchange by setting up a digital trade platform for paperless exchange and verification of documents like purchase documents, letters of credit, bank guarantees, invoices to give further impetus to ease of doing business	▪ Equip Common Services Centres as local employment exchanges by collating demand and supply of labour in the areas they serve ▪ National Government Network	▪ Expand DBT channel beyond bank accounts to reach beneficiaries through BCs, India post, CSCs
C Healthcare for all	▪ Build an integrated Health Information Platform to create and provide access to electronic health records for every Indian ▪ Operationalise a secure digital platform and software for NHPS/Ayushman Bharat	▪ Develop model PPP for setting up digital infrastructure and training for health workers in primary health centres and other medical care facilities	▪ Finalise/implement DISHA Act with National e-health authorities to provide framework for sharing of health information digitally – Frame policies to mandate EHR adoption
D Quality education for the future	▪ Create an open education platform with data on student competency levels to enable individualised learning through customisable, context-ready education solutions	▪ Develop model PPP for setting up digital infrastructure and training for schools and teachers	▪ Clarify rules and policies to recognise distance learning ▪ Prioritise broadband connectivity in schools/educational institutes under BharatNet ▪ Define digital literacy benchmarks for students/teachers

Priority areas	Data platforms with open APIs	Public-private partnership opportunities	Government initiatives (with private sector inputs or execution)
E **Energy for all**	▪ Complete digitisation of bill payments across DISCOMS	▪ Capacity building to conduct research and proofs of concepts for specific smart grid technologies ▪ Create energy service companies for efficient distribution of electricity, including renewables	▪ Install prepaid meters, especially in areas with low collections
F **Next generation financial services**	▪ Create platform for sharing data on financial trail (via GSTN filings, MCA21) to push credit to MSMEs ▪ Launch one-stop digitally-verifiable number for easy verification/authorisation of MSMEs	▪ Implement 100% digital payments by government for all procurement from farm and SME sectors	▪ Uniformity of data across multiple sources in a machine readable format
G **Make in digital India, make for India, make for the world**	▪ Create an integrated multimodal logistics platform with standardised e-documentation processes to help reduce India’s logistics cost from approximately 14% currently to less than 10%	▪ Invest in IoT and AI incubation centres, resource centres and test beds for new IoT and AI based applications for Indian industry ▪ Link small retailers into digitally-linked value-chains	▪ Expand Phased Manufacturing Programme for electronic devices such as LED, LCD/LED TVs, set-top boxes ▪ Develop action plans for specific electronics verticals (medical, automotive, defense)
H **Doubling farmers’ incomes**	▪ Create open data platform to enable creation of ecosystems for — Precision advisory on all aspects of agriculture from farming, marketing of agricultural produce and optimisation of inputs, warehousing — Institutional credit leveraging new data sources like bank transactions and asset (digital land) history — Finetune govt. policy	▪ Develop model PPP to demonstrate agriculture data analytics use cases and impact (e.g., soil health cards)	▪ Create institutional market facilitators to incentivise and execute agricultural trade through online markets ▪ Improve accuracy and timeliness of insurance payouts by estimating agricultural yield using satellite/ drone and weather data, reducing reliance on crop-cutting experiments
I **Jobs and skills for the future**	▪ Create a platform having a profile of all labour, capturing their journey from skill acquisition to job search at a granular level, leveraging channels like the CSCs and Post Offices	▪ Create large-scale national partnership for workforce skill upgrades across industries	▪ Develop policy to encourage and regulate remote training schemes ▪ Outsource government data processing work to semi-urban and rural BPOs

They could be asked to provide inputs to help each sector's digital strategy evolve and to suggest ways to streamline and simplify regulation and compliance to foster growth of the ecosystem.

- **Public digital platforms are important enablers for the vision** — in areas such as GSTN, education, agriculture, health, land, logistics, future skills and jobs, e-governance app ecosystem and digital data and document exchange.
- **Create a digital dashboard to measure progress** on outcomes across existing as well as future digital initiatives. It would serve as an important barometer of the evolution of India's digital economy in the years to come and be a tool for reviewing, streamlining action, and shaping future policy.

■ ■ ■

India's digital transformation is accelerating and has the potential to propel the country to new heights. Working with all stakeholders, the country could build on the dynamism already created to deepen, widen, and scale its digital economy in the coming years.

I

India's Digital Vision

1. India's digital revolution – A story of digital inclusion

Key Highlights

01

India is one of the biggest and fastest-growing digital markets in the world

02

Open, universal digital platforms and APIs, created and promoted by the government, provide a strong digital foundation

03

Decisive government action and private-sector innovation are driving rapid, large-scale digital adoption

04

Global technology trends have spurred private-sector investment and innovation to expand India's digital consumer base

The Digital India programme, launched in July 2015, is a flagship programme of the Government of India with a vision of transforming India into a digitally empowered society and knowledge economy. In line with the Honourable PM Shri Narendra Modi's vision of ensuring that technology is "accessible, affordable, and adds value", the Digital India initiative was aimed at improving the life of the common person. The programme centres on three key vision areas: a) infrastructure as a utility to every citizen, b) governance and services on demand, and c) digital empowerment of citizens. The PM said India may have missed the Industrial Revolution, but it will not miss the information technology revolution.[52] Echoing his sentiments, the Honourable Minister of Electronics and IT, Shri Ravi Shankar Prasad, calls the programme transformational in nature, which will strengthen the youth and future of India.[53]

Three and a half years later, India is in a sharply accelerating "liftoff" phase of its digital journey. Having built a strong foundation of digital infrastructure and expanded internet access through some 560 million subscriptions, India is poised for the next phase of growth — the creation of tremendous economic value and the empowerment of millions of Indians as new digital applications permeate and transform a multitude of activities and types of work at a national scale.[54] Over the last three and a half years, the government has taken up initiatives across many spheres, including e-governance, skills, and digital infrastructure, that have shown significant impact on the way that the nation lives and works. This study is a timely effort to take stock of the digitally enabled change that is under way in India and lay out a vision and road map for the coming years.

India is one of the largest and fastest-growing digital markets in the world

India is a global leader on several aspects of digital adoption (Exhibit 1). With nearly 1.2 billion mobile subscriptions and 560 million internet subscriptions, India is home to the second-largest mobile subscription base in the world and the second-largest internet

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[52] *Text of PM's remarks at the launch of Digital India week*, July 1, 2015, narendramodi.in.

[53] "Digital India to empower youth: Prasad", *Economic Times*, July 17, 2015.

[54] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of September 2018.

EXHIBIT 1

India has experienced large-scale digital adoption between 2013 and 2018, triggered by both government action and market forces

GOVERNMENT-LED

1.22 billion
up from 510 million
people with unique biometric digital identities (Aadhaar)

870 million
up from 55.8 million
Aadhaar-linked bank accounts

98 million
up from 6.5 million
daily e-government transactions

292,748 (as of April 2018)
up from 63,000
functional Common Services Centres providing e-services[2]

26.7 billion
up from 249 million
Aadhaar authentication transactions[2]

BUSINESS-LED

560 million
up from 238.7 million
Internet subscriptions

294 million
up from 90 million
Social media users

200 million
up from 30 million
WhatsApp subscribers

176.8 million
up from 40 million
e-commerce users

24.3 billion
up from 2.5 billion
annual digital payment transactions (digital wallets, net banking, or credit or debit card at point of sale)[3]

1 Figures as on 22nd January, 2019.
2 Common Services Centres and Aadhaar authentication transactions data compared to 2014.
3 Digital payments transactions data for January to December 2018 compared to FY 2013–14; all other figures for 2017/2018 compared to 2013.

SOURCE: Telecom Regulatory Authority of India; Unique Identification Authority of India; We Are Social; *India B2C e-commerce report 2016,* Ecommerce Foundation; Payment system indicators, Reserve Bank of India; Electronic Transaction Aggregation & Analysis Layer; WhatsApp; National monthly progress report, Common Services Centre scheme, November 2017; *Annual report 2016–17,* Ministry of Electronics and IT subscriber base.[55] The 1.2 billion Indians with Aadhaar biometric identities are the largest national population with digitally verifiable identities globally.[56] India has logged more app downloads — 12.3 billion in 2018 — than any other country except China.[57] Signalling the rise of the mobile-only internet generation, India is now one of the largest consumers of mobile internet data worldwide. Some 290 million Indians are active social media users, and the time each user spends on social media each week, 17 hours, now exceeds that in both the United States and China.[58] India has 200 million users active on instant messaging services such as WhatsApp. Collectively, they sent about 20 billion messages on WhatsApp on December 31, 2017, to mark New Year's Eve, out of the total 75 billion WhatsApp messages sent that day.[59] More than 292,000 functional government-approved Common Services Centres around the country deliver assisted online services.[60]

These numbers become even more striking when viewed in terms of growth relative to other major digital economies. Over the past four years, India's growth has been exponential. On many aspects of digital consumption, it ranks higher in terms of quantum of growth achieved than either China or the United States. More than 320 million Indians have joined the global network of internet users since 2013, more than doubling the total national penetration rate.[61] Smartphone ownership more than quadrupled in the same period, from 5.5 phones per 100 people in 2013 to 26.2 phones per hundred in 2018, with India adding more than 280 million smartphone users over that period.[62] Monthly mobile data consumption per user is growing at 171 percent annually — more than twice the rates of growth in the United States and China — while monthly fixed-line data consumption per user more than doubled, from 7.1 GB to 18.3 GB, between 2014 and 2018.[63] The number of digital payment transactions, including those involving digital wallets, internet banking, and credit or debit card transactions at points of sale, reached more than 20 billion in 2017–18 (up from 2.5 billion transactions in 2013–14).[64]

Decisive government action and private-sector innovation are driving rapid, large-scale digital adoption

India's rapid digital adoption has been driven by the government's realisation and commitment to technology as a key means of achieving national objectives, combined with tremendous private-sector innovation and investment to promote digital access and usage in a variety of areas. The government launched the Digital India programme in July 2015 with a vision of transforming India into a digitally empowered society and knowledge-based economy (see Box 1, "An overview of the Digital India programme"). Today, government efforts to establish a strong national digital foundation of public platforms and infrastructure as well as a host of digital applications and services have created real incentives for citizens to get online. Furthermore, global trends and falling technology costs have prompted domestic private-sector telecom and technology players to provide high-speed mobile internet and cloud services at affordable prices while also innovating offerings uniquely tailored for India. Beyond the steady growth in digital usage consistent with India's young demographic and rising per capita income and urbanisation levels, the country has witnessed disruptive actions by both the government and the private sector that have led to discontinuous, breakout growth on several digital parameters.

The government has been using technology to improve delivery of services through a range of initiatives, with significant impact. Common Services Centres provide online government services in over 169,363

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55 *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of September 2018; Analysys Mason, as of December 2018; *Digital in 2018: Southern Asia, Eastern Asia*, We Are Social, December 2018.

56 Aadhaar dashboard, as of April 18, 2018; *Aadhaar: Inclusive by design*, GSMA, March 2017.

57 Priori Data, January 2019.

58 *Digital in 2018: Southern Asia, Eastern Asia, Northern America*, We Are Social, December 2018.

59 "WhatsApp now has 1.5 billion monthly active users, 200 million users in India', *Financial Express*, February 1, 2018.; "Indians sent more than over 20 billion WhatsApp messages on New Year's Eve", *Hindustan Times*, January 4, 2018.

60 *National monthly progress report*, Common Services Centre Scheme, April 2018.

61 *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of December 2013 and September 2018; calculated as number of subscriptions divided by total population, as sourced from World Bank, as of April 19, 2018.

62 Strategy Analytics, as of December 2018.

63 *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, December 2013, and September 2018; Analysys Mason; Ovum network traffic forecast 2015–20; Ovum total fixed broadband subscription and revenue forecast 2016–21, as of March 22, 2018.

64 Payment system indicators, Reserve Bank of India, Table 43, March 2015, December 2018.

Box 1. INDIA’S DIGITAL REVOLUTION: Bridging the Digital Divide

The Government of India launched the Digital India programme in July 2015 to transform into India into a knowledge-based economy and digitally empowered society. It has mobilised Ministries and Departments to launch schemes and projects ensuring Digital Inclusion of all, leading towards Trillion Dollar Digital Economy. Digital India has given boost to entrepreneurship and has enhanced access to health, education and public utilities. It has led India to revolutionise governance by delivering speedy and transparent services to citizens, ensuring their participation and empowering them with the conducive environment to connect and grow. Another important attribute of Digital India is Digital Inclusion with the technology that is transformative, affordable and sustainable.

I. Digital Identity

Aadhaar is World’s largest digital identity programme that has provided a unique digital identity to around 122 crore residents of the country. It provides an identity infrastructure for delivery of various social welfare programmes. It has enabled portability and diversion elimination in PDS, reduction of manual intervention, faster delivery of LPG cylinders and access to cleaner fuel, and facilitating access to digital services of Government.

II. Digital Infrastructure

(i) Broadband highway

Broadband for All—Rural: Aims to provide broadband connectivity by connecting 250,000 gram panchayats by optical-fibre cables. About 2,90,162 kilometres of optical fibre have been laid, connecting 1,15,643 gram panchayats. Limited private-sector participation in building infrastructure is a challenge.

Broadband for All—Urban: Aims to improve broadband connectivity in urban areas. Guidelines for the grant of unified licences to virtual network operators (service providers that do not own infrastructure) and spectrum management have been issued. The government is working on guidelines for reforming right-of-way policy and allowing cable TV networks to provide broadband service to increase its availability to the public.

National Information Infrastructure: Aims to integrate the country’s digital infrastructure to provide high-speed connectivity and cloud platform services to government departments up to the panchayat level besides social sector services like e-education, e-health, e-agriculture, financial inclusion etc. Currently, a pilot is under way in one district each in five states (Gujarat, Nagaland, Karnataka, Kerala and Uttarakhand) and two union territories(Chandigarh and Pondicherry).

(ii) Universal access to mobile connectivity

Aims to deliver mobile coverage to every corner of the country by 2018. Currently, about 52 percent of people living in rural areas have smartphones, and more than 90 percent of 597,608 villages in the country have mobile service coverage. Generating demand for mobile services in rural areas is a challenge, which also results in limited participation from private-sector telecoms and internet service providers.

(iii) National Knowledge Network

National Knowledge Network (NKN) is a state-of-the –art network and is an important step towards knowledge society. Some of the NKN enabled applications are: Virtual Class Rooms, Collaborative research groups over NKN (closed user groups), NDL, NPTEL, Various Grids (like Cancer Grid, Brain Grid, Climate Change Grid), etc. As on Sep 2018 1669 Edge links to Institutions have been commissioned and made operational under NKN across the country which includes 388 links migrated from NMEICT to NKN.497 district links to NIC district centers have been commissioned under NKN.

(iv) GI Cloud (Meghraj)

In order to utilise and harness the benefits of Cloud Computing, this initiative aims to accelerate delivery of e-services in the country while optimizing ICT spending of the Government. This has ensured optimum utilisation of the infrastructure and speed up the development and deployment of eGov applications. More than 890 applications are running on 15300 virtual servers.

(v) eSign

eSign Electronic Signature Service is an innovative initiative for allowing easy, efficient, and secure signing of electronic documents by authenticating signer using e-KYC services. Some applications enhancing services delivery are Digital Locker, e-filing Financial Sector, account opening in banks and post office, driving licence renewal, vehicle registration, certificates for birth, caste, marriage, income certificate etc. 5 e-Sign providers have been on-boarded and more than 5.89crore e-Signs have been issued.

III. Digital India for Better Governance

(i) JAM Trinity for DBT: The combination of 32.94 crore Jandhan bank Accounts, 121 Crore mobile phones and digital identity through 122 crore Aadhaar is helping the poor receive the benefits directly into their bank account leading to a saving of Rs. 90,000 crore.

(ii) Digital Payments: The growth of digital payments ecosystem is set to transform the economy. Over the past four years digital payment transactions have grown multifold from 316 crore transactions in 2014-15 to 2430 crore transactions in 2017-18. Today, BHIM app has become one of the main digital payment instrument for sending, collecting the money and to pay for various utility bills. In Sept, 2018, more than 163 lakh transactions of value Rs 7,065 crore were made using BHIM app.

(iii) UMANG has put the power of governance in the hands of common people. It is a single mobile app that offers more than 307 government services. The target is to provide more than 1200 digital services on a single mobile app. More than 8.4 million users have downloaded this app since its launch in November 2017.

(iv) Digital Delivery of Services is now easily available to common people through digital platforms like:

- **National Scholarship Portal** which has 1.08 Crore students registered with scholarships worth Rs 5295 Crore disbursed in last 3 years.
- **Jeevan Pramaan** for ease of verification of pensioners using Aadhaar digital identity. 1.73 Crore Digital Life Certificates have been submitted since 2014.
- **eHospital and Online registration services** to ensure that patients can get easy access to doctors. Implemented in 318 hospitals. 5.6 Crore eHospital transactions in all States since Sept 2015.
- **Soil Health Card:** National Soil Health Card scheme was launched in 2015 to provide information on soil health digitally. So far, 13 crore cards have been issued.
- **eNAM:** National Agriculture Market (NAM) is a pan-India electronic trading portal which networks the existing Agricultural Produce Marketing Committee (APMC) mandis to create a unified national market for agricultural commodities. Over 585 markets in 16 States have already been integrated. It has around 93 lakh farmers and 84,000 traders registered.
- **DigiLocker:** It is now possible to eliminate the need to carry any paper to avail a government service. With more than 1.56 crore registered users,68 issuers, 27 requesters DigiLocker provides access to over 336 crore certificates in digital format on a single platform.
- **eVisa:** Services of e-Visa involves completely online application for which no facilitation is required by any intermediary / agents etc. E-Tourist Visa (e-TV) has been introduced in 165 countries, 24 airports and at 5 Sea Ports. Since the launch of the scheme (November"2014) more than 41 Lac Visas has been issued.
- **eCourts (National Juidicial Data Grid):** E-Courts MMP has been launched with objective to provide efficient & time-bound citizen centric service delivery, provide transparency of Information and access to its stakeholders, and enhance judicial productivity both qualitatively & quantitatively. E-court is a justice delivery system which is affordable, accessible, cost effective & transparent. Case Information System- National Core Version 2.0 (CIS NC 2.0) is developed using Open Source Technology and implemented in District &Taluka courts of the country in bilingual mode. (Marathi, Hindi, Kannada, Tamil & Gujarati) Case status provided through SMS to Advocates & LitigantsMore than 9.16 crore cases has been registered using this platform and 5.63 crore judgements has been made. National Judiciary Data Grid (NJDG) is a part of eCourts Integrated Mission

Mode Project which works as a monitoring tool to identify, manage and reduce pendency, provide timely inputs for making policy decisions to reduce delay & arrears and promotes transparency & access of information for all the stakeholders. NJDG provides information on cases pending, cases disposed and cases filled for both High Court and District Court complexes in the areas of civil and criminal cases. Information on category wise pending cases and period wise pending cases is also available on the NJDG portal.

- **GeM:** Transparent online market place for government procurements. Over GeM 28,884 Buyer Organisations, 148,833 Sellers & Service Providers and 558,572 Products have been registered.

IV. Digital India for Employment, Entrepreneurship and Empowerment

(i) Digital Service delivery near door-step (Common Services Centres)

A vast network of more than 3.06 lakh of digital services delivery centres, spread across 2.10 lakh Gram Panchayats, across the country has been created to provide access to digital services especially in rural areas at an affordable cost. These centres have also led to empowerment of marginalised sections of the society by creating jobs for 10 lakh people and by promoting rural entrepreneurs, out of which 54,800 are women. CSCs have also undertaken Stree Swabhiman initiative to create awareness about menstrual health and have set up 204 sanitary pad units.

(ii) Digital Literacy to the masses in the Country

In line with the objective to make one person e-literate in every household in the country, two schemes were launched viz. NDLM and DISHA, wherein a total of 53.7 lakhs person were trained & certified in Digital Literacy in the country. In line with the earlier schemes, Government has approved a new scheme “Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA)” to usher in digital literacy in rural India to cover 6 crore rural households. So far, a total of 1.47 Crore candidates have been enrolled under the PMGDISHA Scheme, out of which 1.43 Crore candidates have been trained and 74.5 Lakh candidates have been certified.

Under skill-development schemes in the Electronics System Design and Manufacturing Programme have registered 283,375 candidates, trained 283,370, and certified 181,742.

(iii) BPO Promotion in Small Towns

To create employment opportunities for local youth and secure balanced regional growth of Information Technology and IT Enabled Services (IT/ITES) Sector in each State, India BPO Promotion Scheme and North East BPO Promotion Scheme have been launched under Digital India Programme. Today, more than 100 BPO units have come up in about 100 small towns of India across 20 States and 2 Union Territories, including in places like Visakhapatnam, Bhimavaram, Jammu, Sopore, Shimla, Patna, Muzaffarpur, Sagar, Nashik, Nagpur, Sangli, Aurangabad, Jaipur, Amritsar, Gwalior, Coimbatore, Madurai, Auroville, Bareilly, Lucknow, Kanpur Guwahati, Kohima, etc.

V. Digital India for Make In India

Promotion of Electronics Manufacturing

Government of India has undertaken various initiatives to promote electronics manufacturing in India, with the target of net zero imports by 2020. The Phased Manufacturing Programme for mobile phones was launched with the goal of widening and deepening the mobile handsets and components manufacturing ecosystem in India. From 2 units in 2014, we now have 120 units manufacturing mobile handset and components. Mobile manufacturing giant Foxconn set up four units in Shri City and is planning one in Maharashtra. The duty on import of mobile components fell from over 29 percent to 12.5 percent in 2016–17 and domestic mobile handset manufacturing output increased from 60 million units in 2014-15 to 225 million in 2017-18. The Ministry of Electronics and IT has received 245 applications for investing over $8 billion under the government’s Modified Specific Incentive Package Scheme, of which it has approved 142 applications representing investments. Out of these, 74 companies have started commercial production. This has created more than 4.5 lakh jobs opportunities (direct & indirect). There are about 35 manufacturing units of LCD/ LED TVs and 128 units of LED products in the country. Under Electronics Manufacturing Cluster (EMC) Scheme, MeitY has accorded approval to 23 projects in 15 states across the country.

VI. Early harvest

Aims to implement quick-turnaround projects that can deliver early evidence of the benefits of the digitisation drive. Examples of projects implemented include a biometric system to confirm government employees' attendance, secure government email, a national portal for lost and found children, a template for government email designs, e-greetings in government, Wi-Fi in all universities covered under the National Knowledge Network, and conversion of schoolbooks to e-books. Progress is evident in each of these programmes. MeitY, for example, has uploaded more than 5,258 books to the Central Board of Secondary Education's e-Basta portal and implemented biometric attendance for 901,713 central government employees and more than 1.8 million state employees.

VII. Initiatives in Emerging Technologies

20 Centres of Excellence (CoE) are being set up in the areas of Internet of Things (IoT), Internal Security, Large Area Flexible Electronics, Intellectual Property Rights (IPR), Tactile Graphics for Visually impaired, Agriculture and Environment, ESDM, Fintech, Language Technology, Automotive Electronics, Virtual Augmented Reality, Medical Tech and Health Informatics, BlockChain, Gaming and Animation, and Biometric. Out of this, Ongoing CoEs are 8, proposal of CoEs under consideration are 3 and New Proposals of CoEs submitted to MeitY for consideration are 11.

VIII. Cyber Security

To create an inclusive, safe and secure cyber space for sustainable development, the Cyber Swachhta Kendra (Botnet Clearing and malware analysis centre) has been setup to provide alerts to users for preventing losses of financial and other data. The centre is providing facility to clean botnets in realtime. National Cyber Coordination Centre has been made operational in 2017.

India's digital story is one of digital empowerment and digital inclusion for digital transformation based on technology that is affordable, inclusive and equitable. The Digital India Programme is generating pathways to a future powered by technology and achieving a high growth of our Digital Economy to reach a level of Trillion Dollars by 2025.

gram panchayats and have created entrepreneurial opportunities for an equivalent number of village-level entrepreneurs, or VLEs, including some 54,800 women.[65]

Basic computerisation of land records has been completed in the majority of states, paving the way for more digitised, transparent, and efficient property-related services (such as buying, selling, and financing). The Government e-Marketplace is attempting to address price inefficiencies in public procurement by increasing transparency through an online platform for sourcing. Steps have been taken to supply better information to farmers through digital channels and services such as e-NAM (the national agricultural marketplace), Soil Health Cards, and mKisan text- and call-based information services. The Phased Manufacturing Programme for domestic electronics manufacturing has had initial success, reducing dependency on imports and creating employment: based on government estimates, the manufacturing of mobile phones and mobile parts/components alone has generated over 450,000 jobs.[66] Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) has provided basic digital literacy to over 13.8 million Indians and aims to train around 46 million more.[67] The country's flagship financial inclusion programme, Pradhan Mantri Jan-Dhan Yojana, has opened bank accounts for more than 327.5 million Indians, nearly 60 percent of them in rural or semi-urban areas (Exhibit 2).

States are also aggressively implementing a number of digital initiatives across a wide spectrum of areas leading to significant benefit to the common citizen (Exhibit 3).[68]

Open, universal digital platforms and APIs, created and promoted by the government, provide a strong digital foundation

India Stack — a term used to refer to the universal biometric identity programme, Aadhaar, along with a suite of open APIs linked to it — has played a catalytic role in India's digital foundation and has played a catalytic role in the country's digital evolution (Exhibit 4). It is founded on the core principles that digital services could be "presence-less", or capable of being authenticated from anywhere; "paperless", or reliant on digital records; "cashless", or truly universalising the access and usage of digital payments; and "consent-based", or allowing secure movement of data authenticated by its owners.

India's national biometric digital identity infrastructure is the key component of the country's digital foundation. Enrolment in Aadhaar has risen steadily since 2010, and the government's decision in 2013 to link Aadhaar to welfare scheme payouts provided an added boost. In 2017, almost 90 percent of India's total population — over 1.2 billion people — had an Aadhaar biometric ID, making it the largest digital identity programme in the world.[69]

Complementing Aadhaar are a number of open APIs that the government has created and that India's consumers, businesses, and government agencies can use to gain efficiency, transparency, and cost advantages. In 2011, the government introduced the Aadhaar Payments Bridge and the Aadhaar Enabled Payments System, APIs that use Aadhaar as a digital key to electronically transfer benefits and subsidies from government agencies to targeted beneficiaries.[70] In 2012, the government launched eKYC, an API that allows businesses to perform electronic "Know Your Customer" anti-money-laundering verification processes digitally using the Aadhaar biometric identity or a mobile-phone-based one-time password. In 2015, eSign arrived, enabling an Aadhaar-based digital signature on a document, and then the government introduced

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[65] *National monthly progress report*, Common Services Centre scheme, MeitY, April 2018.

[66] Surajeet Das Gupta, Arnab Dutta, Despite mega announcements, Made in India mobile handsets still a promise, April 13, 2018.

[67] Pradhan Mantri Gramin Digital Saksharta Abhiyan, MeitY, as of April 19, 2018; state-wise PMGDISHA targets, Pradhan Mantri Gramin Digital Saksharta Abhiyan, MeitY, as of September 2018.

[68] Pradhan Mantri Jan-Dhan Yojana website, Department of Financial Services, Ministry of Finance, as of June, 2018.

[69] *State-wise Aadhaar saturation*, UIDAI, March 31, 2018; Aadhaar: Inclusive by design, GSMA, March 2017.

[70] State of Aadhaar report 2016–17.

Exhibit 2

The government's digital initiatives have had a significant impact

Key area	Initiative	Description	Impact[1]
eGovernance	**Common Services Centre**	▪ Access points for delivery of electronic services to villages	▪ **290,000** functional CSCs with 72% of all gram panchayats covered ▪ **54,800 women** entrepreneurs
	Digital land	▪ Development of a modern, comprehensive, and transparent land records management system	▪ **31 states** and UTs with complete computerisation of land records, as of Nov 2017 ▪ **30 states** and UTs with complete computerisation of property registration, as of Nov 2017
	DigiLocker	▪ Cloud-based platform for issuing and sharing key identity documents	▪ **15.3 million** registered users ▪ **20.5 million** documents uploaded
	Direct Benefit Transfer	▪ Subsidy and benefits disbursements directly to bank accounts	▪ **$70 billion** disbursed through DBT ▪ 433 schemes from 56 ministries covered
	Government e-Marketplace	▪ Online marketplace for procurement of goods and services by various government departments	▪ **27,978** buyer organisations and **143,751** sellers ▪ 823,283 orders
Agriculture	**eNAM**	▪ Pan-Indian electronic trading portal for agricultural commodities	▪ **$4.8 billion** value traded, as of August 2018 ▪ 96,118 buyers and 5,076,501 sellers, as of November 2017
	Soil Health Card	▪ Crop-wise recommendations of nutrients and fertilisers required for individual farms	▪ 158.7 million Soil Health Cards dispatched in cycles 1 and 2
	MKisan	▪ Crucial information, services advisories on farming through SMS	▪ **22 billion** text SMSs sent since May 2013 ▪ Kisan call centres answer farmers' queries in **22 languages**
Health	**Rashtriya Swasthya Bima Yojna**	▪ Health insurance coverage for families living below the poverty line	▪ Over **36.3 million** families enrolled ▪ **8,697** public and private hospitals in 278 districts
	E-hospitals	▪ Workflow-based hospital management ICT system	▪ **47 million transactions** made at indoor patient department, labs, or during registrations since 2015 ▪ Transactions implemented at **319 hospitals**

Key area	Initiative	Description	Impact[1]
Education	**SWAYAM**	▪ Web portal for accessing open online courses	▪ **1,031 MOOCs** (massive open online courses) ▪ Courses prepared by over **1,000 faculty** and teachers from across the country
	National Digital Library	▪ Integration of national digital libraries into one single web portal	▪ **700,000 books** by **300,000 authors** in **70 languages** ▪ **Over 18,000 video** lectures
	National Knowledge Network	▪ High-speed internet backbone for educational institutes	▪ Over **1,668 institutes** connected through National Knowledge Network
Manufacturing	**Phased Manufacturing Programme**	▪ Phase-wise increase in tariffs on mobile components to promote domestic manufacturing	▪ **118 mobile handsets and components manufacturing units** set up since 2014 ▪ **Imports reduced by 37%** for mobile phones and **43% for TV set-top boxes** from FY 2016 to FY 2017
Finance	**Pradhan Mantri Jan-Dhan Yojana**	▪ National mission for financial inclusion to ensure access to financial services	▪ **327.5 million beneficiaries** with 60% of beneficiaries at rural/semi-urban centre bank branches ▪ **$12.5 billion deposited** in bank accounts
Power	**UJALA**	▪ Replacement of incandescent bulbs, tube lights with LED bulbs	▪ **307 million LEDs** distributed ▪ **39 billion kWh** of electricity saved per year
Skills	**PMGDISHA**	▪ Digital literacy program for rural citizens	▪ **13.8 million candidates** trained in basic digital skills through partnering with **619 training partners**
Digital infrastructure	**Sectoral CERT**	▪ Computer emergency response teams for every sector	▪ **4 sectoral CERTS** setup for power transmission, thermal, hydro, and distribution ▪ **Dedicated CERTs** for finance sector under way
	MeghRaj	▪ National Informatics Centre (NIC) cloud offering services like platform; infrastructure; software as a service	▪ **Over 750 NIC applications** hosted on MeghRaj ▪ **14,000 virtual servers** operational

SOURCE: National monthly progress report, Common Services Centre scheme, April 2018; Digital India Land Records Modernisation Programme; websites of DigiLocker, Direct Benefit Transfer, Government e-Marketplace, eNAM, Soil Health Card, mKisan, RSBY, eHospitals, SWAYAM, National Digital Library, National Knowledge Network, Pradhan Mantri Jan-Dhan Yojana, PMGDISHA; UJALA dashboard; Ministry of Electronics & Information Technology, Government of India

EXHIBIT 3

Some examples of state-level initiatives in e-governance

State	Scheme	Description	Impact
Bihar 	▪ Smart Energy Infrastructure and Revenue Administration System ▪ Is an integrated framework of web, mobile, and GIS technology to aid electrical infrastructure	▪ Implemented energy billing software, mobile apps in the North Bihar Power Distribution Company across 21 districts and South Bihar Power Distribution Company across 17 districts ▪ ICT-based solutions help in project monitoring, handling grievances, spot electricity billing through mobile app, building an appropriate management information system to monitor revenue collection and other variables ▪ Helps in greater transparency between electricity board and its consumers	▪ Covers 9.8 million rural consumers across Bihar ▪ Monthly revenue has grown from about $53 million in 2014–15 to more than $98 million in 2017–18 ▪ Energy bill distribution on time increased revenue by $297 million annually
Andhra Pradesh 	▪ Aadhaar enabled Public Distribution System ▪ Entirely digitised PDS with supply chain management, fair shop transactions automated with Aadhaar-based biometric ID enables PoS devices	▪ Ration card data is digitised and Aadhaar seeded ▪ Monitors the movement of inventory from the Food Corporation of India godown, or warehouse, to fair-price shops until it reaches consumers	▪ 13 million monthly Aadhaar beneficiaries (ration card holders) ▪ Resulted in $165 million in savings ▪ 28,132 total shops with 12.2 million availed cards and 12.4 million monthly transactions
Karnataka 	▪ SAMRAKSHANE is an end-to-end e-governance solution to handle crop insurance under Prime Minister’s Fasal Bima Yojana programme and Modified Weather Based Crop Insurance Scheme	▪ Connects to Karnataka State Natural Disaster Monitoring Centre for weather data and calculates compensation based on term sheets under MWBCIS ▪ Transparent and farmer-friendly system for enrolment, registering claims, compensation calculation, and payment of compensation to farmers	▪ 1,059,801 enrolments under Kharif (2016) and 1,395,933 enrolments under Rabi (2016) ▪ 1,425,976 enrolments under Kharif (2017) as of August 18, 2016 ▪ 126,928 CSC enrolments with a premium amount of $2.6 million
West Bengal 	▪ Kanyashree Online 5.0 is a flagship programme of the West Bengal government to improve the status and well-being of girls, specifically those from socioeconomically disadvantaged families through conditional cash transfers	▪ Exclusive virtual workspace in Kanyashree online system where girls can share their experiences and take part in e-learning initiatives ▪ Scheme has two transfer components: – Annual incentive of $11.50 to be paid to girls 13 to 18 years old – One-time grant of $385 to be paid after a girl turns 18, provided she was engaged in an academic or occupational pursuit and was unmarried	▪ Serves 4.2 million girls ▪ 15,826 registered institutions ▪ Over $600 million disbursed ▪ 9 million applications sanctioned out of 9.4 million applications received

State	Scheme	Description	Impact
Gujarat 	▪ Direct Benefit Transfer of scholarships	▪ Scholarship schemes of Social Justice and Empowerment Department and Tribal Development Department schemes rolled out in year 2017 via Direct Benefit Transfer through Digital Gujarat Portal	▪ Disbursement of scholarships to roughly 7.5 million beneficiaries comprising $90 million for pre-matric and $92 million for post-matric
Chandigarh 	▪ Aadhaar-based food subsidy	▪ Traditional public distribution system of food grains replaced with Direct Benefit Transfer (DBT) ▪ First in the country without any fair price shop and with 100% Aadhaar Payment Bridge public distribution system	▪ 65,000 households with 280,000 beneficiaries impacted ▪ 100% DBT amount is transferred digitally to the account of 'Grehni' (elderly women of the household) through Aadhaar Payment Bridge ▪ DBT to the tune of $0.5 million done monthly ▪ Food DBT amount is transferred to the woman head of the family ▪ Beneficiaries free to purchase food grains of their choice
Himachal Pradesh 	▪ **e-District** project is a mission mode project, which aims to provide integrated citizen-centric services	▪ Project envisages integrated and seamless delivery of citizen services by district administration through automation of workflow, backend computerisation, and data digitisation across participating departments ▪ Citizens can access services at their doorstep in an integrated manner and online without having the trouble of physically traveling long distances	▪ 52 services rolled out under the project ▪ Responsive, transparent, and accountable service delivery ▪ Cost savings for citizens on account of — Fewer trips — Less waiting time — Possibility of tracking status of applications — Citizen's empowerment
Tripura 	▪ Common Services Centres	▪ CSCs were envisaged as internet enabled front-end delivery points, set up at gram panchayats (GP)/VC for government-, private- and social-sectors services to rural citizens — One CSC is to be set up for each GP	▪ 990 CSCs have been registered covering 608 GPs/VCs in the state ▪ 19 services are being currently offered, with about 2.9 million transactions monthly, reducing service time and costs for the government and citizens
Rajasthan 	▪ Bhamashah Swasthya Bima Yojana	▪ Scheme to provide cashless facility to the inpatient department's patients for the families identified under the National Food Security Act and Rashtriya Swathaya Bima Yojana	▪ 45 million people have received a total of $220 million worth of benefits so far

SOURCE: www.edistrict.hp.gov.in; digitalgujarat.gov.in; dit.tripura.gov.in; rajasthan.gov.in

EXHIBIT 4

Significant government investment in foundational platforms has helped accelerate digital adoption

AADHAAR UID

12-digit unique identification number based on biometric and demographic data

26.7 billion
Aadhaar-based authentications, as of January 23, 2019

597 million
Aadhaar payment bridge accounts linked, as of May 2018

E-SIGN

Replaces manual paper-based signatures by allowing Aadhaar holders to electronically sign documents

8.7 million
eSign transactions in FY17

222%
Y-o-Y growth over FY16

Public Digital Platforms

e-KYC

Paperless KYC process, verifying subscriber's identity and address electronically through Aadhaar

6.7 billion
eKYC transactions, as of January 23, 2019

DIGILOCKER

Platform for issuing and verifying documents digitally using cloud storage linked to Aadhaar

17.4 million
users, as of January 23, 2019

23.0 million
documents uploaded, as of January 23, 2019

UPI

Enables all bank account holders to send and receive money instantly using smartphones, without bank account information

3.7 billion
cumulative transactions from Jan 2018-Dec 2018

$1.4 billion
monthly value in 2017–18

GSTN

Unified indirect tax administration platform for the entire country to handle invoices, returns, registrations, and payments

10.3 million
businesses registered, as of March, 2018

SOURCE: UIDAI; Ministry of Electronics & Information Technology, Government of India; DigiLocker; National Payments Corporation of India; *Role of GST in widening tax base,* answer to Lok Sabha unstarred question number 2405, March 9, 2018

DigiLocker as a platform to issue and verify digital documents, obviating the need for paper.[71] In 2015, the government released the Unified Payments Interface as an open-source platform that integrates other payment platforms via a single mobile application, enabling quick, easy, and inexpensive payments from any entity — individual, business, or government agency — to any other entity.[72] In future, a range of different digitally verifiable identify systems will continue to evolve, in line with the Supreme Court of India's ruling, regulatory policy changes underway, further technology developments that enable identification through alternative means such as QR codes, voice-recognition, and beyond.

Another important national public digital platform, rolled out in July 2017, is the Goods and Services Tax Network.[73] Structured as a national information utility, GSTN provides the IT backbone for India's Goods and Services Tax regime and aims to bring all transactions of indirect tax-paying businesses onto one digital platform. GSTN is an important platform that will enable a host of consent-based open APIs for tax filing, compliance, credit assessment, analytics, and other uses in the years to come.

Global technology trends have spurred private-sector investment and innovation to expand India's digital consumer base

Technology is making huge strides globally, propelling rapid advances in computing capability and driving down costs. Mobile and cloud computing have become massive global forces, with mobile adoption worldwide reaching more than 66 percent and mobile internet penetration reaching 43 percent in 2017.[74] In India, falling costs for both are enabling much greater digital access across the population.

Private-sector telecom operators — including Bharti Airtel, Idea, Reliance Jio, and Vodafone — have seized the opportunity to provide high-speed mobile data subscription services at affordable prices, stimulating rapid growth in the subscriber base. Investment in mobile broadband technologies has risen; India is now among the leaders in 4G availability, with about 88 percent of the network covered, up from 50 percent in 2013–14.[75] Average mobile download speed reflects this activity; it increased by 7.6 times from 1.3 Mbps in 2014 to 9.9 Mbps in 2017.[76] A sharp fall in mobile data prices has accompanied these technology and infrastructure improvements. Today, one gigabyte of data costs about 0.1 percent of the monthly gross national income per capita, compared with 9.8 percent in 2013, representing an average annual decline of 68 percent.[77]

The large Indian market is spurring global technology giants — including Amazon, Facebook, Google, Microsoft, and Netflix — to innovate services tailored to India's consumers and unique operating conditions (Exhibit 5). Netflix, for example, reportedly plans to spend roughly $300 million on India-focused content for its streaming service.[78] Amazon in 2016 introduced Tatkal, a streamlined registration process that aims to enable India's small and medium-size enterprises to set up shop on Amazon's platform in under 60 minutes.[79] Google's Android launched the Android One series of low-cost phones and is working with Reliance Jio on a smartphone that would retail for around $30. Facebook supports 12 local languages, and its Express Wi-Fi project is rolling out 20,000 hotspots in partnership with the mobile service provider Airtel.[80]

Indian businesses have actively adopted the cloud. India's public cloud market is estimated to be $2.6 billion

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[71] eSign Online Electronic Signature Service, Controller Of Certifying Authorities, Ministry of Electronics & Information Technology, 2015; Aadhar Linked Digital Locker, Press Information Bureau, Ministry of Communications, Government of India, March 4, 2015.

[72] Unified Payments Interface: the product to enable money transfers – both 'Push' and 'Pull' through Smart Phones, Press Information Bureau, Ministry of Finance, Government Of India, May 6, 2016.

[73] Special Webpage on Goods and Services Tax (GST) on PIB Website, Press Information Bureau, Ministry of Information & Broadcasting, Government of India, June 30, 2017.

[74] The Mobile Economy 2018, *GSMA Intelligence*, February 2018.

[75] The State of LTE (February 2018), OpenSignal, February 2018.

[76] Speedtest Global Index Ookla, November 2018.

[77] Analysys Mason, as of January 09, 2019; World Bank, as of March 22, 2018.

[78] Vidhi Choudhary, "Netflix, Amazon set aside Rs 2,000 crore each in battle for India market", livemint, April 10, 2017.

[79] *Make way for Amazon Tatkal, a unique service-on-wheels for SMBs from Amazon.in*, Amazon, February 7, 2016.

[80] "The best of Android and Google with Android Oreo (Go edition) and Android One, Google, February 22, 2018 "MediaTek, Reliance Jio working on Android Go Oreo smartphones", *Hindu BusinessLine*, January 30, 2018; Karan Choudhary, "Facebook eyes more likes from Bharat to expand user base", *Business Standard*, October 21, 2016; "Facebook partners with Airtel to roll out Express WiFi to deploy 20,000 hotspots in India", *Financial Express*, May 4, 2017.

EXHIBIT 5

Global and Indian digital innovators are shaping offerings tailored to the Indian market

Telecom

Jio

- Reliance Foundation Information Services disseminates information about agriculture, fisheries, and livestock to over 2 million individuals in 9 languages through Jio chat and other means
- Jio 4G LTE connectivity and Jio Cloud to bring digital content to rural Andhra Pradesh schools

airtel

- Airtel payments bank has 10 million accounts, at least 70% in rural areas, and has helped create 2,000+ cashless villages
- Airtel Mitra app facilitates digital acquisition, re-verification, bill payments etc. for more than 1.6 million retailers
- Airtel's Wynk music streaming platform with more than 1 billion streams monthly

vodafone

- Vodafone M-Pesa digital wallet has 29.5 million active users through a network of more than 287,400 agents
- Mobile based information service for farmers Kisaan Mitr has 2.1 million users
- Vodafone Sakhi product offers enhanced benefits to women for their security

Global platforms

Google

- Offline maps and YouTube for areas with limited data connectivity
- Google Translate supporting 9 Indian languages
- Project with Railtel to provide Wi-Fi at 400 railway stations
- Internet Saathi programme to train rural women to get online (helping more than 10 million women)

- 6.2 billion Android app downloads in 2016, second in the world to China
- Launched Android One series of low-cost phones
- Android skilling program to train 2 million app developers

Social media and instant messaging services

WhatsApp

- More than 200 million active WhatsApp users
- Supports 11 local languages by crowdsourcing user efforts to translate WhatsApp through an online tool
- Video-calling feature designed for slower Indian network conditions

- 250 million active Facebook users
- Supports 12 local languages
- Express Wi-Fi project launching 20,000 Wi-Fi points in partnership with Airtel

E-commerce

amazon

- Amazon Tatkal service to enable SMEs to get online in less than 60 minutes
- Chai Cart to create awareness among 10,000 sellers about e-commerce
- Seller flex system that replicates warehousing practices at facilities owned by third-party sellers

Flipkart

- Flipkart Spotlist offers instant cataloguing and listing for small-scale sellers and artisans
- Flipkart technology enables over 14 million product updates daily
- Restbus, a custom messaging solution, can handle millions of messages with 99.9999% uptime
- Flipkart's marketing platform is capable of managing more than 1 million keywords

Digital payments

HDFC BANK

- 80% of all transactions on internet or mobile
- 88% of fund transfers, 94% of customer instructions online
- Smart City personalised card and app in Thane
- Metro personalised travel cards in Jaipur and Lucknow metros
- Pungrain automated grain procurement system for Food Corporation of India and public distribution system

SBI

- SBI pay app for enabling all UPI transactions
- Missed call banking services under SBI Quick cover basic account and ATM services
- Digi Voucher for online submission of applications for transactions, e.g., bank drafts
- Digital Slate under SBI Scribe project to convert handwritten text to digital

Paytm

- PayTM app enables offline retail businesses such as restaurants, grocery stores, etc. to accept digital payments by scanning QR code; more than 5 million merchants onboarded
- PayTM mall (online marketplace) app, launched in 2017 for shopping, bill payments, etc, already has over 100 million downloads
- PayTM gold to digitise gold transactions. More than 200 kg of gold transacted by over 200,000 customers, with minimum investment as low as 1 rupee

SOURCE: Airtel; Vodafone; SBI; HDFC; PayTM; Reliance Foundation Annual Report, 2015–16; M-Pesa; livemint; Google India; Amazon; Flipkart; exchange4media; Tata Consultancy Services; Times of India; MicroEnsure; BW Disrupt.

in 2018 and expected to grow to over $4 billion by 2020.[81] About 90 percent of India's top chief information officers are either already actively using cloud technologies or plan to do so within the next year. More than 120,000 firms in India already use Amazon's cloud storage business, Amazon Web Services.

Fintech innovation has grown rapidly. One survey ranked India second in the strength of the fintech movement, with 76 percent of consumers saying they use at least one nontraditional firm for financial services.[82] Some are reaching huge scale: Alibaba-backed Paytm, India's largest mobile payments and commerce platform, has over 300 million registered mobile wallet users and six million merchants.[83] Other players are also growing rapidly. Freecharge, with over 54 million users, handled 500 million transactions in June 2017.[84] Mobikwik's user base jumped from 25 million to 55 million in November 2016 after the government invalidated all 500- and 1,000-rupee banknotes to curb the shadow economy and disrupt criminal activity.[85] To ride the fintech wave, banks are collaborating with fintech startups. Axis Bank, for example, acquired Freecharge in July 2017, and YES Bank launched the YES FINTECH accelerator programme, which involves mentoring 100 fintech startups to cocreate innovative financial solutions for its customers.[86]

India's universal banks have also driven significant digital innovation across the spectrum of financial services, facilitated by the banking regulator, the Reserve Bank of India, which recently outlined possible steps for the adoption of blockchain technologies in the financial sector.[87]

Private-sector innovation has propelled growth in India's e-commerce industry as well. In 2017, India had 176.8 million e-commerce users and registered consumer goods e-commerce sales of $20 billion.[88] Amazon, Flipkart, and other players have used innovative sales and logistics models to grow rapidly. Amazon offers over 160 million products from more than 300,000 sellers in India and delivers to 97 percent of serviceable PIN codes, with 75 percent of new customers coming from non-metro locations.[89] Flipkart has registered over 100,000 sellers and promises a 15-minute process to list products and register as a seller. Both have invested significantly in logistics capabilities, especially in smaller towns.[90]

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[81] India's public cloud market to rise by 53%, says Akash Ambani, Times of India, January 19, 2018.

[82] *World FinTech Report 2017,* Capgemini and Linkedin in collaboration with Efma.

[83] Harichandan Arakali, "Paytm reloaded: It's no longer just a mobile wallet", *Forbes*, March 15, 2018.

[84] "Axis Bank agrees to buy payments wallet provider FreeCharge for $60 million", Devidutta Tripathy, Sankalp Phartiyal, *Reuters, July 27, 2017*.; "FreeCharge crosses 500 mn transactions", *The Economic Times*, June 29, 2017.

[85] Jon Russell, *India's MobiKwik is raising new funding at $1B valuation to battle payment rival Paytm*, TechCrunch, June 15, 2017.

[86] *Axis Bank acquires Freecharge*, Axis Bank press release, July 27, 2017; *YES BANK in association with T-Hub & Antill launches YES FINTECH*, YES BANK press release, January 17, 2017.

[87] RBI arm to launch model platform for blockchain technology soon, *Hindu BusinessLine*, September 1, 2017.

[88] Digital in 2018: Southern Asia, We Are Social, January 2018.

Government action combined with market forces has triggered a rapid rise in digital usage

Steady year-on-year growth in India's digital market can be expected, given the favourable drivers — a young population, rising per capita income, and greater urbanisation. Beyond steady growth among existing customers, India has witnessed rapid and discontinuous growth in the number of new users, due to competitive market dynamics and determined government action.

The launch of Jio 4G VoLTE service in September 2016 disrupted India's telecom market. Jio rolled out unlimited voice telephony and SMS, 4 GB of data, and much more for about $7.70 per month, along with a smartphone offered against a low refundable deposit.[91] Many other telecom operators also made extremely competitive terms available to their subscribers. Bharti Airtel, for example, slashed its 3G and 4G mobile internet charges by up to 80 percent, to as low as $0.80 per gigabyte, under a special scheme.[92] A combination of the forces of innovation and competition led to the mobile internet subscription base rising by 63 million, jumping over 18 percent to 410 million from September 2016 to June 2017.[93] Mobile data consumption reached 8.3 GB per user per month in September 2018, compared with less than 60 MB per user in December 2013, while fixed-line data consumption per user rose from 7.1 GB to 18.3 GB per user per month from 2013–14 to 2017–18.[94]

The government, for its part, has used Aadhaar to drive greater financial inclusion and market efficiency. Opening bank accounts with Aadhaar has in the past resolved the absence of a legal identity document, which previously accounted for some 20 percent of financial exclusions.[95] Following its introduction of the Pradhan Mantri Jan-Dhan Yojana (a mass financial-inclusion programme) in 2014, the government stimulated a rapid rise in enrolment in Aadhaar and raised demand for Jan-Dhan bank accounts by deciding to transfer benefits for over 220 welfare schemes directly to people using the Jan-Dhan–mobile–Aadhaar trinity.[96] More than 327.5 million Jan-Dhan accounts have been opened as of April 2018, about 225.8 million of which have been linked to Aadhaar (out of the total of over 870 million Aadhaar-seeded bank accounts in India today).[97] Nearly $30 billion went to more than 1.2 billion recipients under the Direct Benefit Transfer scheme in 2017–18, up from $1.1 billion to about 108 million recipients four years earlier.[98] The value of transactions through Aadhaar-enabled micro-ATMs, simple devices used by a field force to authenticate cash transactions, grew 10-fold in one year, to more than $3.5 billion in 2017–18.[99]

The government's decision in November 2016 to withdraw 500- and 1,000-rupee currency notes (worth approximately $7.50 and $15, respectively) encouraged the acceptance of digital payments around the country.[100] The government also offered incentives such as discounts for using digital products to pay for fuel purchases and seasonal or monthly rail tickets, as well as zero transaction fees on digital payments to government departments and public-

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[89] *Amazon announces a specialised network of 15 fulfilment centres to enhance AmazonNow delivery experience for customers*, Amazon.in, February 27, 2018; "Amazon India crosses 3-lakh sellers mark on its marketplace", *Economic Times*, February 18, 2018; "Amazon claims orders delivered to 97% pin codes in second leg of Great Indian Festival", Anirban Sen, livemint, October 21, 2016.

[90] "Flipkart Global opens a world of opportunities to Indian sellers", Flipkart Global Stories, August 24, 2017; Flipkart website, as of May 17, 2018.

[91] Akash Sinha, "Reliance Jio data plan tariffs: All you want to know", *Economic Times*, September 2, 2016.

[92] "Airtel cuts 4G price by up to 80 percent to check Reliance Jio effect", *Economic Times*, August 29, 2017.

[93] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of September 2016, and September 2018.

[94] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, as of December 2013 and September 2018; Ovum network traffic forecast 2015–20; Ovum total fixed broadband subscription and revenue forecast 2016–21, as of March 22, 2018.

[95] *State of Aadhaar report 2016–17*, IDinsight, May 2017.

[96] Aman Sharma, "Centre to pay out Rs 1 lakh crore via direct benefit transfer scheme in 2017–18", *Economic Times*, May 17, 2017.

[97] *Linking of Jan Dhan accounts with Aadhaar*, as of September 2018, Ministry of Finance press release, December 29, 2017; MeitY, as of February 28, 2018.

[98] Direct Benefit Transfer website, as of April 19, 2018.

[99] *State of Aadhaar report 2017–18*, IDinsight, May 2018.

[100] Demonetisation to power 80% rise in digital payments, may hit Rs 1,800 crore in 2017–18, *Times of India*, November 4, 2017.

sector undertakings, capping of monthly point-of-sale equipment rentals paid by merchants at $1.50, and withdrawal of customer charges on low-value cashless payments. The number of digital payment transactions grew to about 2.03 billion per month in 2017–2018, from 202 million per month in 2013–14; more than 2.03 billion transactions, with a total value of more than $1.4 billion, went through the UPI system monthly in 2017–18.[101] The government's UPI app, BHIM, has been downloaded more than 33.2 million times since its launch in December 2016, signalling the large number of Indians who are inching toward a less-cash economy (Exhibit 6).[102]

Meanwhile, banks have conducted about 6.4 billion Know Your Customer digital anti-money-laundering checks under the eKYC programme in the last four years; DigiLocker has registered close to 15.3 million users since its launch in 2016, with more than 3.3 billion issued documents and 20.5 million uploaded documents; and more than 49 million electronic signatures.[103] The roll-out of the Goods and Services Tax regime nationwide in July 2017 was also a significant discontinuity — almost 10.3 million businesses have joined the GSTN platform and are generating digital sales invoices as a result.[104]

The strong digital foundation and expanding reach of technology are changing Indians' lives in many tangible ways

The spread of digital services has brought real benefits in terms of greater connectivity, convenience, choice, and savings to millions of Indians from all walks of life.

In many parts of the country, a low-income consumer, if he chooses to, can now open a bank account or apply for a loan using eKYC without having to produce physical documents or visit a distant bank branch. Consumers can use financial services through a network of banking correspondents using micro-ATMs and can receive their wages electronically in their bank accounts without losing money to middlemen. Poor rural homemakers can receive cooking gas and food subsidies directly in their bank accounts by proving their identity using Aadhaar. Migrant workers have activated new mobile connections in minutes rather than days using Aadhaar eKYC; have accessed personalised, local-language music, news, and video content; have video chatted with family members; and have remitted money to them at low cost. Shoppers in Tier 2 and 3 cities have access to a wider range of products at a lower cost. A senior citizen can visit the

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[101] Payment system indicators, Reserve Bank of India, Table 43, March 2015, September 2018; UPI product statistics, National Payments Corporation of India, as of March 31, 2018.

[102] BHIM analytics, National Payments Corporation of India, as of September 27, 2018.

[103] Aadhaar dashboard, as of September 27, 2018; DigiLocker website, as of September 27, 2018; MeitY, as of March 31, 2018.

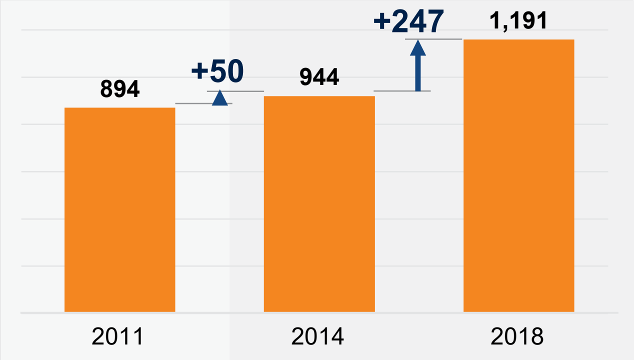
[104] Role of GST in widening tax base, answer to Lok Sabha unstarred question no. 2405, March 9, 2018.

EXHIBIT 6

Decisive actions by the government and the private sector have led to discontinuous growth in digital adoption

Mobile phone subscriptions

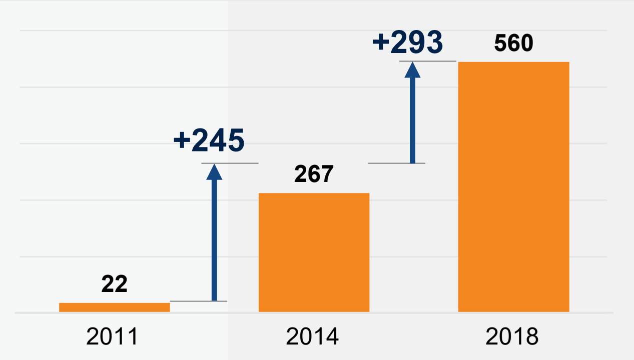
Mobile subscriptions, million



Source: TRAI, as of December 31; 2018 figure is of September 2018

Internet subscriptions

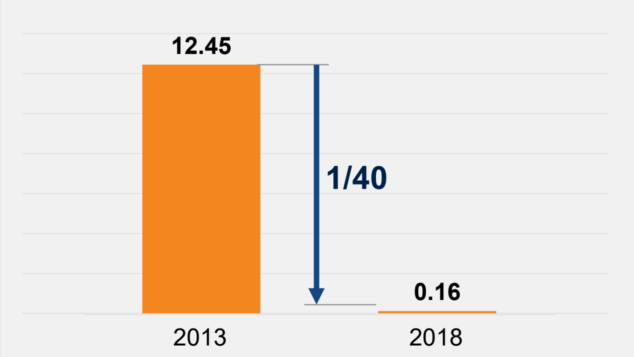
Internet subscriptions, million



Source: TRAI, as of December 31; 2018 figure is of September 2018

Mobile data price

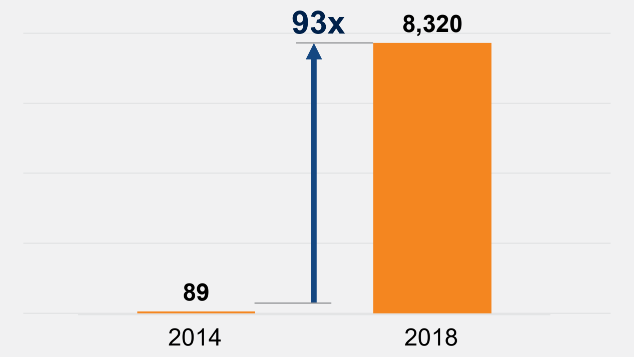
Price per GB of data, $



Source: Analysys Mason, TRAI

Mobile data consumption

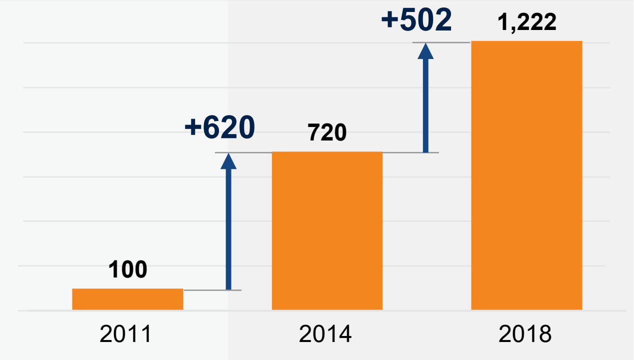
Average monthly mobile data consumption per user, MB



Source: TRAi, as of December 31, 2014; TRAI, as of September 2018

Aadhaar

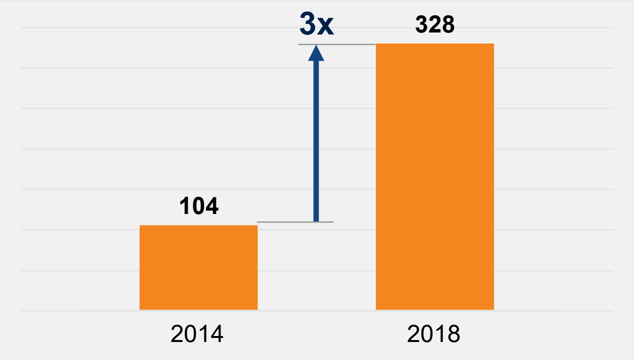
People enrolled, million



Source: UIDAI

Jan-Dhan accounts

Million



Source: Pradhan Mantri Jan-Dhan Yojana website local CSC and avoid travelling long distances for services such as Aadhaar enrolment, passport application or renewal, obtaining a PAN card, banking, educational services, and increasingly for medical consultations. Microentrepreneurs and self-employed (or independent) workers can link to organised, digitally enabled value chains, such as cab-hailing apps, job marketplaces, and e-commerce firms, giving them better income-earning opportunities.

The wave of digital transformation has also empowered women, a hitherto underserved segment, in many ways. These include helping women find opportunities for gainful employment, one of the key areas where they lag behind their counterparts in peer countries.[105] The BPO industry in India employs some 3.1 million workers, about 30 percent of them women. A three-year awareness programme in rural India on the opportunities in the BPO industry enhanced women's enrolment in BPO training programmes and increased school enrolment among young girls by 3 to 5 percent.[106] Likewise, 54,800 women have become village-level entrepreneurs at CSCs, providing digital services to the catchment population (see Box 2, "Common Services Centres: An example of women's empowerment").[107] Technology is also empowering women by enabling them to move into jobs that were previously considered unconventional for them. In 2015–16, the BabaJob portal saw a sevenfold increase in demand from employers for female cab drivers and a 153 percent increase in women's applications for driver jobs.[108]

Box 2. Common Services Centres: An example of women's empowerment[1]

Government-run Common Services Centres act as access points for digital delivery of services to the rural population, which still has gaps in internet usage. A growing number of women are serving as village-level entrepreneurs providing digital services throughout the country; some 54,800 village-level entrepreneurs, or VLEs, running Common Services Centres are women.[2]

These women act as role models to other women and girls in their communities, thus broadening the spectrum of empowerment. Ujjwala Sawant, a VLE from Pune, has encouraged other women in her community to join CSCs, forming the Anand self-help group, which has 15 women members providing round-the-clock services to citizens. Another VLE, Manjeet Kaur from Jind in Haryana, has established Muskan, an organisation at her CSC that works to educate girls and spread digital literacy.

Snehlata Devi from Alwar has trained her block of the Banjara community in financial digital literacy. Under the Digi Dhan Abhiyaan, she has made her block fully literate in digital finance.

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[1] *Digital India: Empowering Women*, Common Services Centre scheme, MeitY, April 2018.

[2] *Women village level entrepreneurs (VLEs) are the change agents of digitally empowered rural India women*. VLEs will be doubled from 47 thousand to one lakh across India: Shri Ravi Shankar Prasad, Ministry of Electronics and IT press release, March 8, 2018.

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[105] *The power of parity: How advancing women's equality can add $12 trillion to global growth*, McKinsey Global Institute, September 2015.

[106] Deepak Mishra et al, World Bank. 2016. World Development Report 2016: Digital Dividends. Washington,DC: World Bank.

[107] MeitY, as of April 2018.

[108] "More women taking up odd jobs; opt to be cab drivers, guards", *The Economic Times*, June 5, 2016.

2. New index reveals India's digital leap

Key Highlights

01

India's position is assessed using a three-part framework of digital foundation, digital reach, and digital value

02

India is the second-fastest digitising country among a group of 17 mature and emerging digital economies globally

03

On a cross-country basis, India is a leader in a few foundation elements but has scope to grow on many aspects of reach and value

04

Affluent states lead in digitisation, but lower-income states are catching up, bridging the digital divide

05

India to have more than 900 million internet subscribers by 2025

India has performed well over the last few years on multiple aspects of digitisation through a combination of government action and business innovation and investment, and the impact is being felt in all aspects of life for an ever-increasing number of Indians. However, the country is still in the midst of its digital transformation — indeed, it is in the liftoff phase — and has a long way to go in terms of its realising the full potential of digitisation.

To assess how far India has travelled, this chapter compares the country's digital evolution with those of other countries and assesses digital adoption across states within India. On the Country Digital Index, India's overall score is below those of mature and emerging digital economies such as China, South Africa, Sweden, and the United States, but it shows the second-highest digital growth momentum over the past four years. The gap between India's overall digital adoption and that of other countries can be explained by disparities within India. The degree of digital adoption within the country is uneven, with some states and union territories having moved much faster and further than others. To assess the levels of digital adoption within India, this study examined the penetration of internet and digital access to the unserved population through the CSC network at the state level. Overall, states show significant variation in performance along each indicator, although low-adoption states show signs of rapid leapfrogging.

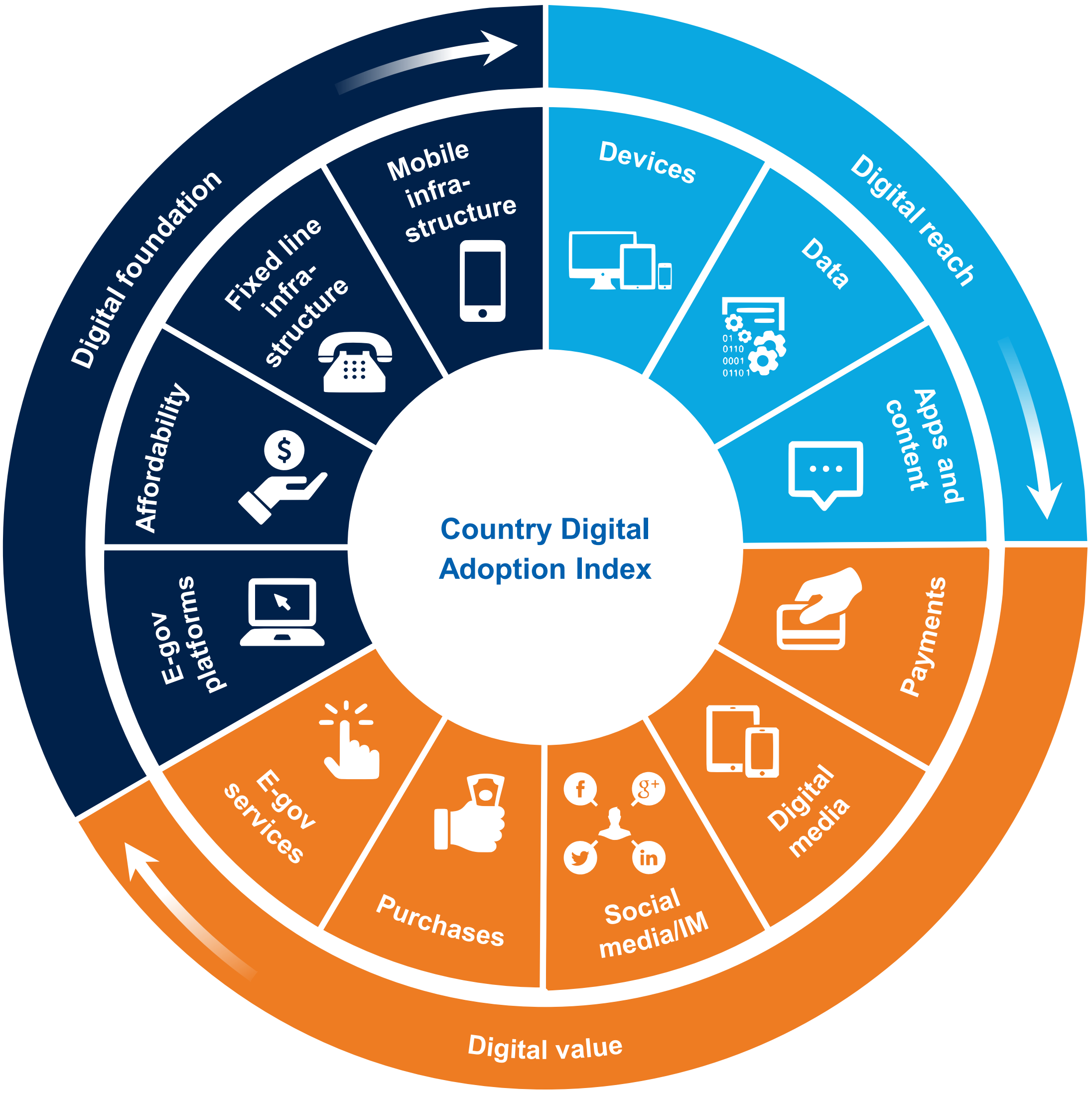
India's position is assessed using a three-part framework of digital foundation, reach, and value

To take stock of the extent of India's digital transformation in a global context, the Country Digital Index compares the entire country's position relative to other emerging and mature digital economies. This index is constructed to reflect three pillars of a digital economy (Exhibit 7):

- **Digital foundation.** The availability of digital infrastructure and platforms in the country (for example, spectrum availability, internet download speed, internet affordability, and e-government platforms and services offered).

EXHIBIT 7

Country Digital Adoption Index takes a 360-degree view of digital adoption


Country Digital Adoption Index
Digital foundation
Mobile infra-structure
Fixed line infra-structure
Affordability
E-gov platforms
Digital reach
Devices
Data
Apps and content
Digital value
Payments
Digital media
Social media/IM
Purchases
E-gov services

DIGITAL FOUNDATION
The availability of digital infrastructure and platforms

DIGITAL REACH
The penetration of digital devices, data, and content

DIGITAL VALUE
The adoption of various digital use cases

Analysis of data of 30 indicators across 17 countries for 2014 to 2017

- **Digital reach.** The actual penetration or ownership and use of digital devices and services among the population (for example, the size of the mobile and internet user base, availability of local-content websites, and data consumption per user).
- **Digital value.** The actual usage of various digital applications (for example, utilisation levels of use cases across e government services, digital media, e-commerce, and digital payments).

On a cross-country basis, India is a leader in a few foundation elements but has scope to grow on many aspects of reach and value

The Country Digital Adoption Index measures digital adoption along 30 metrics across the three pillars. It compares India with a cross-section of countries that includes the largest advanced economies in the world; those that are smaller in economic size but are clear digital leaders; and the BRICS countries, representing emerging economies that are developing digital capabilities rapidly and gaining leadership positions.[109] The 17 countries considered in the comparison set are Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Russia, Singapore, South Africa, South Korea, Sweden, the United Kingdom, and the United States.

India's overall score in 2017 in Country Digital Index was 32 on a scale of 0 to 100, where 100 represents the highest theoretical value (computed as the combined value of individual scores on each of the 30 metrics). India falls into the medium range of digital index scores.[110] The mature digital economies of South Korea and Sweden are digital leaders, with scores above 70 (South Korea has the highest score, 75), and the countries like Australia, Canada, Germany, Japan, Russia, Singapore, the United Kingdom, and the United States are in the very high range, with scores ranging from 60 to 70. Next come Brazil, China, Russia, France, Italy, and South Africa in the high range, with scores ranging from 40 to 60.

The Country Digital Adoption Index and its individual pillars are strongly correlated with GDP per capita; however, India's overall digital score has risen sharply in the last three years, with a trajectory much steeper than that suggested by the rate of growth of per capita income (Exhibit 8).

India's overall score masks significant variation across the three pillars and individual metrics (Exhibit 9). India holds a position of relative leadership on some metrics in the digital foundation pillar. For example, the World Bank's Digital Adoption Index gives India a relative score of 100 on digital identification, relative to 58 for China and 35 for the United States.[111] The digital identification score is based on aspects such as biometric functionality and digital signature. India is also among the leaders on 4G availability on mobile phones,

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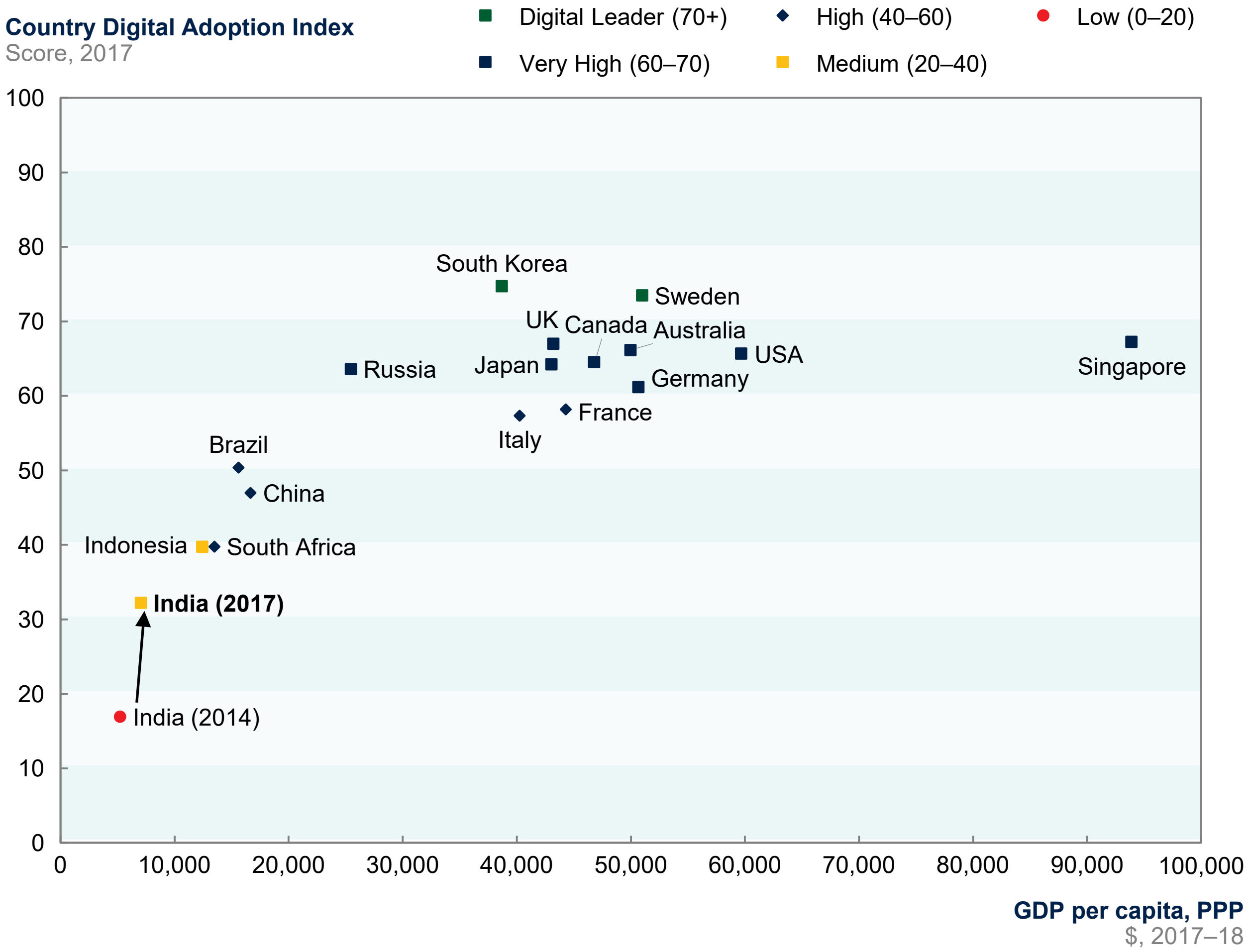
[109] The BRICS countries are Brazil, Russia, India, China, and South Africa.

[110] For the overall digital score, "very high" indicates index values between 60 and 100, "high" indicates values between 40 and 60, "medium" indicates values between 20 and 40, and "low" indicates values between 0 and 20.

[111] *Digital adoption index: Measuring the global spread of digital technologies*, World Bank, 2016.

EXHIBIT 8

India's score on the Country Digital Adoption Index has risen faster than the trend based on GDP per capita in the last four years



SOURCE: Ovum; Open Signal; Akamai State of the Internet Report Q1 2014, Q1 2017; International Telecommunication Union; Analysys Mason; UN e-Government Survey; Digital Adoption Index, World Bank; Strategy Analytics; We Are Social; Euromonitor International Consumer Finance and Retailing 2017 Editions

with about 88 percent of the network covered (up from 50 percent in 2013–14).[112] India is also among the leaders on government online services, another key aspect of the digital foundation, with a score of 74 for 2017.[113]

On many other metrics, particularly those of digital reach and digital value, India needs to move from the lower end of the spectrum to at least the median level compared with other countries. Chief among these is mobile broadband internet penetration, which measures how much of a country's population has access to high-speed mobile connectivity (the figure is 38.7 percent in India, compared with 80.7 percent for China and 78.9 percent for Indonesia).[114] Similarly, India can travel a significant distance in appropriating value from digital adoption. For example, consumers in India make 7.6 cashless consumer transactions per year on average, compared with 803 per person in Singapore.[115]

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[112] *The state of LTE (February 2018)*, Open Signal, February 2018.

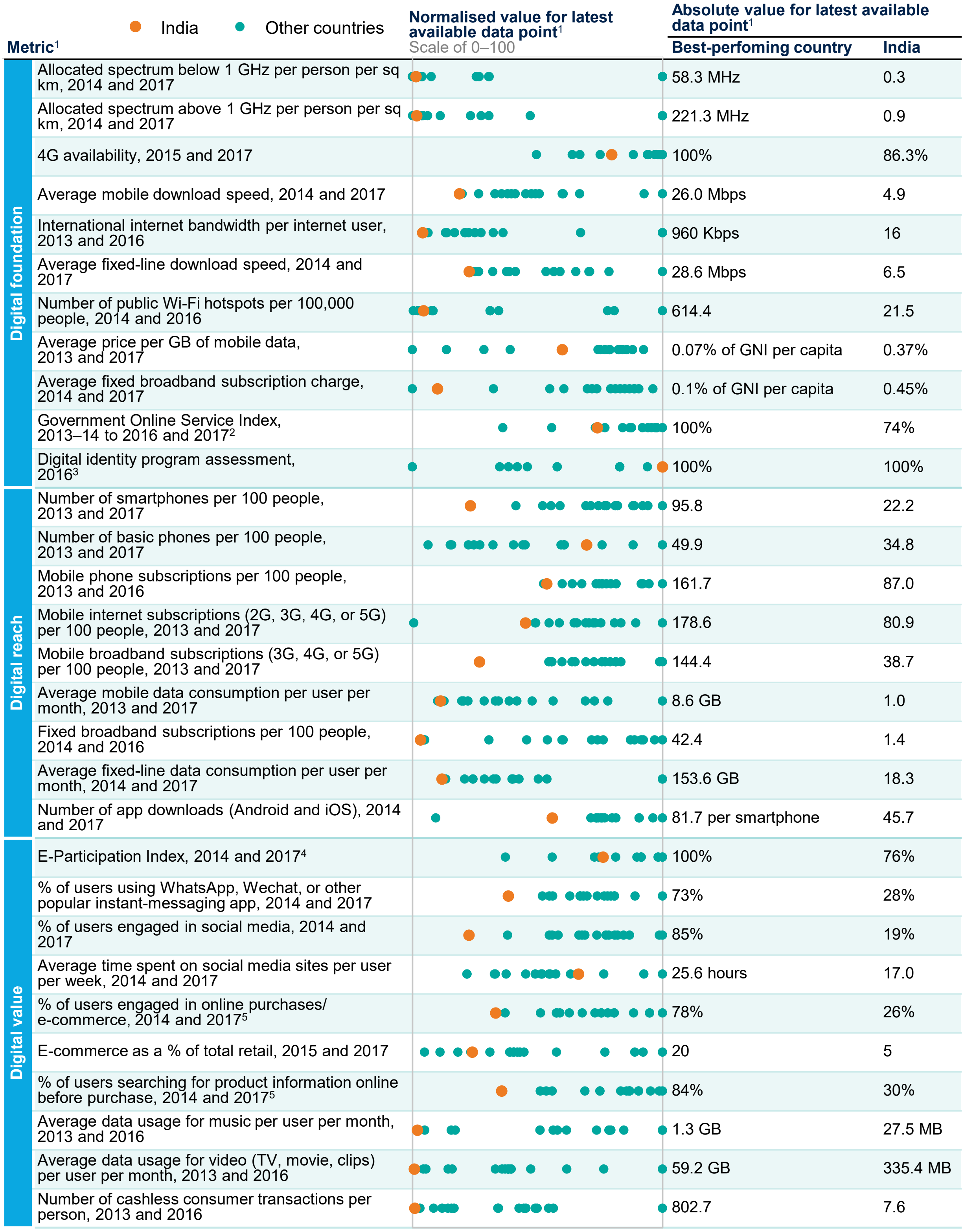
[113] *United Nations e-government survey 2016*, Department of Economic and Social Affairs, United Nations, July 2016.

[114] Analysys Mason, as of March 21, 2018.

[115] Financial cards and payments 2016 country reports, Euromonitor International, as of March 29, 2018.

EXHIBIT 9

India's position relative to 16 other countries in metrics used to calculate Country Digital Adoption Index



	Metric[1]	Absolute value for latest available data point[1]: Best-perfoming country	India
Digital foundation	Allocated spectrum below 1 GHz per person per sq km, 2014 and 2017	58.3 MHz	0.3
	Allocated spectrum above 1 GHz per person per sq km, 2014 and 2017	221.3 MHz	0.9
	4G availability, 2015 and 2017	100%	86.3%
	Average mobile download speed, 2014 and 2017	26.0 Mbps	4.9
	International internet bandwidth per internet user, 2013 and 2016	960 Kbps	16
	Average fixed-line download speed, 2014 and 2017	28.6 Mbps	6.5
	Number of public Wi-Fi hotspots per 100,000 people, 2014 and 2016	614.4	21.5
	Average price per GB of mobile data, 2013 and 2017	0.07% of GNI per capita	0.37%
	Average fixed broadband subscription charge, 2014 and 2017	0.1% of GNI per capita	0.45%
	Government Online Service Index, 2013–14 to 2016 and 2017[2]	100%	74%
	Digital identity program assessment, 2016[3]	100%	100%
Digital reach	Number of smartphones per 100 people, 2013 and 2017	95.8	22.2
	Number of basic phones per 100 people, 2013 and 2017	49.9	34.8
	Mobile phone subscriptions per 100 people, 2013 and 2016	161.7	87.0
	Mobile internet subscriptions (2G, 3G, 4G, or 5G) per 100 people, 2013 and 2017	178.6	80.9
	Mobile broadband subscriptions (3G, 4G, or 5G) per 100 people, 2013 and 2017	144.4	38.7
	Average mobile data consumption per user per month, 2013 and 2017	8.6 GB	1.0
	Fixed broadband subscriptions per 100 people, 2014 and 2016	42.4	1.4
	Average fixed-line data consumption per user per month, 2014 and 2017	153.6 GB	18.3
	Number of app downloads (Android and iOS), 2014 and 2017	81.7 per smartphone	45.7
Digital value	E-Participation Index, 2014 and 2017[4]	100%	76%
	% of users using WhatsApp, Wechat, or other popular instant-messaging app, 2014 and 2017	73%	28%
	% of users engaged in social media, 2014 and 2017	85%	19%
	Average time spent on social media sites per user per week, 2014 and 2017	25.6 hours	17.0
	% of users engaged in online purchases/ e-commerce, 2014 and 2017[5]	78%	26%
	E-commerce as a % of total retail, 2015 and 2017	20	5
	% of users searching for product information online before purchase, 2014 and 2017[5]	84%	30%
	Average data usage for music per user per month, 2013 and 2016	1.3 GB	27.5 MB
	Average data usage for video (TV, movie, clips) per user per month, 2013 and 2016	59.2 GB	335.4 MB
	Number of cashless consumer transactions per person, 2013 and 2016	802.7	7.6

1 Based on harmonised dataset as of May 2018.
2 A World Bank ranking of the quality of governments' online services.
3 Government indicator of the World Bank's Digital Adoption Index.
4 A supplement to the UN E-Government Survey that gauges how well governments use digital technology to increase political participation by their citizens.
5 Based on survey on internet users aged 16–64 years.

SOURCE: Ovum; Open Signal; Akamai State of the Internet Report Q1 2014, Q1 2017; International Telecommunication Union; Analysys Mason; UN e-Government Survey; Digital Adoption Index, World Bank; Strategy Analytics; We Are Social; Euromonitor International Consumer Finance and Retailing 2017 Editions

India is in a "lift-off" phase with one of the highest rates of growth on several dimensions

As stated above, at 90 percent growth in the Country Digital Adoption Index from 2014 to 2017, India had the second-fastest momentum on digital adoption among the group of 17 countries considered, just behind Indonesia at 99 percent during the same time (Exhibit 10).[116] India's rate of growth is high across all three pillars of the digital index, but greatest on the digital foundation pillar, on which progress on the digital identity programme has more than doubled since 2014. Further, India has more almost quadrupled its average fixed-line download speed.[117] It has also reduced the price of one gigabyte of mobile data significantly, cutting it from 9.8 percent of per capita monthly gross national income in 2013 to 0.1 percent in September 2018.[118] Yet India's growth momentum on digital adoption could be viewed in the context of a low base. Going forward, it is imperative to maintain this trajectory and improve on it where possible.

Affluent states lead in digitisation, but lower-income states are catching up

The degree of digital adoption within India is uneven, with some states and union territories having moved ahead faster than others. To assess the pace of digital adoption within India, growth in penetration of internet subscriptions and the penetration of digital access to underserved populations through the CSC network at the state level was examined. Overall, states show significant variation in performance on the two indicators (Exhibit 11).

Digital penetration and GDP per capita or affluence are strongly correlated. States in the top third of GDP per capita levels, such as Punjab, Kerela and Himachal Pradesh, together with the small, highly urbanised states and union territories of Chandigarh, Delhi and Goa have the highest internet penetration, ranging between 28 percent in Uttarakhand to more than 170 percent in Delhi. Similarly, states in the bottom third of GDP per capita, such as Bihar, Jharkhand, Odisha, and Uttar Pradesh, are among states with the lowest penetration rates, for example 22 percent in Bihar and 22 percent in Jharkhand. State-level analysis reveals that all states have grown their internet subscriber basis by a minimum of 12 percent annually between 2014 and 2018, while states with relatively lower internet penetration rates to begin with, such as Uttar Pradesh, Madhya Pradesh, and Bihar, have grown their subscriber base distinctly faster, at 24 to 26 percent over the same period. Of the 293 million new Internet subscribers added nationwide over the last four years, Uttar Pradesh alone accounted for 36 million, with Assam, Odisha, West Bengal, and Bihar adding another 47 million (Exhibit 11).

Assisted access to digital services through networks like CSCs plays a key role in ensuring that Digital

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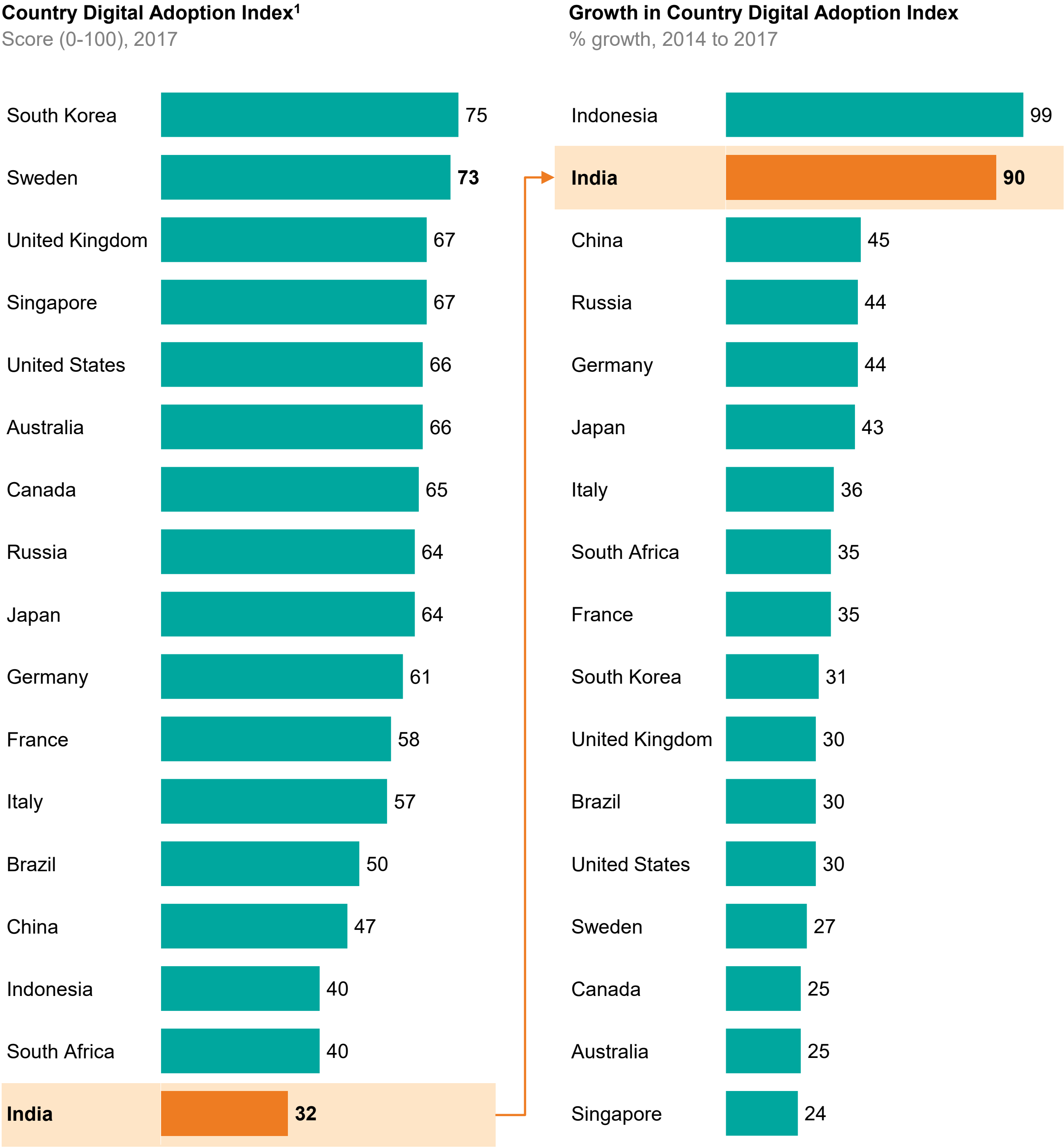
[116] In terms of the rate of growth of the digital score, "high" represents a rate of growth of above 50 percent over the three-year period, "medium" is between 25 and 50 percent, and "low" is below 25 percent.

[117] *Akamai state of the Internet report*, Akamai Technologies, Q1 2014 and Q1 2017.

[118] Analysys Mason, January 09, 2019.

EXHIBIT 10

India, coming off a low base, is the second-fastest digital adopter among 17 major digital economies

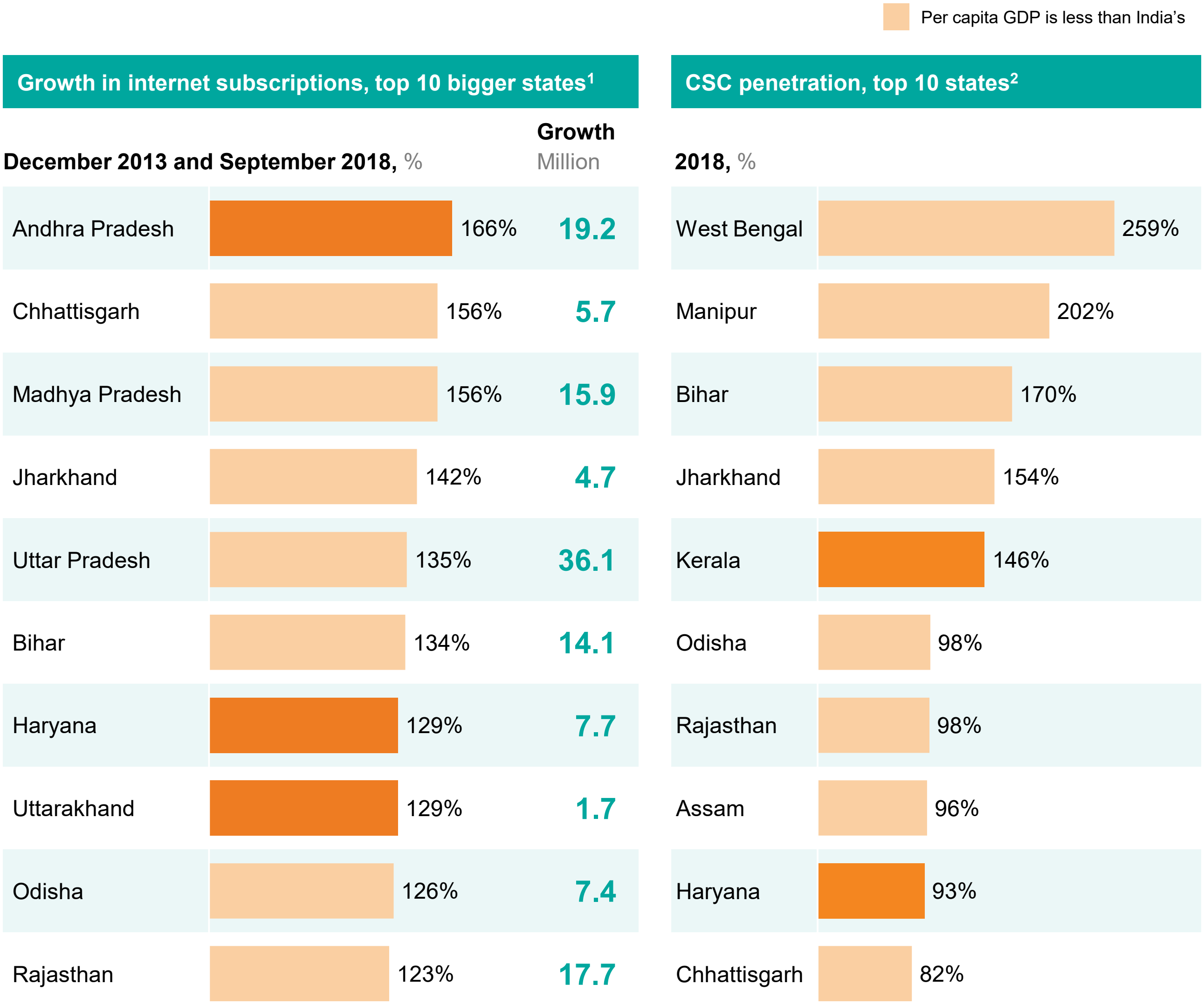


1 MGI's Country Digital Adoption Index represents the level of adoption of digital applications by individuals, businesses, and governments across 17 major digital economies. The holistic framework is estimated based on 30 metrics divided between three pillars: digital foundation (eg, spectrum availability, download speed), digital reach (eg, size of mobile and internet user bases, data consumption per user), and digital value (eg, utilization levels of use cases in digital payments or e-commerce). Principal component analysis was conducted to estimate the relative importance of the three pillars: 0.37 for digital foundation, 0.33 for digital reach and 0.30 for digital value. Within each pillar, each element is assigned equal value, with indicators normalized into a standard scale of 0–100 (0 indicating lowest possible value). A simple average of the normalized values was then used to calculate the index.

SOURCE: Akamai State of the Internet Report Q1 2014, Q1 2017; Analysys Mason; Euromonitor International consumer finance and retailing overviews, 2017 editions; International Telecommunication Union; UN e-Government Survey; Strategy Analytics; Open Signal; Ovum; We Are Social; Digital Adoption Index, World Bank

EXHIBIT 11

The digital divide between the “haves” and “have-nots” is being bridged



1 Population more than 10 million.
2 Coverage at gram panchayat level, as of April 2018; calculated as number of functional CSCs at gram panchayats divided by number of gram panchayats.

SOURCE: TRAI Performance Indicator Report, December 2014 and September 2018

India improves the quality of life in India's countryside. The percentage of gram panchayats covered by CSCs could be used as a proxy to understand the ease with which rural residents can access digital services. Here again, of the five states with the most CSCs in gram panchayats, four of them — West Bengal, Manipur, Bihar and Jharkhand — have below-average per capita GDP. Yet, on average they have more than 1.5 CSC per gram panchayat.[119]

India can have more than 900 million internet users by 2025

Realising the potential of digitisation to create economic value and improve quality of life hinges on the ubiquitous availability of high-speed, affordable, and reliable internet connectivity. India, with 560 million internet subscriptions, has the second-largest subscription base in the world.[120] Smartphone penetration has been increasing at a rapid pace, from 5.5 percent in 2014 to 26.2 percent in 2018.[121]

Globally, internet use and smartphone penetration tend to be strongly correlated. For instance, across a set of 17 countries, a correlation of 0.83 between the two measures was observed. In India, the rise in smartphone penetration will be aided by shifting income distribution, as a large number of households move from the "strugglers" income segment to become "aspirers" and "consumers".[122] According to a report by McKinsey & Company, India could gain 67 million aspiring and consuming households between 2017 and 2025.[123] This would improve smartphone affordability significantly, helping drive its adoption. The experience of more digitally mature economies suggests that as smartphones become affordable, their penetration rises steeply, until it stabilises at about 75 percent of overall mobile subscribers. Currently, there are about 350 million smartphone devices in India. Assuming that the Indian market follows the global S-curve, propelled by improved affordability, smartphone share could reach the 75 percent threshold by 2022, making India a market with approximately 700 million smartphones in that year, rising to about 850 million by 2025. On this basis, internet penetration could reach 890 million to 930 million by 2025, or an internet penetration rate of 65 to 68 percent. This compares well with China's current internet penetration rate (53 percent in 2017) but still trails that of the United States (88 percent).[124]

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[119] National monthly progress report, Common Services Centre scheme, April 2018.

[120] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, June 2014, and September 2018; Digital in 2018: Southern Asia, Eastern Asia, We Are Social, January 2018.

[121] Strategy Analytics, December 2018; World Bank, as of March 21, 2017.

[122] Household classification based on annual disposable income. "Consumers" are households whose annual income is INR485,000 to INR1,700,000 ($7,250 to $25,300), "aspirers" fall between INR180,000 and INR485,000 ($2,700 and $7,250), and "strugglers" are households with annual income of less than INR180,000.

[123] *India's economic geography in 2025: States, clusters, and cities*, McKinsey & Company, October 2014.

[124] "Digital in 2018: Eastern Asia, Northern America", We Are Social, January 2018.

3. Thirty digital themes can help transform India

Key Highlights

01

Themes to build digital infrastructure and software capabilities

02

Themes to create e-governance of the future

03

Themes to boost education and healthcare access and quality in the economy

04

Themes to build new digital ecosystems to unlock value in energy, financial services and agriculture

05

Themes to encourage Make in India and Jobs and skills for all

For the next phase of India's digital evolution, the government intends to build a future-ready foundation of technology infrastructure and capabilities, extend ubiquitous and affordable digital access to all Indians, and enable new digital ecosystems and digitally transformed business models to solve many of the country's economic and social problems. Achieving this vision would mean that India could unlock sizable economic value for its enterprises and workers, and become a digital leader in the world by capturing a greater share of rapidly growing global digital flows, act as a magnet for investment in technology sectors, and establish itself as a factory for digital product and service innovation to serve the world (Exhibit 12).

The vision is translated into 30 specific digital themes, aligned to india's national priorities

To make the vision tangible, specific, and actionable, we identified 30 digital themes across nine areas of national importance (Exhibit 13). We chose these themes after reviewing national challenges and aspirations in nine important areas that straddle the whole economy. We took into account vital components of a strong digital economy based on global examples, and then identified digital applications and business models that seem to be successful or promising within India and can be scaled up to achieve sizable impact at a national level by 2025. Each digital theme has the potential to raise India's productivity, unlock efficiency, remove barriers to growth, and improve the quality of life for millions of Indians.

These digital themes are not futuristic or improbable. Many are already at various stages of experimentation, pilot programmes, or getting ready for full scale implementation by the private sector and government, providing promising models that can be expanded to achieve national impact within the next five to eight years. Yet scaling up these pilots and initiatives is by no means an automatic or trivial process. The country will need to systematically address implementation barriers for all initiatives. Furthermore, local contexts across India vary greatly (for example, different states and regions are at different stages of development, have different economic and social priorities, possess varying financial capacities and resource endowments, and must contend with diversity even in terms of language,

EXHIBIT 12

Aspiration for Digital India

DIGITAL FOUNDATION

A strong national digital foundation …

- Universal coverage of digital identity, authentication, and consent framework
- World-class environment for cybersecurity and data protection
- Digitised data assimilated from open API framework with utilities developed using deep analytics and real-time visualisation
- Largest global base of skilled workers in new digital and emerging technologies

DIGITAL REACH

… to connect unserved and underserved people …

- Affordable, high-speed internet to every household through fibre and 5G with more than 1 billion internet users and two-way data speed of 20 Mbps
- Strong local-language content
- Universal digital literacy

… and solve problems

- Dematerialised, digitised, disintermediated processes to empower consumers and businesses in
  - G2B and G2C interactions
  - Land and property markets
  - Financial and credit markets
  - Skill and job markets
- New digital platforms and delivery models in agriculture, education, transportation, and other services

DIGITAL VALUE

Creating a $1 trillion digital economy…

- Digital and data-backed innovation to boost productivity in manufacturing, agriculture, and services sectors
- Vibrant IT-BPM, telecom, e-commerce, and electronics sectors
- Explosion of new digital startups
- More workers in the formalised, digitised sector via tech platforms and value chains

… and India to emerge as the “digital factory” for the world

- Global leader in digital identity and public digital platforms, and data utilities
- Hub of innovation in fintech, edutech, healthtech, agritech, and other areas of technology innovation
- A data analytics engine for the world
- Global supplier of digitally skilled workers

SOURCE: Ministry of Electronics and Information Technology, Government of India

EXHIBIT 13

Thirty digital themes will pave the way to Digital India 2025

DIGITAL FOUNDATION

A 21st-century IT infrastructure and software capabilities

1 A vibrant IT/BPM industry with significant reskilling of its workforce in digital technologies of the future

2 State-of-the-art cybersecurity, robust laws and policies for secure and safe collection, and storage of personal data

3 Real-time data visualisation and deep analytics to track national projects and provide open data platforms for innovation

DIGITAL REACH

4 Ubiquitous coverage of broad-based, affordable, high-speed internet connectivity through a combination of fibre to the home (FTTH) and wireless technology

DIGITAL VALUE

C Healthcare for all

11 Universal electronic health record for every Indian capturing and making available clinical encounters, to achieve a rapid, accurate, and affordable healthcare value chain (across drug discovery, diagnostics, delivery, and financing)

12 Tech-enabled health delivery with e-health centres, tele-consultation, tele-diagnostics, analytics-based protocols, remote monitoring, feedback to patients and caregivers

13 Universal health insurance platform for rapid, mass, low-cost customer onboarding, provider, and claims interface for national health protection schemes

D Quality education for the future

14 Integrated digital education platform with customisable local-language content created as an open societal platform for teachers, learners, education providers, and all stakeholders

15 Digital content delivery and learning in schools and higher education institutes through online lessons, video, simulations, continuous assessment, and adaptive learning systems, supported by trained teachers

E Energy for all

16 Digitally enabled power access to every household while improving the financial condition of DISCOMs

17 Grid automation and optimisation using digital technologies to integrate renewable energy sources and improve grid reliability

F Next-generation financial services

18 Digital payment solutions across the full spectrum of government, business, and consumer payments in all states of India to transition to a less-cash economy

19 Flow-based lending and advanced credit underwriting for MSMEs using GSTN and other data for pricing and credit risk management

B E-governance of the future

5 Government e-Marketplace adopted by all government departments/agencies, with comprehensive coverage of buyers, sellers, and service providers, and end-to-end digital enablement from tendering to payment and fulfilment

6 Digital Land 2.0 to accelerate property market transactions enabled by record verification and interoperable platform for all land record–related documents

7 National document and data exchange (using digital locker) to facilitate exchange of documents/data and enable straight-through verification/compliance for multiple individual and business needs (e.g., eKYC, employment, and utilities)

8 Digital technologies to improve urban e-governance for local bodies and satisfied citizens to address challenges of congestion, security, and utility management

9 Comprehensive Direct Benefit Transfers to eliminate losses and inefficiencies in disbursement of benefits and subsidies across wages, food, fertiliser, cooking gas, power, and other areas

10 Profitable digital service provider ecosystem (CSC in every gram panchayat) by expanding range and volume of G2C and B2C goods/services delivered (e.g., e-commerce, insurance, education, health, and agriculture)

G Doubling farmers' income

20 Digital financing and insurance payouts (credit, insurance, payments, risk management) using data from digitised land records, crop-cutting experiments, satellite images, fertiliser DBT, digital sales, and sensors

21 Precision agriculture know-how sharing through multiple channels based on multiple existing and new data sources (soil health cards, weather data, farm/tractor-based sensors)

22 Online agricultural marketplaces leveraging wholesale markets and buyer-seller platforms, providing farmers and traders with timely information on local prices, e-warehousing receipts, and transaction guarantee through direct and e-enabled channels

H Make in digital India, make for India, make for the world

23 End-to-end digital supply chain, e-enabled trade and ecommerce across manufacturers, SME vendors, and wholesale/retail trade, with transition to GSTN, online inventory management, and growth of ecommerce

25 Integrated logistics platform to fully integrate and share information on transportation of physical goods

24 Efficient transportation through digital platforms for passenger transportation such as cab-hailing, and similar sharing-economy applications

26 IoT-based advanced analytics and automation to improve manufacturing processes with plant availability, yield, and throughput, and save costs through asset management

27 Boost electronics manufacturing and exports from India by facilitating financing, investment in R&D, and building best-in-class infrastructure

I Jobs and skills for the future

28 Building skills with updated curriculum (across multiple use cases such as remote ops and advanced analytics) rolled out in all colleges and ITIs in partnership with industry, leveraging digital technology (MOOCs and AR/VR)

29 Online talent marketplaces to provide employers, job seekers, and skills trainers with an array of content, job market information, and supply and demand matching platforms for a variety of occupations

30 Digitally enabled jobs through investment in the next wave of BPO in small towns and semi-urban India, the sharing economy, on-demand workers, and new digital value chains in healthcare, agriculture, and other services

SOURCE: Public and private-sector consultations a major factor in the adoption of technology). As a result, a flexible and locally tailored approach is advisable, to accommodate variation in the nature and types of digital applications across the country.

The initiatives stem from nine important national areas for India, and within them, 30 digital themes that can help accelerate progress toward achieving significant progress in each of these critical areas. In this chapter, we provide an overview of all 30 themes. In the next chapter, we outline the potential economic value — about $1 trillion, given certain assumptions — that could be created by achieving the potential of these themes (by 2025) and their implications for jobs. Finally, in Section 2 of the report, we provide more details on each of the 30 themes, including an outline of promising current initiatives, the prerequisites needed to achieve widespread adoption, and what could be done to improve the chances of scaling them up and realising their maximum value by 2025.

Themes to strengthen the foundation and reach of India's digital economy

The first 11 themes pertain to strengthening India's digital foundation and reach by creating technology, telecom infrastructure, and software capabilities for the future, and by bolstering digital capabilities in government.

GOAL A: 21st-century IT infrastructure and software capabilities

A strong and vibrant technology and telecom sector is a critical foundation for an emerging digital economy. Four themes will be important to achieve this:

Theme 1: An IT-BPM industry equipped for digital technologies of the future.

India's information technology and business process management (IT-BPM) services industry has played a key role in the nation's economic growth, and its continued vibrancy is pivotal to achieving the country's digital economy aspirations for 2025. Technology spending is already about 40 percent of the total investment of enterprises in leading economies such as the United States, and global enterprise spending on technology and business services is likely to reach $4 trillion by 2025.[125] As much as 60 percent of future spending is likely to be on new digital technologies such as analytics, automation and artificial intelligence, cloud, cybersecurity, mobile, and social media, at the expense of spending on legacy systems.[126]

Around the world, digital upstarts in many industries have gained 15 to 20 percent of the market from incumbents, and in such an environment, businesses tend to prioritise the objectives of growth and business model transformation over those of cost reduction. The predominant digitisation objectives of the most senior corporate executives globally are to acquire more customers and to meet their rapidly rising demand for convenience, simplicity, and value added services.[127] In response to these changing needs, new categories of digital specialist firms are emerging in the Indian IT-BPM landscape — for example, EPAM Systems, an automation specialist, and ProKarma, which specialises in the digital transformation of customer experiences and design.

Globally, governments and companies invested $170 billion in data centre infrastructure in 2015.[128] This was driven mainly by the United States and Singapore, with India accounting for 1.3 percent of the total. With the right policies for data governance, data encryption, cloud adoption, and data privacy, India could persuade domestic as well as global investors to set up data centres in India. The country has an abundance of talent that has helped it grow in the IT-BPM sector. Workers can be retrained and redeployed for data centres, and new employees trained in analytics and cloud computing can help data centres to flourish. Consequently, there is a shift in the IT-BPM industry paradigm, from being a purely cost-reducing lever to more of an exercise in protecting and increasing market share in the wake of the broader digitisation of businesses. India's IT-BPM companies will need to reinvent themselves to stay competitive as clients reorient their spending to new technologies and demand greater agility and business orientation. IT-BPM players will need to build new digital offerings that are particularly relevant to their customers, revamp their front

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125 *Perspective 2025: Shaping the digital revolution*, National Association of Software and Services Companies, 2015.
126 Ibid.
127 According to a global survey of more than 2,000 CEOs and CxOs by McKinsey & Company.
128 *Gartner says worldwide IT spending is forecast to grow 0.6 percent in 2016*, Gartner press release, January 18, 2016.

end sales and presales capabilities, and build new design skills and DevOps capabilities, which are the practices and tools that help an organisation to deliver technology applications and services at a rapid pace.

As highlighted above, about 50 percent of the $1 trillion of economic value would come from applying digital technologies and applications by local businesses in new and emerging areas like manufacturing, agriculture, health, and education to help them reduce costs, increase output, or generate value. Creating this value necessitates large-scale adoption of digital technology and tools by both government and private-sector stakeholders. Going forward, domestic businesses in India (as in the developing world in general) would become big buyers of IT solutions, in addition to the traditional markets of the developed world. Adoption of model request for proposal (RFP) bidding documents to help standardise and rationalise IT and IT enabled services procurement across all states of India could go a long way in ensuring that implementation keeps pace with potential.

India's IT-BPM sector has made a significant contribution by working with colleges, universities, and technical institutes to improve the quality and industry relevance of tertiary education. Now, however, digital technology is evolving so rapidly that the education system may struggle to keep pace, at least in the short run. In the coming decade, India will need more trained professionals — whether employed in IT-BPM or in other sectors that are hiring more digital skills directly — in new and emerging areas such as advanced geographic information systems (GIS), artificial intelligence, robotics, and biotechnology (see Box 3, "Technologies of the future"). Under the aegis of the National Association of Software and Services Companies (NASSCOM), a trade group, the IT-BPM industry can foster innovation clusters around emerging technologies, launch and fund research centres, set up networks for sustained global collaboration, and brand India as a digital factory of the world. NASSCOM intends to launch a retraining programme for more than nine million workers by 2022 in IT-BPM and cross-functional needs in other sectors.[129] It will focus on skills needed for current job roles as well as for those growing rapidly, such as social media advertising managers, content managers, cybersecurity experts, big data analysts, data miners, automation engineers, robotics developers, network engineers, and 3-D designers.

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[129] *Skill action plan*, NASSCOM.

Box 3. Technologies of the future

While the government is actively implementing a number of new technologies, several others show great promise but have yet to gain traction. We believe these technologies could become game-changers before the end of the next decade because they hold immense potential to not only boost industry productivity but also help e-governance initiatives in innovative ways. Following is a summary of the most exciting technologies:

Artificial intelligence

Overview: AI is the field of computer science specialising in the development of systems that exhibit "intelligence" in cognitive tasks such as learning, problem solving, and pattern recognition. Machine learning is a subfield of artificial intelligence seeking to develop systems that "learn"; practitioners "train" systems rather than programme them. Supervised learning is a machine-learning technique that uses a set of sample input and desired output pairs to train a system to respond appropriately to stimuli. It is often used when the training set for one problem is small, but the training data for a related problem is plentiful. Neural networks are AI systems based on simulating connected "neural units", loosely modelling the way neurons interact in the brain. Other emerging technologies such as autonomous vehicles and robotics also rely on AI learning. Artificial intelligence has a considerable number of potential applications and value potential across sectors such as advanced electronics and semiconductors, automotive and assembly, chemicals, basic materials, transportation and logistics, tourism, oil and gas, pharmaceuticals and medical products, aerospace and defence, agriculture, and consumer packaged goods.

Global examples: PayPal uses machine learning to fight money laundering. The company has tools that compare millions of transactions and can distinguish legitimate from fraudulent transactions. A hospital study used computer-assisted diagnosis to review the early mammograms of women who later developed breast cancer, and the computer spotted 52 percent of the cancers as much as a year before human doctors diagnosed the disease. AI can extend the life of aircraft beyond what is possible using traditional analytic techniques by combining plane model data, maintenance history, IoT sensor data, and images and video of engine condition.[1]

Relevance for India: Technology, media, and telecom companies as well as banks, financial services firms, and insurers have actively adopted AI throughout their operations. India's largest public-sector bank, State Bank of India, introduced a chatbot called SIA (for SBI Intelligent Assistant) in September 2017 to assist customers with everyday banking services as effectively as human representatives. SIA has been set up to handle nearly 10,000 enquiries per second, or as many as 864 million in a day.[2]

AI also can help shape economic and national security, and can be a critical element of the Make in India, Skill India, and Digital India programmes. The government can also make use of public-sector applications of AI, such as detecting tax fraud, preventing subsidy leakage, targeting beneficiaries, and evaluating models of defence research, for its national security strategy.

Additive manufacturing

Overview: Additive manufacturing (AM), which includes 3-D printing, works by adding rather than removing material to create a shape — hence the name, which distinguishes the technology from "subtractive" manufacturing processes such as milling and drilling. AM allows for more customised and efficient manufacturing: it reduces material and production costs, decreases manufacturing time, and offers flexibility in designing and printing spare parts.

Global examples: AM is used by automotive, plastics, aerospace, medical, and pharmaceutical companies, as well as retail and logistics. GE, for example, manufactures functionally integrated fuel nozzles for its best-selling product, the LEAP engine, and generates fuel savings of as much as $1.6 million per aircraft per year.[3] Amazon uses 3-D printed drones for last-mile logistics[4].

Relevance in India: AM carries tremendous potential for India, by providing fast and customizable medical devices such as hearing aids, implants such as cranial plates and hip joints, and external prostheses, and by enabling the manufacture of complex machine parts used in industries.

Blockchain

Overview: Blockchain is a protocol for exchanging value over the internet without an intermediary. By maintaining an immutable and chronologically ordered record of all actions and files ("blocks") linked together ("chain") in a distributed and decentralised database, blockchain creates an efficient

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1 Bernard Marr, "The Top 10 AI and machine learning use cases everyone should know about", *Forbes*, September 30, 2016.
2 SBI launches chatbot to help customers in banking services, livemint, September 25, 2017.
3 Tomas Kellner, "A short flight for a jet, a giant leap for a jet engine", *GE Reports*, October 10, 2014.
4 Farhad Manjoo, Think Amazon's Drone Delivery Idea Is a Gimmick? Think Again, *The New York Times*, August 10, 2016.

and cost-effective database that is virtually tamperproof. Blockchain can play an important role in storing individuals' data, helping conduct secure transactions, and maintaining a permanent and private identity record.

Global examples: Countries around the world are working to clarify their blockchain strategies. For example, Dubai has a road map, the Dubai Blockchain Strategy 2020, to improve the delivery of government services by adopting the technology. The emirate's government estimates that it stands to save nearly $1.5 billion and 25.1 million hours in document-processing time.[5]

Relevance in India: The private sector has started working on blockchain applications. For example, ICICI Bank co-created a blockchain application as an electronic decentralised ledger for trade finance in 2016.[6] Mahindra and IBM created a blockchain solution for supply chain finance, and Bajaj Electricals replaced its manual bills discounting using a blockchain solution.[7] More recently, the Reserve Bank of India announced that it is considering launching its own cryptocurrency, similar to Bitcoin, which is a popular use of blockchain.[8]

Autonomous vehicles

Overview: Autonomous vehicles can manoeuvre with little or no human intervention. Computers use data from external sensors to control acceleration, braking, and steering. This allows tightly spaced cars and trucks to safely travel at higher speeds — when one vehicle in line brakes or accelerates, they all do. Other forms of autonomous vehicles, such as crop-spraying drone aircraft, self-guided forklift trucks, and law enforcement surveillance drones, also may become widely used.

Global examples: Autonomous vehicles are gaining momentum globally. Google has equipped an autonomous Toyota Prius with computers, sensors, actuators, and other technology and test-driven it for 300,000 miles.[9] General Motors, Toyota, Mercedes-Benz, Audi, BMW, and Volvo are testing their own vehicles. The mining company Rio Tinto, which has used 150 semiautonomous trucks in Australian operations, is also testing fully autonomous vehicles.[10]

Relevance in India: India reports roughly half a million road accidents each year; autonomous vehicles can play an important role in making driving safer. They could also reduce travel times, encourage car sharing, and reduce pollution caused by traffic.

Advanced genomics

Overview: Next-generation genomics includes fast, low-cost gene sequencing and advanced genetic technologies that can improve agricultural productivity, nutrition, and healthcare. Advanced genomics promises to play a critical role globally in addressing healthcare needs through medicines tailored to particular patients, including cancer therapies based on the genetics of a particular tumour and advanced gene-based therapies for diabetes. This could lead to novel treatments and new types of genetically engineered products (such as genetically engineered biofuels), while enabling the nascent field of synthetic biology.

Global examples: Recent breakthroughs have revealed the value of more advanced genomic tumour assessments that identify mutations in a cancer cell's genetic profile. Advanced genomic testing is now being offered through Cancer Treatment Centers of America, a network of comprehensive care centres and outpatient care centres in the United States.[11] ExxonMobil and Synthetic Genomics are pursuing the development of biofuel via an algal research program. Synthetic Genomics is targeting 2025 to achieve the technical ability to produce 10,000 barrels of biofuel per day.[12]

Relevance in India: Genomics could aid agriculture in India by analysing plant genomes that could lead to more advanced genetically modified crops and further optimise the process of farming by tailoring growing conditions and farming processes to a crop's genetic characteristics. It may be possible to create high-value substances such as biofuels by modifying simple organisms such as E. coli bacteria.

Virtual and augmented reality

Overview: In healthcare, virtual reality can allow medical students' virtual entry into operating theatres to understand complex procedures, help support staff receive required training without risk, and act as a therapy tool for patients with psychological problems such as vertigo. BNP Paribas Real Estate has developed a "teleportation" capsule called the POD, which enables prospective home buyers to port themselves into an apartment in a distant city or a building under construction and view it in 3-D.[13]

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[5] Smart Dubai website, as of May 1, 2018.

[6] ICICI Bank executes India's first banking transactions on blockchain in partnership with Emirates NBD, ICICI Bank website, October 12, 2016.

[7] Mahindra and IBM to Develop Blockchain Solution for Supply Chain Finance, *PRNewswire*, November 30, 2016.
Sanjay Gupta, How Bajaj Electricals uses blockchain to pay suppliers, *livemint*, February 24, 2017.

[8] Another experiment with currency? RBI is looking at its own Bitcoin, *Economic Times*, September 16, 2017.

[9] Frederic Lardinois, *Google's self-driving cars complete 300K miles without accident, deemed ready for commuting*, TechCrunch, August 7, 2012.

[10] *Rio Tinto to expand autonomous truck operations to fifth Pilbara mine site*, Rio Tinto press release, March 7, 2018.

[11] Cancer Treatment Centers of America website, as of May 1, 2018.

[12] Irving, TX & La Jolla, ExxonMobil and Synthetic Genomics Report Breakthrough in Algae Biofuel Research, Synthetic Genomics website, June 19, 2017.

Global examples: Wearable devices such as Google Glass not only make it possible to deliver content in novel ways (for example, projecting images from the web that appear to float in space in front of the wearer), but also make it possible to develop "augmented reality" applications that let the wearer step into virtual spaces just as virtual reality goggles do. Many hospitals in the United States and the United Kingdom use simulators (dummies with sensors) to teach procedures for diagnosis, emergency room care, and surgery. Realityworks provide simulated e-learning in areas such as business management and entrepreneurship, urban planning, welding (using fully functional, computer-enabled tools), and even infant care, with simulated babies that record data to assess the quality of care being provided.[14]

Relevance in India: Simulated learning systems have the potential to help India close its skills-training gap in areas such as healthcare, manufacturing, and business management. Using immersive learning software, virtual reality displays, and motion sensors, a student can practice skills and be evaluated in a risk-free environment.

Advanced GIS

Overview: Advanced geographic information systems allow the integration of maps and images with geotagged data. They can be used to map spatial data, such as flood patterns in a city, and identify relevant features and structures, such as emergency centres close to flood zones. Based on such criteria, they can determine which emergency centres need additional support in a particular crisis. Advanced GIS data are also important for precision farming — combining geographic information with data on soil conditions and other factors to show farmers exactly when to plough, plant different crops, and water fields. Advanced GIS can also help in disease and epidemic-control programmes, by enabling health officials to make quick and effective decisions. For example, in the case of outbreaks of infectious diseases, timely geospatial information about the spreading pattern of the disease could help in containing the infection to a specific region through effective quarantine techniques.

Global examples: In Glasgow, the local police used GIS to address violent crime to prioritise the strategic and focused use of resources. Combining GIS data with information on unemployment and poverty, as well as data from hospitals, fire departments, and other sources, city officials identified trends and patterns in criminal behaviour to reduce the incidence of crime.[15]

Relevance in India: In India, the government is setting up the National Centre of Geo-Informatics for use in public service delivery, healthcare, agriculture, water resources, land records, and other areas.[16] This could help India integrate multilayered GIS data into many consumer, government, and business applications. The government has also set up the Indian Space Research Organisation's Indian Regional Navigation Satellite System reducing India's dependence on the Global Positioning System run by the United States.

Robotics

Overview: Robots are programmable machines that can carry out a series of actions autonomously or semiautonomously. They interact with the physical world via sensors and actuators. Because they are reprogrammable, they are more flexible than single-function machines. In industrial automation, robots are used as a flexible way to automate a physical task or process. Collaborative robots are designed to carry out tasks in the same way a human would. More traditional industrial robots tend to carry out tasks more efficiently than a human would.[17]

Global examples: A robotic walker called Lea is designed to help care for the elderly and infirm by, for example, reminding them to eat and drink regularly, take medications on schedule, and exercise. RobotWorx robots can replace manual welders.[18] Physicians at a hospital in Wisconsin have successfully performed cardiac, gynaecologic, and other procedures using the da Vinci robot.

Relevance for India: Robotics have many use cases for Indian industry, including welding, painting, assembly, pick and place for printed circuit boards, packaging and labelling, palletising, product inspection, and testing; all tasks are accomplished with high endurance, speed, and precision. Robots can help in material handling and provide interfaces. Personalised robots can replace humans in some roles, such as assisting shoppers, conducting routine inspections and maintenance, and even performing intricate surgeries.

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[13] *BNP Paribas contributing to the development of virtual reality*, BNP Paribas press release, May 30, 2017.

[14] Realityworks website, as of April 25, 2018.

[15] *The technology that helped transform a crime capital*, esri Malaysia website, September 15, 2016.

[16] National Centre of Geo-Informatics website, ncog.gov.in/.

[17] *A future that works: Automation, employment and productivity*, McKinsey Global Institute, January 2017.

[18] RobotWorx website, as of May 1, 2018.

Theme 2: State-of-the art cybersecurity and data protection.

The ubiquity of smartphones, the popularity of social media, and successful digital-inclusion projects by the government have markedly increased Indians' digital presence — and their overall privacy risk exposure. In a country with 260 million school-age children where 52 percent of the population is either illiterate or has only a primary education, data privacy in cyberspace can be a significant risk for large sections of the population.[130] Cyberbullying, cyberdefamation, and cyberstalking are crimes that affect the most vulnerable sections of society, especially women and children.

Cyberattacks have become more commonplace and sophisticated, and they arise in different ways. In 2015–16, the Computer Emergency Response Team India (CERT-IN) handled over 50,000 cybersecurity incidents, and the number of attacks increased at a compound annual growth rate of 6 percent from 2014 to 2016.[131] India placed 23rd among 165 countries ranked by their commitment to cybersecurity, indicating that there is room for improvement[132]. In 2015 Honourable Prime Minister Shri Narendra Modi said the world faces a "bloodless" cyberwar threat.[133]

India has dealt with cybersecurity and data privacy at the highest level. The Supreme Court recently endorsed privacy as a fundamental right of every citizen.[134] The Ministry of Electronics and Information Technology released a white paper for public consultation on the key principles of a data protection law; it seeks to provide a secure cyberspace through appropriate laws supported by a regulatory structure that allows flexibility for innovation, which is critical for the widespread adoption of digital applications and necessary to create value.[135] The landscape has evolved since India adopted cybersecurity measures in 2013, so it is essential to update the policy.[136] Furthermore, many different government bodies look at different aspects of cybersecurity, such as surveillance, regulation, and education and awareness. These include CERT-IN, the National Critical Information Infrastructure Protection Centre, the National Security Council, the Ministry of Home Affairs, the Defence Research and Development Organisation, the National Technical Research Organisation, the Department of Telecommunications' security wing, the Ministry of Electronics and Information Technology, the Data Security Council of India, and the private group of "white hat" hackers that calls itself the Indian Cyber Army. Ensuring a robust system of cybersecurity in India will require these agencies to work together, potentially through a national coordinating body.

Theme 3: Real time data visualisation and deep analytics.

India will see an explosion of data in the coming decade as information pours in from over a billion mobile phones, digital platforms, wireless sensors, and other sources. Data storage capacity and computing and processing speeds will increase, their costs will fall, and ever-more-sophisticated algorithms will make sense of it all. The convergence of these trends will make data the new currency, and data analytics will become the lifeblood of the digital economy. Data visualisation and analytics capabilities provide many opportunities at the industry and firm levels, but equally importantly, if properly harnessed by the government in collaboration with other stakeholders, they can help create public goods and improve national outcomes.

India has taken several steps to create aggregated data portals and visualisation tools. The government launched a national open data portal (data.gov.in) in 2012 to increase transparency in public affairs and make data available to the public to encourage its innovative use. Currently, the portal offers access to information from more than 170,000 resources, including data and documents published by various government departments and agencies, and has registered

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[130] *School Education in India 2015–16*, Flash Statistics, Universal District Information System, September 30, 2015; *Annual report*, University Grants Commission, 2016; All India Survey of Higher Education, Ministry of Human Resource Development, 2015–16; *Education for all 2000–2015: Achievements and challenges*, UNESCO.

[131] *Technology to stop cyber crimes*, answer to Rajya Sabha question number 891, answered on February 9, 2018.

[132] India ranks 23rd among 165 nations in cybersecurity index, Economic Times, July 6, 2017.

[133] *Text of PM's remarks at the launch of Digital India week*, July 1, 2015, narendramodi.in.

[134] Data protection laws of the world: Full handbook, DLA Piper, September 19, 2017.

[135] *White paper of the committee of experts on a data protection framework for India*, Ministry of Electronics and Information Technology, 2018.

[136] *Notification on National Cyber Security Policy — 2013*, Ministry of Communication and Information Technology, July 2, 2013.

5.72 million downloads and tallied 15.73 million views.[137] The government's eTaal portal captures state level data on e services across 21 central ministries.[138] Other initiatives — such as the UJALA dashboard of the Ministry of Power and the CORE (Chief Minister's Office Realtime Executive) dashboard of the Andhra Pradesh government — are good examples of using real time data and visualisation to increase transparency, identify and diagnose bottlenecks, and surface opportunities to make progress on government goals. Digital dashboards can be much more effective than traditional paper reports in project tracking and implementation.

Government agencies can further expand the coverage and scope of open data and dashboards and can harness data for specific applications and use cases. Governments in countries around the world have started making use of data and analytics capabilities to solve pressing national problems, whether predicting disease transmission patterns and developing proactive actions, using social media data analysis for informed and targeted subsidy reform, optimising the number and location of ambulances, accurately predicting the onset of chronic diseases, or increasing tax revenue by identifying circumstances or individuals most likely to yield results, to mention a few examples.

To make full use of India's data explosion, a number of prerequisites exist: a clear definition of which data sets could be shared by government departments and in what format, a national dashboard to bring high profile programmes together to track progress, sector specific open data aggregations from multiple sources using open API frameworks that ministries, companies, and other stakeholders can use to improve their performance, and specific use cases in the government to demonstrate value and encourage wider use. To facilitate innovation, every government digital initiative needs to conform to the MeitY open API guidelines in the National Data Sharing and Accessibility Policy. The open data should be machine readable, real-time, and fine grained for good quality characterisation. Also, the government needs to develop a long term view of the talent required and must establish partnerships with businesses, technology innovators, global government partners, and nongovernmental organisations that can bring innovation and expertise in analytics to bear. It is worth mentioning that gov.in data could be restricted to open use by Indian organisations and companies only, to act as magnet for researchers and innovators to migrate to India.

Theme 4: Visual broadband for everyone.

To excel in the digital future, or even to ensure that all Indians participate fully, the widespread availability of affordable, high-speed internet connectivity is essential. There is ample opportunity for India to grow in this area, as only around 36 percent of Indians currently have access to broadband service.[139] India's considerable progress on mobile internet adoption through 3G and 4G notwithstanding, the country still has a long way to go before every citizen can leverage the transformative power of digital applications. India's average mobile download speed is 9.9 Mbps, but developed countries have long since achieved higher speeds. In the United Kingdom, the current average mobile download speed is 29.2 Mbps; in Germany it is 31.7 Mbps; and in the United States it is 32 Mbps.[140]

Unless India acts decisively, that gap may widen. Europe has set its strategic objective for 2025 as "access to download speeds of at least 100 Mbps to be upgraded to 1 gigabits per second (Gbps) for all European households".[141] Sweden envisions a bandwidth speed of 100 Mbps to 90 percent of households by 2020.[142] Taiwan has set an aspirational speed of 1 Gbps by 2020 to all rural areas, and Israel of 1 Gbps data to 70 percent of all homes and businesses by 2020.[143] Emerging economies such as the Philippines have also envisioned bandwidth speed of 10 Mbps by 2020 to 100 percent of households.[144] China started its broadband strategy study in 2009, and in its 12th Five-Year "Broadband China" plan it envisioned fixed broadband service to 50 percent of

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[137] Open Government Data (OGD) platform, as of April 25, 2018.

[138] *eTaal user and technical document*, Ministry of Electronics & Information Technology.

[139] *Indian telecom services performance indicators*, Telecom Regulatory Authority of India, September 2018.

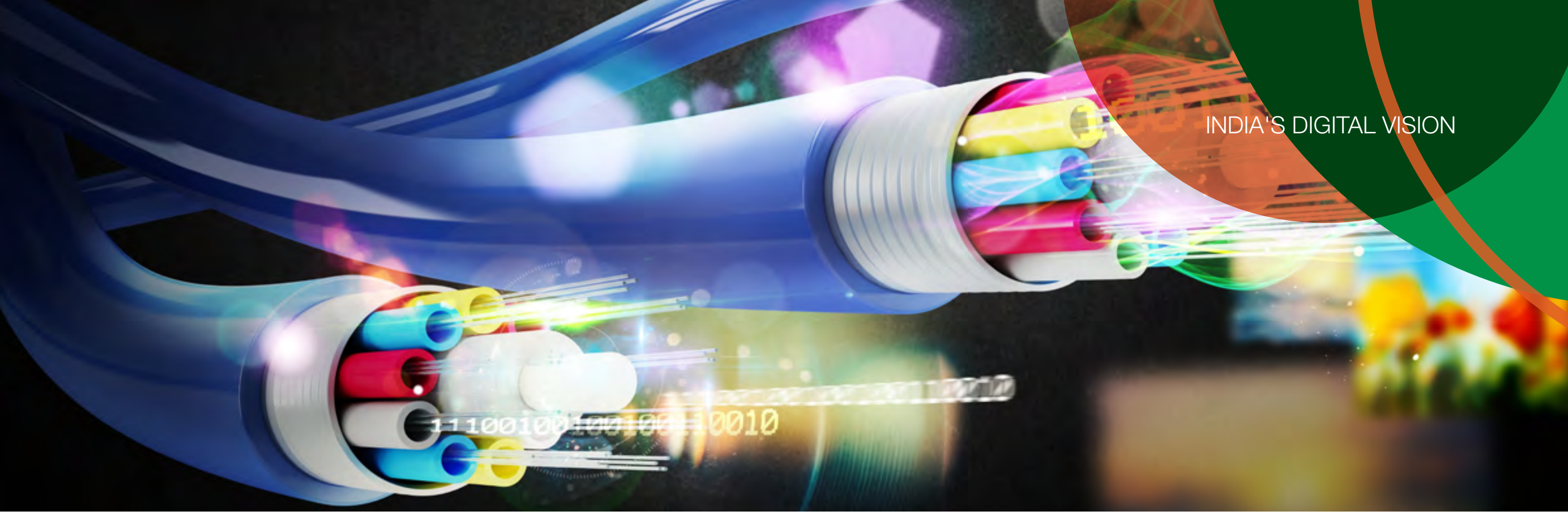
[140] Speedtest Global Index by Ookla, November 2018.

[141] *Connectivity for a European gigabit society*, European Commission, October 19, 2017.

[142] Letter from the Secretary of the Telecom Regulatory Authority of India to the Secretary of the Department of Telecommunications, May 24, 2016.

[143] *Digital Israel — national initiative*, Embassy of Israel in India, February 3, 2014.

[144] *National broadband plan*, working draft, Department of Information and Communications Technology, Republic of the Philippines, March 3, 2017.



homes and businesses by 2015, and 70 percent by 2020. China has set goals of 50 Mbps in urban areas and 12 Mbps in rural communities.[145]

Public Wi-Fi hotspots can also offload mobile data overload to meet user demand for internet on the go. Cisco estimates that Wi-Fi and mobile devices will grow from 51 percent of IP traffic in 2016 to 63 percent in 2021, and forecasts that the number of public Wi-Fi hotspots will increase from 94 million in 2016 to 541.6 million in 2021 globally.[146] There are currently only 31,000 public Wi-Fi hotspots in India, compared to 13 million in France and 10 million in the United States.[147] National Digital Communications Policy 2018 has also set a goal for 5 million by 2020 and 10 million public Wi-Fi hotspots by 2022.[148]

To achieve India's digital aspirations, the country will need to ensure that everyone in the country has affordable access to a new visual broadband standard, irrespective of location, by 2025. Visual broadband is defined as two-way data-transfer speeds of 20 Mbps, the speed required to run two HD videos simultaneously in the same household. In a young country, with a significant number of illiterate residents in villages and remote areas, digital applications — like telemedicine consultation for people living in remote areas and high-quality learning material for students — are more useful when they rely more on images than on text, thus transcending education, age, and location boundaries. Meeting the visual broadband goal requires a future-proof and cost-effective technology strategy, which has fibre to the home (FTTH) in the country as a backbone.

Through the BharatNet programme, India has followed a state-sponsored model for national broadband connectivity. The initiative laid more than 220,000 kilometres of fibre optic cable through the end of 2017, covering more than 100,000 gram panchayats. The government aims to lay fibre to each of the remaining 150,000 gram panchayats by the end of 2018, providing at least 1 Gbps broadband access up to that point.[149]

The aspiration of making visual broadband available to every household could be extended initially from the current BharatNet infrastructure for so-called last-mile coverage — that is, the link between the network and individual users' homes and businesses. An expert body would lay out the overall loop-design architecture and road map for the eventual roll-out of the network. This expert body would be able to evaluate design and technology specifications, policy ideas, RFPs, and guidelines using an objective methodology rather than a consensus-based design approach. The infrastructure roll-out would require investment from government supplemented by private operators. Following the infrastructure roll-out, the fibre infrastructure could be shared with empowered national and local operators or cooperatives for last-mile broadband access. A quality certification of internet providers will be required to ratify these operators on technical parameters. This would allow multiple players to provide quality service to consumers in a fair, competitive market. Supportive policies, regulations, and enforcement mechanisms will also be required to improve the fibre/internet infrastructure and provide right-of-way guidelines for private companies' participation in urban areas.

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145 "12th five-year" development plan for the internet sector, People's Republic of China, May 2012; Phillippa Biggs and Youlia Lozanova, *The state of broadband: Broadband catalyzing sustainable development*, Broadband Commission for Sustainable Development, September 2017; China Academy of Information and Communications Technology.

146 *The Zettabyte era: Trends and analysis*, Cisco, June 2017.

147 *Report on TRAI public open Wi-Fi pilot*, TRAI, April 2018.

148 *National Digital Communications Policy 2018*, Department of Telecommunications, May 1, 2018.

149 "Govt starts BharatNet Phase 2, aims 100 percent connectivity by 2020", *Times of India*, November 3, 2017.

GOAL B: E-governance of the future

India's government is committed to using digital technologies to enhance its transparency and efficiency as it delivers services to citizens and businesses. Six digital themes can help make government to citizen and government to business services more efficient while also developing a foundation that other economic players (including large and small businesses and self employed workers) can utilise to raise growth and competitiveness.

Theme 5: Government e-Marketplace.

Procurement by general government, department enterprises, and nondepartmental enterprises constitutes about 13 percent of GDP, which amounts to about $300 billion annually.[150] Efficiencies unlocked in the government procurement process could therefore yield significant benefits. In 2016, the government set up the Government e-Marketplace (GeM) to significantly cut the cost of commonly used goods and services, reduce the time taken in procurement without weakening risk management, and promote the transition to digital payments.[151] GeM is an open API that includes e-commerce functionalities such as search, price comparisons, selection, order placement, e bidding, reverse auction, demand aggregation, and dynamic pricing as well as digitally verified buyer authentication, facilities for digital documents, digital signing of contracts, easy return policy, and continuous vendor assessment and rating. GeM has registered some 27,978 buyer organisations and 143,751 sellers offering over 494,951 products and 4,920 services.[152]

GeM itself is growing, and GeM 3.0 added many features. By enabling standardised bid creation and technical evaluation based on criteria such as quality and cost, GeM can make the bid process automated and objective. The greater use of data analytics and a comprehensive audit trail made possible by capturing minute user details will make the procurement system less prone to fraud, waste, and abuse. A catalogue-management system reducing or eliminating ambiguity in specifications of goods and services will make buying decisions easier, while a feature allowing consumers to rate goods and services offered on the platform will push for quality. Other features, including a multilingual platform, price comparison using third-party websites, online vendor assessment, and multicart functionality, will contribute to making GeM more robust. When rolled out fully, GeM could lead to significant savings in procurement bills and reduced leakage in the payments chain. Moreover, it could level the playing field for government procurement, allowing small and medium-size enterprises from all parts of the country to compete with large suppliers for orders.

Currently, GeM is at a nascent stage of adoption, and an intensive effort to capture the full potential of this digital theme is required. Approaches could include expanding the vendor base and signing up states and union territories to use GeM (making it mandatory, where feasible). The government is also looking at using GeM services for different government programmes, such as outsourcing IT service jobs to rural BPOs. As GeM grows to national scale, it could collaborate with India's large e-commerce platforms to pursue best practices in managing the large scale registration of vendors and delivering inventory for SMEs, to make it easier for smaller businesses to get onto the platform.

Theme 6: Digital Land 2.0 for digitising land transfer, leasing, and tracking.

India's land markets are in urgent need of improving transparency. Matters related to land and property make up about two-thirds of all civil cases in the country.[153] Digitised land records, which mirror the situation on the ground, will go a long way toward improving the efficiency of land markets, unlocking value from this most important asset class for a majority of Indian households. Banks, for example, could use digital land records as easily verifiable collateral for loans; insurance companies could do the same for risk assessment; municipal authorities for town planning and property tax assessment, estimation, and recovery; and welfare programme and benefit planners for designing welfare schemes linked to home or farm ownership. Courts could use digital land records to resolve property disputes quickly and to simplify and expedite land acquisition by the government for important national infrastructure.

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[150] National accounts statistics, Central Statistical Organization, Ministry of Statistics and Programme Implementation.

[151] *Procurement made smart*, Government e-Marketplace, Ministry of Commerce and Industry, January 23, 2017.

[152] GeM website, as of September 27, 2018.

[153] World Bank. 2007. India – *Land policies for growth and poverty reduction (English).* Washington, DC: World Bank.

The government launched the Digital India Land Records Modernisation Programme in 2008 with the objective of delivering a single window for all land processes, to ensure that cadastral records and titles are accurate; providing automated mutation, or ownership changes, following registration; and issuing title insurance that indemnifies title holders against loss arising from any defect.[154] To achieve these objectives, government must take multiple steps: computerising land records, records of rights, and mutation of data, and converting maps into digital GIS ready formats. So far, 31 of 36 states and union territories in India have computerised land records; nationwide, they have digitised 86 percent of land records (record of rights), 47 percent of mutations (ownership or property) and 46 percent of cadastral maps.[155] However, the documents are currently individual files whose accuracy has not been verified by linking them to other land record documents. To prepare for the next stage of Digital Land 2.0, the government needs to complete the foundational Digital India Land Records Modernisation Programme, and put in place important enablers to fully realise the potential of digital land records.

Some simple steps can accelerate completion of land record computerisation and achieve more citizen benefit. For example, the government could financially incentivise digitalised land-registration outcomes achievement across states, and continue with the task of equipping subregistrar offices with adequate hardware, software, process reengineering, and training, in line with progress that has been made in 31 of 36 states and union territories.[156] It could merge the registration and revenue databases in all states to remove the duplication of effort required to update each database separately. Also, a combined database could further be linked to banks, insurance companies, and others to simplify ownership verification. The government could also use mobile apps and web portals to enable people to access their digital land records. An open record system could also be set up to allow citizens to voluntarily register for resurveying their land record with the aim of a conclusive title.

Theme 7: National document and data exchange.

Many business and personal transactions require individuals and businesses to furnish paper documents such as birth, death, marriage, and educational attainment certificates; driver's licences; income tax returns; bank statements; and rental agreements. The cost and inconvenience of handling, verifying, and storing physical documents is high, for both those furnishing the documents and those receiving them.

An integrated platform is required that consolidates documents from different bodies and can securely transfer data between them, in the shape of a digital locker. A national document exchange would use digital lockers to allow document-issuing and requesting agencies and document owners (individuals or businesses) to exchange documents digitally. This concept could be extended to facilitate the exchange of data between agencies. Each digitised document would be stored securely, tagged with a digital key, and pushed to the requesting agency after verification of the owner's consent. A Digital Locker Authority has been established to license public and private sector agencies as digital locker service providers.[157]

The government has launched a cloud-storage platform called DigiLocker on which issuers and requestors can exchange documents through a consent-based approach by the user. Currently, 50 organisations issue documents via DigiLocker.[158] Certain key documents such as PAN cards, passports, election cards, and birth and death certificates are not issued digitally and are not accessible through DigiLocker.[159] Moreover, many public and private organisations, such as banks, telecom service providers, railways, airports, and police agencies, currently do not accept digital documents. DigiLocker is planning to create an API based data exchange framework that would operate digitally in a secure and seamless manner across various government organisations and agencies based on user consent.

Several potentially valuable use cases are possible for document and data exchange. For example, a lender could sanction a loan by digitally receiving the applicant's

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[154] Digital India Land Records Modernization Programme, website, as of April 24, 2018.
[155] *Land records and titles in India*, PRS, September 2017.
[156] Land records and titles in India, PRS, September 2017.
[157] Digital Locker Authority website, as of May 2018.
[158] DigiLocker website, as of April 25, 2018.
[159] Ibid.

PAN card, salary slips, and property records; the bank would be the requestor and the Income Tax Department, the borrower's employer, and the land registry would be issuers of the documents.

India's national document and data exchange can scale up rapidly, provided that the government undertakes a focused campaign to increase agencies' acceptance of digital documents, and MeitY publicises its legal validity and security. Acceptance of digital documents can also be made mandatory; for example, the Reserve Bank of India could conduct eKYC anti-money-laundering background checks using DigiLocker documents.

Theme 8: Improved urban e-governance using digital interventions.

E-governance has evolved from the simple computerisation of government departments to initiatives that involve qualitative aspects of governance such as more transparency and improved service. The focus today is on designing e-governance applications in such a way that government-related information, services, and grievance-handling mechanisms are accessible online on a real-time basis. Digital interventions, by increasing transparency, efficiency, and reliability in service delivery, have the potential to transform the efficacy of governance for India.

Digital interventions in cities have the potential to bring about transformative change in services such as emergency response, traffic and water management, safety and security, and grievance redressal. Such interventions go a long way in improving the liveability of urban centres as well as the ease of doing business. Recognising this potential, the Government of India has undertaken a number of digital initiatives to improve service to citizens. An example is the Unified Mobile Application for New-age Governance (UMANG), a mobile app offered by MeitY that is designed to increase citizen access to government services. UMANG, which was introduced in 2017, offers 205 services from 38 departments and is expected to expand to many more.[160] MoHUA's Smart Cities Mission is rolling out infrastructure improvements and technology applications to improve the delivery of urban services; its objective is to make 100 Indian cities "smart" by 2019.[161]

Central and state governments could take steps to hasten the adoption of digital applications at the local level. The impact of the most promising solutions can be maximised by sharing best practices. The relevant ministries could convene periodic sessions for senior officers to share information on challenges and successful interventions. In the spirit of sharing best practices, APIs and digital tools should be hosted in a shareable format to allow local bodies to customise tools to meet specific requirements. There is also a need to bolster capacity at the local government level to help officials to successfully implement smart, intervention-based projects at local levels.

Theme 9: Comprehensive Direct Benefit Transfers.

The Government of India runs large scale benefits and subsidy programmes for its citizens. These programmes include a public distribution system to dispense subsidised food, scholarships to students, pensions, and disability allowances, among others. To eliminate leakage (losses resulting from theft and fraud) and to reduce inefficiencies in the disbursement of benefits and subsidies, the government has progressively moved toward Direct Benefit Transfers. The system handles both electronic transfer of money directly to the intended beneficiary and — in many cases, such as food subsidies — using digital verification to eliminate duplicates, ghost recipients, and fraud. From the launch of the Direct Benefit Transfer programme in January 2013 through December 2017, the government transferred a total of $70 billion in benefits from 433 schemes to 596 million (non-unique) beneficiaries.[162]

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[160] UMANG website, as of April 25, 2018.

[161] Ministry of Housing and Urban Affairs website, as of April 25, 2018.

[162] Direct Benefit Transfer website, as of August 31, 2018, Government of India, dbtbharat.gov.in.

While Aadhaar is not mandatory for DBT, 76.6 percent of beneficiaries as of March 2017 had bank accounts seeded with their Aadhaar numbers, enabling digital verification of their identities.[163]

Additional large subsidy and benefit pools could be moved to Aadhaar enabled DBT over the next few years. The first phase covered mainly scholarships, pensions, and other subsidies and welfare benefits paid in cash, but payments to service providers such as Anganwadi workers and in kind benefits to individuals also could be moved progressively to DBT. This last group could include subsidies for food grains, skills training, midday meals for schoolchildren, and the construction of toilets under the Swachh Bharat programme. The state of Andhra Pradesh began Aadhaar enabled public distribution of food grain through more than 28,000 fair-price shops, enabling the government to save $185 million in administrative costs since its roll out in the state. The government has run similar pilots for an Aadhaar enabled fertiliser subsidy.[164]

To further expand the reach of such digital payment programmes, banking infrastructure could be enhanced by utilising banking correspondents, the post office, and Common Services Centres to make it easier for citizens to access payments to them. Private-sector banks, MeitY, and the post office, in conjunction with the Direct Benefit Transfer scheme's mission, can play a pivotal role in scaling up DBT.

Theme 10: A profitable Common Services Centre in every gram panchayat.

India aspires to ensure that every individual has personalised mobile internet access and a range of e-services. But until internet connectivity, portal design, and user capability enable that, a form of assisted access to online services will be important. CSCs are a cornerstone of Digital India's strategy to bridge the digital divide and provide e services to millions in rural and semi-urban areas that have limited reach. CSCs are staffed physical outlets that provide both government and private-sector e services to local consumers. A unique aspect is that each CSC is set up by a local businessperson, or village level entrepreneur, who is free to tailor the services he or she provides based on the needs of the local market, and is incentivised through commissions.

As of April 2018, there were 183,217 functional CSCs at the gram panchayat level with over 292,748 functional CSCs overall.[165] Making such centres profitable and viable is crucial to ensuring that the model is self sustaining and continues to grow and evolve. The vision for CSCs in 2025 could be to double the income of VLEs by expanding the range and volume of private and government goods and services delivered through the CSCs. With the help of private-sector, public-sector, and government partnerships, VLEs can expand their businesses in a number of ways, such as making last-mile deliveries of e-commerce purchases, acting as sales agents for local MSMEs, selling e-insurance, or offering online education and skills training, technology enabled healthcare services, agricultural information, and assisted e transactions for financial services. They can also act as livelihood hubs that attract local employers and job seekers, and help them register for and use online job portals.

Achieving the full potential of the CSCs, and similar digital service centres, will require a concerted effort to work with governments of states and union territories to expand the range of services offered, unlock rules and regulations that impede certain services from being provided (for example, telemedicine and the sale of over the counter drugs are not permitted under current rules in many parts of the country), and develop new services, such as being a local internet service provider, in response to a continuously evolving environment.

Even for those individuals with wireless and internet connectivity, it is important to make all government services accessible on an integrated platform that serves as a single access point for service delivery. The UMANG app, launched by the government in November 2017, brings together e-governance services including My PAN, Jeevan Praman, Soil Health Card, and Saral, to name a few, on a single mobile application.[166] With two million downloads in its first week, the app is a step in the right direction to provide G2C services to the masses.

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[163] Direct Benefit Transfer website, Government of India, dbtbharat.gov.in.

[164] AePS and AeFDS notes, Babu.A, IAS, Collector, Krishna District, Andhra Pradesh, November 2016.

[165] *National monthly progress report*, Common Services Centre Scheme, April 2018.

[166] UMANG website.

Themes to build new digital ecosystems and unlock economic and societal value across the country

The previous section outlined themes that can help build India's digital foundation and expand reach. This section deals with technology enabled business models and value chains that serve other sectors of the economy, such as agriculture, education, energy, financial services, healthcare, manufacturing, and transportation and logistics, as well as the labour market. Each of these themes will need significant innovation and investment by the private, public, and social sectors, and in many cases active collaboration and partnership among stakeholders.

GOAL C: Healthcare for all

India aims to attain the highest level of health and well-being for citizens of all ages by making universal access to quality healthcare services available without causing financial hardship.[167] This requires lowering costs as well as instituting such public health goals as reducing the incidence of communicable and noncommunicable diseases, and infant and maternal mortality. Technology is making significant advances in how healthcare is delivered to people. According to experts, in the next decade, it may become mandatory for doctors to consider second opinions from a tech or a software solution on patient procedures. It is possible that a software platform will emerge in the not-so-distant future as the biggest provider of healthcare, creating a bedless hospital. This is similar to what we see today in the field of mobility and hospitality, where the biggest solution providers — Uber and Airbnb — do not own the inherent assets. While many basic health system gaps need to be filled, including inadequate physical infrastructure and trained healthcare providers, three digital themes can help make better use of available resources to improve health outcomes by leveraging technology.

Theme 11: A universal electronic health record (EHR) for every Indian.

The universal electronic health record (EHR) is an important long-term foundational element for efficiently providing quality healthcare to every Indian. By integrating health data from multiple sources such as healthcare centres, hospitals, and diagnostic labs, EHRs could provide a more comprehensive summary of a patient's health than paper records, and could be particularly helpful in improving healthcare services. Properly implemented and maintained EHRs not only provide a 360-degree view of an individual's medical history, but also provide valuable insights on epidemiology and public health for effective and timely policies and programmes.

Proprietary EHR systems have been rolled out by a variety of Indian healthcare providers, such as Piramal Swasthya's rural clinics and Narayana Health and Manipal Specialty Hospitals institutions.[168] Going beyond the proprietary systems, a universal public EHR platform that enables multiple proprietary systems to communicate with it can yield benefits for the entire health system.

There are some key enabling elements for achieving the potential of EHRs. First, EHRs need a comprehensive regulatory framework. This includes templates for data capture (for example, the nature of fields such as age and sex to be captured for a diagnostic test), rules for data sharing and aggregation (such as consent-based sharing of test results as opposed to deemed consent), and rules for usage of EHR data (including a permit process for health data aggregation). The Ministry of Health and Family Welfare has already approved metadata and data standards developed by the Ministry of Electronics and Information Technology.[169] MoHFW has also released a draft Digital Information Security in Healthcare, Act (DISHA) to enforce privacy and security measures for electronic health data, and to regulate storage and exchange of electronic health records.[170] MoHFW defined EHR standards in 2013 and updated them in 2016.[171] In order to accelerate adoption, the government could mandate the use of EHRs in phases.

To realise the full potential of EHRs, the public or private sector will need to build a technological backbone to securely collect, store, and share data within established protocols. Currently there is no secure cloud-based platform for EHRs, and no user-friendly app or web portal that can enable medical providers and consumers to access or update their records. To address this need, the Ministry of Health and Family Welfare has started thinking about working through a special-purpose vehicle — a legally independent subsidiary — to build and manage an interoperable EHR platform, which could be done by using the DigiLocker framework. The government has begun soliciting bids from contractors to design, develop, and implement just such a portal, called the Integrated Health Information Platform, or IHIP.[172]

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[167] *National health policy*, 2017, Ministry of Health and Family Welfare, Government of India.

[168] Piramal Swasthya, Manipal Hospitals, Narayana Health.

[169] Standards for eGovernance, Ministry of Electronics and Information Technology.

[170] *Digital Information Security in Healthcare, Act*, Ministry of Health and Family Welfare, November 2017.

[171] Electronic Health Records, Ministry of Health and Family Welfare.

Theme 12: Tech-enabled health delivery system for primary, secondary, and tertiary care.

India currently has 0.8 physician for every 1,000 people, which is below the ratio of 1 per 1,000 recommended by the World Health Organization.[173] Furthermore, significant inequity exists between India's urban and rural areas — 60 percent of hospitals are in urban areas, home to about 32 percent of India's overall population.[174] Digital solutions such as teleconsultations and telemedicine have the potential to extend healthcare to the needy, irrespective of their location. For example, technology-enabled e-health centres and e-hospitals, equipped with internet connectivity and communication equipment such as tablets and mobile devices, could provide access to a network of doctors who can consult via voice calls or HQ video.

Rapid and mass-scale adoption of remote healthcare warrants clear and supportive regulatory frameworks and public-private partnerships to support training healthcare workers and provide infrastructure facilities. Laws need to clarify the legal validity of teleconsultations and online prescriptions, as well as legal jurisdictions for medical negligence disputes when advice is delivered through telemedicine by a doctor located in a different state than the patient. Privacy and security standards must be set for storing and transmitting health records and advice for remote healthcare delivery — for example, adopting standards for saving data from video and audio recordings of consultations, and setting rules for data collected by remote diagnostic devices. The Ministry of Health and Family Welfare has been studying these issues and has drafted a Digital Information Security in Healthcare Act.[175] This Act has listed powers and functions to the National Electronic Health Authority of India to collaborate and work with standardisation testing and quality certification of digital healthcare system, while also addressing other key issues like data sharing.[176] The Act on has been drafted and is in public consultation provides a robust foundation.[177]

Most health extension workers are currently not equipped to use digital devices, nor do they have the training in clinical protocols to enable decision making for remote consultation. Training for all healthcare professionals could be enabled through e-learning. The Ministry of Health and Family Welfare is also looking at developing an e-learning platform for all health workers, which would be especially helpful in training workers in remote areas. This platform could have modules to teach basic and recent healthcare practices, but also could be used to train and certify health workers on informatics skills. The ministry is also formalising partnerships with academic institutions to develop and evaluate content. Public-private partnerships could be considered an effective supplementary strategy to quickly kick-start remote health services as the state ramps up physical and health resources to deliver a large portfolio of, at least, outpatient services through digital means. All remote healthcare initiatives should be evaluated for adequacy, certainty, and quality outcomes to determine if they are truly delivering on need in remote areas.

Theme 13: A universal health insurance platform.

With over 70 percent of healthcare expenditure in India being out-of-pocket and 15 to 20 percent of households facing catastrophic health expenditures annually, providing universal healthcare insurance to vulnerable sections of the society is a key health goal for India.[178] Health insurance for low income populations is expanding through the government's Rashtriya Swasthya Bima Yojana scheme, which currently covers over 36 million families, and through state level health insurance programmes targeted at the poor, such as Andhra Pradesh's Aarogyasri scheme.[179] The national scheme aims to ensure the inclusion of all targeted beneficiaries (that is, to minimise unintended exclusions), with a service delivery model focused on demand financing (enabling the consumer to choose what to pay for, as is the case with out-of-pocket spending on healthcare), freedom of choice among accredited government and private hospitals as healthcare providers, and cashless services reimbursable to the provider at predetermined prices and package rates.

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[172] Electronic health records, Press Information Bureau, Ministry of Health and Family Welfare.

[173] Global health workforce statistics, World Health Organization, 2016.

[174] *Report on healthcare access initiatives*, KPMG-OPPI, KPMG in India, August 2016.

[175] Digital Information Security in Healthcare Act, as of March 21, 2018.

[176] Ibid.

[177] *Digital Information Security in Healthcare, Act*, Ministry of Health and Family Welfare, November 2017.

[178] *World Bank support to the health sector in India*, World Bank, April 6, 2010; *Trends in catastrophic health expenditure in India — 1993 to 2014*, World Health Organization, November 2017.

A digital health insurance platform is essential as a technology backbone for successfully rolling out the National Health Protection Scheme, helping to quickly on-board insurers, reduce the risk of false claims, and efficiently process claims and settlements. This public digital platform could connect consumers, insurers (private and public), and hospitals. Insurers could enrol clients and validate and process their claims online. Each person insured could have a digitally verifiable database with his or her EHR. Analytics on demographics through access to anonymised medical records and consent based individual records could help insurance providers determine accurate premiums.

Beyond covering low income people, for whom the government buys health insurance, a digital platform could capture health insurance policy and claims data for all segments of Indians (high , middle , and low income consumers, whose premiums may be financed by government, employers, cooperatives, or the individuals themselves). A universal platform that captures insurance coverage and transactions data could yield powerful system wide benefits. It would enable pooling and analysis of national health data at an unprecedented level of detail, leading to opportunities for better health system planning and forecasting, more effective drug research, more targeted insurance pricing, and more effective public response systems for emergencies and outbreaks.

GOAL D: Quality education for all

Enrolment in India's primary schools is now above 96 percent, but learning outcomes need significant improvement — in 2016, a quarter of all children in standard VIII in rural India were unable to read a standard II–level text.[180] In higher education, despite a relatively higher tertiary education attainment rate, students lack many skills required for employability. Only 17.9 percent of the country's IT graduates are employable in the IT services sector, and 3.7 percent in IT products.[181] Similarly, if Indian Institutes of Management graduates are left out, only 7 percent of all Indian MBA students are employable.[182] India needs to improve learning outcomes across all schools and higher education institutions, in both the public and private systems, in rural as well as urban areas, as a critical national priority. Two digital themes can help make progress toward this goal.

Theme 14: Integrated digital education platform for students, with local-language content.

Digital content has the potential to make teachers more effective and productive in the classroom, but also can make it easier for them to receive continuous training outside the classroom. This theme acknowledges that educational and skills training systems in India have highly varied localised needs and contexts.

Multiple initiatives under way in the Ministry of Human Resource Development are focused on building digital content and solutions. While these initiatives are all individually useful for different stakeholders, their adoption and usage is limited compared to global platforms like Khan Academy, which says it has delivered over 1 billion lessons and is used by 40 million students and 2 million teachers every month.[183]

In a similar vein, there is a need to simplify the user experience offered by different initiatives in India, especially for students. This could be done by creating a one-stop digital education platform for students of all ages. The vision could be to have profiles of every student on the platform and allow them to log in and track their learning activities and outcomes. The platform could act as a digital parallel for students' education journeys. It could be integrated with data and resources from different agencies such as the National Achievement Survey, the All India Senior School Certificate Examination, and state boards to provide a holistic picture of student performance at the individual and aggregate levels.

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[179] Rashtriya Swasthya Bima Yojana, as of March 2017, rsby.gov.in.

[180] *Annual status of education report (rural), 2016*, ASER Centre, January 2017.

[181] *National employability report (engineers): Annual report 2016*, Aspiring Minds, 2016.

[182] *B and C category B-schools producing un-employable pass-outs*, The Associated Chambers of Commerce and Industry of India, April 27, 2016.

[183] Khan Academy Turkey website, Translated to English, Accessed May 2018, tr.khanacademy.org/.

Moreover, the platform could provide building blocks of digital infrastructure for content creators and solution developers. Such an approach would attract entrepreneurs with the potential to create innovative and user-friendly solutions, which is critical for catalysing national-level adoption. This content development innovation could be supported with new sources of capital like an innovation fund (similar to the Revitalising Infrastructure and Systems in Education initiative). A government-led fund of funds and hackathons would support edtech innovation and promote further investment in this field.

Theme 15: Digital content delivery and learning in schools and higher education institutions.

Online learning in a facilitated environment can improve student proficiency in reading, mathematics, and other K 12 subjects, as well as in more advanced courses in higher education.[184] The use of digital tools in Indian classrooms could follow a hybrid model, facilitated by teachers who use online lessons, videos, and simulations to build a greater understanding of concepts and their application. An important feature would be the use of continuous assessment tools and adaptive learning systems that help teachers create personalised learning plans for students, based on individual learning achievements and gaps.

A few basic requirements need to be met for digital content delivery models in classrooms. The first is high-speed internet connectivity in classrooms at all levels, which could enable streaming and downloading of videos and other content. Second, students and teachers need devices to access content; this could be addressed with a mix of shared computers and individual tablets where possible. Direct-to-home video streaming and other innovative channels also can be explored. The National Knowledge Network already makes high-speed internet connectivity available in 1,688 premier institutions and universities.[185] However, much remains to be done. Only 27.3 percent of the country's schools have computers, let alone internet access.[186] Bringing broadband internet to all schools has been made a part of the BharatNet implementation.[187] Third, teachers and students need a rich repository of digital content that is available in local languages and is either hosted on a cloud server or downloadable onto devices.

The availability of the internet and of devices, though critical, are only the enablers. Teachers and students need to be trained in ICT in order for digital-enabled teaching and learning to become a reality. The reach of teacher training programmes could be expanded through MOOCs, or massive open online courses, and the adoption of DIKSHA (the national digital infrastructure for teachers) by educators all over the country. Given the critical role digital learning will play in the future, India could launch a national movement toward digital literacy with participation from the central and state government.

The full potential of distance learning has not been realised because it is not considered equivalent to classroom learning. The Ministry of Human Resource Development is drafting a new policy on online learning and virtual university instruction. This policy would enable students to gain access to higher education and certification virtually, which would greatly expand access to higher education for the estimated 30 million students entering tertiary education from 2017 to 2025.[188]

Areas without adequate physical infrastructure or safety can gain access to education through digital channels. The digital infrastructure required in such locations would include not just internet service and devices, but also supporting infrastructure, like solar-power supply. Structured and managed effectively, education programmes in such areas (like MOOCs and online courses) have the potential to improve social outcomes and stability.

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184 Rachel Jones, Christine Fox, and Douglas Levin, *National educational technology trends: 2011*, State Educational Technology Directors Association, 2011; Kelly Shapley et al., *Evaluation of Texas technology immersion pilot: Findings from the second year*, Texas Center for Educational Research, 2008.

185 Premjit Lal, Digital India, Ministry of Electronics and Information Technology, August 31, 2017.

186 *School education in India 2015–16*, Flash Statistics, Universal District Information System, September 30, 2015.

187 Government rolls out BharatNet Phase 2, aims 100% connectivity by 2020, *Economic Times*, November 14, 2017.

188 *The world at work: Jobs, pay and skills for 3.5 billion people*, McKinsey Global Institute, June 2012.

GOAL E: Power for all

Theme 16: Digitally enabled power access.

India is the fourth-largest consumer of electricity and the third-largest producer of electricity in the world.[189] Historically, India's power sector has focused on improving access, but new reforms such as the Integrated Power Development Scheme are promoting the use of IT to improve distribution and transmission.[190] These digital reforms will expand focus from access to consumer-level reliability and quality of power supply. Digitising the distribution network and operations lies at the core of reducing aggregate technical and commercial losses. In India, these AT&C losses, which include theft and power lost to faulty equipment, are currently estimated to be around 20 percent, which exceeds global standards.[191]

The most fundamental component of digitisation would be the installation of digital meters for all households in the country. Advanced metering infrastructure, which consists of smart meters connected to the internet, could allow for bidirectional communication between the consumer and the utility. While the cost of these meters is high compared to that of meters equipped for automatic reading, demand aggregation has the potential to lower the price. Distribution companies could consider having private players use build-own-operate-maintain models for smart metering to order to reduce the burden to the DISCOM to make a large investment. After a fixed period, these private players could transfer ownership to the distribution companies.

To address reliability, the other key component would be a supervisory control and data acquisition system to monitor losses at the 11-kilovolt (kV) feeder level, usually found in populated areas. SCADA implementation is in progress in 59 towns in 18 states, with $240 million designated for project implementation under the Integrated Power Distribution Scheme.[192]

State governments also may consider using electronic Direct Benefit Transfer to deliver power subsidies to households below the poverty line and to farmers. This could reduce the working capital problems of state distribution companies and ease state governments' subsidy burden through better targeting of subsidies to customers identified through Aadhaar and other acceptable methods.

Theme 17: Smart grid integrating distribution generation and renewables.

Renewable energy sources, the use of which is increasing, and distributed generation require a smart grid. To equip the grid to handle the power from distributed renewables, transmission companies could upgrade the grid for the bidirectional flow of power — that is, to allow electricity to flow from the grid to customers or from customers to the grid if customers have more power than they need from their own solar panels, wind turbines, fossil-fuel-powered dynamos, or even hybrid or electric vehicles. Utility companies across the country and the government could initiate active and passive demand-side management programmes for domestic consumers, such as offering customers financial incentives to use less power and teaching them how to save money by conserving energy, as well as demand-response programmes that use time-based rates or other financial incentives to encourage consumers to reduce electricity usage during peak demand periods. Energy service companies, or ESCOs, can play a transformative role in implementing demand-side management by providing energy-efficient solutions through a risk-sharing model with the consumer.

The government launched the National Smart Grid Mission in 2015 to promote technologies such as advanced metering infrastructure, which is an integrated system of smart meters, communications networks, and data-management solutions to enable two-way communication between utilities and their customers. The mission has accelerated smart grid deployment by absorbing newer technologies — smart meters that follow standard IS 16444 published by the Bureau of Indian Standards (BIS), Companion Standard IS 15959 for Smart Meter Data Exchange published by BIS, and model smart grid regulations released by the Forum of Regulators — international collaboration for smart grid knowledge exchange with the International Smart Grid

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[189] *Power, India Brand Equity Foundation,* February 2018, ibef.org., https://www.ibef.org/download/Power-February-20181.pdf.

[190] Integrated Power Development Scheme, Press Information Bureau, Government of India, November 20, 2014.

[191] Data provided by the Ministry of Power, Government of India, for states participating in the Ujjwal Discom Awas Yojana (UDAY) program for the financial turnaround of electricity distribution companies.

[192] *Review of SCADA/DMS implementation*, Integrated Power Development Scheme (IPDS), Ministry of Power, January 2017.

Action Network and bilateral dialogues, and so forth.[193] It also agreed to renovate and modernise substations, deploy real-time monitoring of distribution transformers, and install harmonic filters and other measures to improve the quality of the power being delivered. Twelve smart grid pilot projects are currently under implementation, including one Smart City R&D Platform and one Smart Grid Knowledge Centre.[194]

There is a need to bridge the capability gap that prevents DISCOMs from using digital technologies in operations and maintenance of the power grid. To address this gap, distribution companies could collaborate with original equipment manufacturers, service providers, think tanks, and academia to conduct research and establish proofs of concept for specific smart grid technologies. The government will need to support utility companies to transition to become energy service companies. ESCOs can play a transformative role in implementing demand-side management by providing energy-efficient solutions through a risk-sharing model with the consumer.

GOAL F: Next generation financial services

India has moved to correct large scale financial exclusion through the massive roll-out of bank accounts, reaching over 325 million underserved people in the past few years.[195] The country now aspires to expand the scope of financial inclusion and enable innovative, modern financial solutions for all segments of the country. Two digital themes can help catalyse actions in this area.

Theme 18: Digital payments solution and transition to a less cash economy.

Digital payments are rising rapidly in India. From about 876.5 million transactions in November 2016, they climbed by more than 27 times to reach about 24.3 billion transactions in December 2018.[196] Nonetheless, there is a long way to go. Measured by value, a significant share (26 percent) of India's retails payments in 2017 were made electronically.[197] India's government has already made significant progress toward mass, affordable digital payments by creating strong and affordable infrastructure and solutions through initiatives such as the National Payment Corporation of India's launch of the BHIM app and Aadhaar-enabled payment app. Private-sector innovation in digital payments has also grown explosively, as evidenced by Paytm, Airtel Payments Bank, and HDFC Bank's DigiThane. India would reap considerable economic value and consumer benefits in terms of saving the costs incurred in handling cash and increasing transparency by moving to a less-cash economy.

While digital payment ecosystems have started to emerge in India, until recently they have been difficult to scale because of a lack of internet and digital payments infrastructure, especially in rural areas. Also, customers are not fully aware of the benefits of digital payments and are concerned about the security and reliability of transactions. Similarly, MSMEs also have concerns about switching to digital payments because doing so would mean becoming part of the formal financial system and because they would have to pay digital payment transaction fees. These charges, called the merchant discount rate, or MDR, are 0.3 to 0.9 percent for debit card transactions, depending on the amount and mode of the payment and whether it is made through a point-of-sale machine or using a QR code.[198]

To encourage the spread of digital payments, the government could require all ministries, departments, and agencies to accept them. Many consumers are unwilling to shift toward digital payments due to lack of basic digital skills, low awareness of the hidden cost of cash transactions, and doubts about the security and reliability of digital transactions. The government could take the lead in educating socially and financially excluded people about the use and benefits of digital payments. Additionally, huge potential could be tapped by creating real incentives (for example, cheaper finance) for traders, farmers, and microenterprises to move payments online.

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[193] Inputs from National Smart Grid Mission, Ministry of Power, Government of India, as of March 2018.
[194] Ibid.
[195] Pradhan Mantri Jan-Dhan Yojana (beneficiaries, as of August 31, 2018), Ministry of Finance, Government of India.
[196] Payment system indicators, Reserve Bank of India, Table 43, March 2015, December 2018.
[197] Euromonitor Passport, as of March 29 2018.
[198] *Rationalisation of merchant discount rate for debit card transactions*, RBI notification, December 6, 2017.

Theme 19: Flow based lending and advanced credit underwriting.

MSMEs had an unmet credit gap of $300 billion in 2011, and this is likely to rise to $800 billion by 2025 on the basis of past momentum.[199] The paucity of financial records and verifiable credit histories is a major factor that has impeded the flow of credit to MSMEs. Going forward, India's small businesses are poised to generate a large volume of data through online interactions; the GSTN, for example, could universalise online sales invoicing, the use of digital payments, greater participation on e-commerce sites and online procurement portals, such as the Government e-Marketplace.

Lending institutions can automate much of the loan underwriting process. To begin, loan applications can be digitised, allowing individuals to request a loan on web and mobile platforms. As part of the process, banks request applicants' consent to access a set of conventional data sources, including tax returns, bank statements, and credit history. Subject to the privacy regulations and user permission, banks may also tap unconventional data sources, such as the GSTN, mobile phone accounts, utility bills, digital wallet activity, e-commerce history, and social media use. Once a bank has access to data from all of these sources, it can use advanced algorithms to assess the applicant's creditworthiness for the type of loan requested. Advanced credit underwriting can deliver value to individuals and MSMEs by improving their access to credit despite the absence of a conventional financial history. It may also help lower interest rates for some borrowers due to data-backed risk pricing and a shift from high-interest informal money lenders.

The major barrier to scaling up this powerful theme is the paucity of consistent, uniform, machine readable digital data. A focused effort would be required to raise digitisation and data-sharing targets across government agencies and create data sharing interfaces and protocols tailored for financial institutions, with appropriate safeguards to protect privacy and ensure borrowers' consent where relevant. The Ministry of Corporate Affairs could mandate usage of machine-readable formats like extensible markup language (XML) for data that companies of all sizes upload to government portals such as MCA21, the Ministry of Corporate Affairs' e-governance initiative. The Ministry of Micro, Small and Medium Enterprises could set up a single body to solve data availability issues for MSMEs by making government data available digitally, designing architecture for data sharing, and building supporting infrastructure like APIs, data security, and consent architecture. Policies set up by the Ministry of Finance and Ministry of Micro, Small and Medium Enterprises would also be required to encourage the Udyog Aadhaar–based eKYC anti-money-laundering database and consent architecture for businesses.

GOAL G: Doubling farmers' incomes

Agriculture's importance in India is difficult to overemphasise. It accounts for about 13 percent of the country's GDP and employs about 45 percent of its workforce.[200] While improvement in productivity in agricultural products is still required, the more urgent need is to improve price realisation to improve famers' incomes. Digital applications can play a critical role in improving yields — as well as reducing costs and increasing the market value of crops — by making it easier for farmers to obtain financing, optimise agricultural inputs, and increase direct access to markets. In this way, digital applications promise to play a significant role in the government's quest to double farmers' incomes by 2022.[201] Three digital themes can help accelerate India's progress along this path.

Theme 20: Digital farmer financing and insurance payouts.

Access to affordable credit and insurance is a challenge many farmers in India face. Informal rural lending costs significantly more than formal finance (an estimated 10 percentage points higher than bank lending rates on average), and even where insurance is available to farmers, payouts tend to be slow.[202] From a financier's perspective, farm lending is risky and expensive because loan sizes are small and assessing credit is difficult in the context of poor data and the absence of credit histories.

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[199] *Sub-group on flow of private sector investments to MSME*, Planning Commission, 2011–12.

[200] National accounts statistics, Central Statistical Organisation, Ministry of Statistics and Programme Implementation; Report on fifth annual employment-unemployment survey, Ministry of Labour and Employment, 2015–16.

[201] *Draft volumes* of the Strategy for doubling farmers' income by 2022, Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare.

[202] *Household Indebtedness in India*, NSSO, 70th Round, 2012–13.

In the coming years, this could change, as data from a variety of sources will be available, including digitised and digital identity seeded land records, photographic images of standing crops, evidence of digital payments to agri input companies, digital payments received on e-marketplaces from the sale of agricultural commodities, Direct Benefit Transfer scheme payments into farmers' bank accounts, drone and satellite based images, and tractor and field based sensor data. Such data will enable credit risk assessment using algorithms, which, when coupled with electronic bank accounts, can be used to efficiently acquire customers, control financial inflows and outflows, manage credit risk, recover loans, and achieve faster insurance payouts. Common Services Centres and banking correspondents can facilitate online applications, eKYC verification of land records, and other steps in the process.

Payouts on crop insurance are currently approximated based on yield forecasting at the village or district level based on crop-cutting experiments, which aren't representative of productivity in individual farmers' holdings. Farmers can suffer significant losses when they do not receive timely insurance payouts, especially when they have a low yield or crop failure due to local factors. The government has taken some steps along these lines through the Kisan pilot programme, which is experimenting with satellite and drone based imaging and geospatial technology to estimate crop yields and undertake index based insurance.[203] Other information sources, such as satellite, drone, and weather data, could be combined with crop-cutting experiment results to improve forecasts' accuracy through improved data capture frequency and rationalise the number of crop-cutting experiments in different areas.

Much more action would be required to unlock value from digital farmer financing: state revenue departments must make digitised land records seamlessly available to lending institutions, for example, and farmers need to be encouraged to move all of their payments and receipts to digital channels. Meanwhile, banks and insurance companies have to step up innovation to create algorithms for risk assessment and recovery management solutions that work. Farmers' credit and flow data are scattered across multiple channels, making it difficult to secure loans. Collating that information under a standardised verifiable identity — would make credit more available. A credit score could be developed for farmers based on financial flow-based data, similar to a CIBIL credit score which assesses credit worthiness of an individual. The NITI Aayog is drafting a Model Agricultural Land Leasing Act to help lessee cultivators gain access to credit.[204]

Theme 21: Precision agriculture know-how for every farmer.

Agricultural yields in India are 10 to 50 percent lower than in many other Asian countries.[205] Moreover, the average Indian landholding is approximately 1.3 hectares, compared with the global average of 3.7 hectares.[206] This makes it difficult to economically implement standard precision agriculture programmes developed for large farm holdings. Precision agriculture is the practice of using detailed, real-time data from a variety of sources to minimise inputs and maximise outputs. Public or private agencies advise farmers on crop mix, fertiliser use, and other inputs — a "package of practices" — after analysing soil nutrient condition, aerial images, weather forecasts, and other factors over a four- to six-month crop cycle. Additional advice is provided based on real-time data from probes and IoT sensors in the field and from animal health monitoring, and GPS-enabled equipment that delivers the optimal amount of inputs at the individual crop level.

The Ministry of Agriculture and Farmers Welfare has taken a big leap in terms of dispatching over 158.7 million Soil Health Cards[207], capturing details of the soil type of each individual farm, along with advice on the amount and fertiliser mix that should be used maximise yield. The usage of this existing infrastructure could be improved by raising awareness through demonstration programmes in all villages in the country or giving financial incentives to both farmers and vendors.

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[203] *Dr. Sanjeev Kumar Balyan launched KISAN Project and Hailstorm app*, Ministry of Agriculture and Farmers Welfare press release, October 5, 2015.

[204] Report of the expert committee on Land Leasing, NITI AAYOG, March 31, 2016.

[205] *India's technology opportunity: Transforming work, empowering people*, McKinsey Global Institute, December 2014.

[206] *Highlights of agricultural census*, Press Information Bureau, Ministry of Agriculture and Farmers Welfare, December 9, 2015.

[207] Soil Health Card website, as on September 27, 2018.

A significant number of digital platforms already exist. The Ministry of Agriculture alone operates approximately 80 portals, and state departments and universities combined run roughly 800 portals covering almost all aspects of the agriculture value chain, with a reasonable level of geographic granularity.[208] These multiple data or knowledge portals could be aggregated in the single integrated agriculture platform to provided bespoke advice to farmers through mobile apps or through secure unstructured supplementary service data text-messaging services, which currently have a wider reach. To realise precision agriculture, multiple players have to be brought together to consolidate agricultural data. Data from new and upcoming avenues such as drones, satellites, and digital payments must be included as part of this integrated platform for it to be a true one-stop solution for all information on Indian agriculture.

Theme 22: Universal online agricultural marketplaces to connect farmers to the market.

Farmers' incomes depend on the prices they receive for their products, and initiatives to improve price realisation are key to the goal of doubling farmers' incomes. Most farmers can sell produce only in the closest mandi, or wholesale market, and thus have very little bargaining power, resulting in poor income realisation.

The government's Electronic National Agriculture Market (eNAM) platform is available in 585 markets across 16 states, transmitted live.[209] An online trading platform based on scaling up the eNAM and the mKisan Buyer Seller Platform could address this problem by providing both farmers and traders with direct, electronically enabled channels delivering timely information about local prices, supply, counterparty records, and transaction fulfilment. When accompanied by an e-warehousing and logistics interface to assure timely produce delivery, such a digital venue would open farmers' market options from trading within a single mandi to intermandi trading within a state, and ultimately to interstate trading.

While the benefits from scaling such initiatives can be large, steps need to be taken to help the digital infrastructure reach far flung farmers and mandis (including through private market yards linked to the online marketplace), accelerating the adoption of eNAM in all states by making required regulatory changes, and improving mandis' capabilities in grading crops, verifying trades, and resolving disputes. The Department of Agriculture and state agriculture departments could come together with private players to set up adequate infrastructure for the online marketplace. There is a need for a market facilitator that brings trust in digital trading and ensures consummation of trade between the buyer and seller once agreed. A policy could be created for institutional market facilitators to execute electronic trades and resolve disputes.

India's aspiration could for be for 40 to 60 percent of traded agriculture products to move through a universal marketplace by 2025, leading to a 15 percent improvement in prices to farmers.[210] As discussed earlier, online marketplaces could also shift more farm-sector payments to digital channels, with related benefits such as easier access to formal financing.

GOAL H: Make in digital India, make for India, make for the world

To establish a vibrant economic structure, India's nonfarm economy, and particularly its manufacturing sector, needs to improve productivity and global competitiveness. For this, four digital themes would be critical.

Theme 23: End to end digital supply chain, e enabled trade, and e-commerce.

Large manufacturers, small and medium-size vendors, wholesale and retail trade channels, and e-commerce companies are players along the supply chain, unified in their desire for more flexible, dynamic, granular, and predictive operations. Customers are demanding faster delivery and better service, while businesses need to reduce the cost of carrying inventory and reach more locations with reliable delivery times. A digital supply chain can address these issues. Digitising the supply chain means that all players throughout the chain adopt digital payments, transition to the GST Network, use online inventory-management systems, and provide data supported feedback to one another — for example,

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[208] Expert interview.

[209] eNAM website, Ministry of Agriculture and Farmers Welfare, Government of India, as of May 2018.

[210] Ramesh Chand, Doubling farmers' income: Rationale, strategy, prospects and action plan, National Institution for Transforming India policy paper number 1/2017, March 2017.

from retail stores to manufacturers and back. One of the major benefits of a digital supply chain would be lower inventory carrying cost (around 40 percent lower, by some estimates).[211] Important advantages could be flow based lending for vendors and trade channels, and the availability of microsegmentation and predictive analytics to help manufacturers and e-commerce companies to better match the demand and supply of goods.

E-commerce, a part of the overall digital supply chain theme, has the potential to grow significantly by 2025. In other emerging economies, the share of e-commerce in retail trade has grown in line with national internet penetration. China's experience suggests that e-commerce provides a strong impetus for consumption growth in smaller towns that do not have access to modern offline retail infrastructure, and provides growth and productivity-boosting opportunities to small manufacturers and logistics players.[212] Similar benefits could be expected in India.

Leading consumer goods and e-commerce companies in India are implementing innovative methods of digitising their supply chains. Hindustan Unilever has reduced its inventory carrying cost by 14 to 16 percent and noted significant improvement in understanding and predicting microsegment demand and servicing its retail channels using digital supply chain solutions. Amazon runs an end to end digital platform with warehouses and fulfilment centres all over India and offers digital supply chain services to more than 300,000 sellers on its platform, many of them small and medium-size enterprises.[213]

To fully realise the potential of the digital supply chain, it is essential for the Ministry of Finance, public- and private-sector banks, and application service providers to come together to create a platform to aggregate GSTN data and use it for value-creating analytics. Application service providers can develop software to handle supply chain analytics for smaller businesses at prices they can afford. Large private companies focused on so-called fast-moving consumer goods can benefit by encouraging small retailers and even wholesalers to install point-of-sale digital terminals to track tertiary sales.

Theme 24: Efficient transportation enabled by shared platforms.

The transport sector in India is entrusted with the unenviable task of ensuring swift and safe movement for its 1.3 billion people[214]. The country has developed extensive infrastructure to make it happen. India has almost 4.7 million kilometres of roads, one of the largest systems in the world, and 115,000 kilometres of railway track.[215] The government, realising the importance of infrastructure, has made road and highway construction one of its key priorities in recent years, reaching an all-time high rate of 8,231 kilometres of new highway construction in 2016–17, compared with 4,410 kilometres in 2014–15.[216]

Despite these achievements, pressure on the country's road infrastructure is immense and increasing. Average peak speed on city streets is low and declining. Traffic congestion in Indian cities causes people to spend more time in traffic, reducing productivity, and causes vehicles to spend more time idling, wasting fuel and releasing more pollutants into the air. The effects of this are perceptible: in 2016, the World Health Organization concluded that ten of the 20 most polluted cities in the world were in India.[217]

Shared mobility offers a solution, namely, on-demand transportation by a vehicle and mode of the user's choice. A ride aggregator not only helps reduce travel costs by splitting expenses but also aids in reducing road congestion and pollution. Shared mobility has the potential to benefit countries globally. A NITI Aayog report estimates that India could reduce carbon emissions 37 percent by 2030 by pursuing a shared, electric, and connected mobility future.[218] For example, Ola Cabs, a local cab aggregator in India, reported saving

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211 Expert interviews.

212 *China's e-tail revolution: Online shopping as a catalyst for growth*, McKinsey Global Institute, March 2013.

213 "Amazon India crosses 3-lakh sellers mark on its marketplace", *Economic Times*, February 18, 2018; *Amazon.in doubles its specialised network for large appliances and furniture – adds 6 new fulfilment centres*, Amazon.in press release, March 19, 2018.

214 Infrastructure, India Brand Equity Foundation, October 2017, ibef.org.

215 *Demand for grants 2018–19 analyses*, PRS Legislative Research, February 28, 2018; "Safety in Indian railways", The PRS Blog, August 24, 2017.

216 *2017: A year of ambitious roll-outs and engineering marvels*, Ministry of Road Transport and Highways, January 1, 2018.

217 Jayashree Nandi, "10 of world's 20 most polluted cities in India: List inside", *Times of India*, May 15, 2017.

218 Shikha Juyal et al., *India leaps ahead: Transformative mobility solutions for all*, NITI Aayog and Rocky Mountain Institute, May 2017; *The future of mobility in India: Challenges and opportunities for the auto component industry*, McKinsey & Company, September 2017.

4 million litres of fuel and reducing 6.5 million kilograms of carbon-dioxide emissions through ride sharing in seven Indian cities in 2016.[219]

The shared mobility solution would require clear guidelines for cab aggregators and ride-sharing platforms. Cab aggregators are inherently different from traditional taxi companies, in that they use the power of digital platforms' real-time matching of demand and supply to provide mobility solutions. Currently, private vehicles are not allowed to be registered on ride-sharing platforms and offer rides for a fee. The relaxation of licensing requirements for taxi and auto drivers will also help India address its current shortage of drivers as ride-sharing platforms gain prominence.

Theme 25: Integrated logistics platform.

India currently spends 13 to 14 percent of its GDP on logistics, compared to 9 percent for the US and 8 percent for Europe.[220] Estimates suggest that while most of the discussion about high logistics costs has focused on direct costs, indirect costs make up as much as 40 percent of the overall cost.[221] In 2018, India was ranked 44th out of 160 countries on the World Bank's Logistics Performance Index, with a score of 3.18 out of 5.[222] India's low ranking can be attributed to its lagging performance on the timeliness of shipments in reaching destination within the scheduled or expected delivery time and the efficiency of clearance processes, including customs.

Having robust, reliable, and efficient logistics in India is critical to increasing productivity and thus making Indian goods competitive in global markets. This assumes even greater importance in the context of the government's Make in India programme, which seeks to raise manufacturing's share of GDP from approximately 16 percent currently to 25 percent by 2022.[223] Realising this, the government in January 2018 set out to create a national logistics platform, an integrated portal that will serve as a transactional e-marketplace to connect logistics buyers and service providers with all government agencies such as customs, as well as port community systems, sea and airport terminals, shipping lines, and railways. The key objective is to reduce the cost of logistics to 10 percent or less of GDP, from the current 13 to 14 percent of GDP, to level the playing field for Indian producers and manufacturers.[224]

As is clear from the above discussion, creating an integrated platform in this loosely knit, predominantly unorganised sector will require a concerted multistep strategy. There is a need to create a structure in the immediate future to engineer and monitor quick wins while at the same time preparing an organisational setup that can best address the creation and maintenance of the national logistics platform. Stakeholders could achieve significant savings by getting better at sharing information to minimise the need to actually transport physical goods. The government could immediately implement a modern port-community system that will not only help to standardise and streamline data, but will also reduce the current redundancy in multiple documents requiring the same information. Given the unorganised nature of the logistics industry, most of its workforce is at best low-skilled. Going forward, with the advent of technology throughout the sector — from smart warehouses to electronic tolls — the workforce needs to be adequately trained to keep up with changing times and remain relevant.

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[219] *How India commuted in 2016 — our insights*, Ola Blog, January 6, 2017.

[220] *Building India: Transforming the nation's logistics infrastructure*, McKinsey & Company, July 2010.

[221] Debunking India's logistics myths, Mint, March 23rd, 2018, McKinsey & Co..

[222] *Country Score Card: India 2018,* Logistics Performance Index, World Bank.

[223] *Manufacturing sector in India*, India Brand Equity Foundation, March 2018.

[224] *RFP for engaging a consultant for working out integrated logistics plan for the country, Ministry of Commerce*, Government of India, January 2018.

Theme 26: Manufacturing automation and IoT based advanced analytics.

Automation and IoT-based advanced analytics are fundamental technologies that will become increasingly pervasive across businesses and sectors in the coming decades. These technologies may have the potential to unlock huge productivity gains for the economy through performance benefits, including greater throughput, higher quality, improved safety, reduced variability, less waste, and higher customer satisfaction. Manufacturing processes that use these next-generation technologies are referred to as Industry 4.0.

Manufacturing automation — the reorganisation of human work amid advances in technologies such as robotics, artificial intelligence, and machine learning — will be an unavoidable and irreversible trend in coming years. India's "automation potential" — the share of work that can be automated — for the year 2025 has been pegged at 60 percent.[225] Taking into account wage rates and the cost of automation, a cost-benefit analysis by the McKinsey Global Institute suggests that it would be economically feasible to automate a smaller share of work hours — 21 percent.[226] Finally, given the technology-adoption curve, upto 10 percent of the total hours spent may actually be digitised.

Manufacturing is one of the biggest users of the Internet of Things, a global system of sensors, actuators, machines, and other devices connected via the web. Manufacturers were active buyers of IoT technology in 2016 and 2017, spending $148 billion and $169 billion respectively, but there are potential use cases in many sectors of the economy.[227] Coupling the IoT with advanced analytics can help to maximise the yield and throughput of plants while minimising energy consumption. With the help of advanced analytics, it is possible to optimise input and process parameters to maximise a plant's yield and throughput while also ensuring efficient energy consumption. Input and process parameters can also be tuned to improve product quality. IoT-based advanced analytics in manufacturing can scale rapidly, as long as the government and private sector act to ensure affordable IoT infrastructure and the capability to use it. The workforce will inevitably be affected by business automation and IoT, as with all other technology adoption, and will need to be retrained, repurposed, and in some cases redeployed into new jobs. IoT devices currently lack interoperability, and concerns about cybersecurity are high. Companies need to invest in expensive system-integration software to capture data from multiple systems that don't necessarily speak to each other. Data leaks and privacy are key concerns for businesses, and MeitY is designing appropriate frameworks and law to address data security and privacy.

Theme 27: Electronic device manufacturing ecosystems.

The demand for electronics in India in 2017–18 stood at $106.1 billion, of which domestic electronics manufacturing fulfilled $59.6 billion.[228] Indian electronics manufacturing industry's value added accounts for only 0.6 percent of GDP.[229] It is important to realise India's growth potential in this field, and to promote the domestic electronics manufacturing sector. Doing so can both increase employment and provide affordable electronics to the country, which is critical for leveraging the benefits of digital applications.

Big boost to domestic production of mobile handsets came from the Government's Phased Manufacturing Programme (PMP), under which import duty is being imposed on the notified sub-assemblies used in manufacturing of cellular mobile handsets, in a phased

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[225] *A future that works: Automation, employment, and productivity*, McKinsey Global Institute, January 2017.
[226] Ibid.
[227] *IDC Worldwide Semiannual Internet of Things Spending Guide*, International Data Corporation, November 2017.
[228] Ministry of Electronics and Information Technology, Government of India, May 2018.
[229] Ibid.

Sipna's Digital Library
Access to E-Journals & E-Books

manner.[230] While PMP has resulted in increased domestic value addition and growth of manufacturing of mobile handsets and their parts and components in India, the next big step is to roll out the PMP for other electronics goods with the objective of increasing domestic value addition to strengthen the manufacturing base in long run and speedily move ahead with effective measures aimed at promoting exports from India in the medium to long term. The time is ripe to focus on medical electronics and consumer electronics such as LCD/LED televisions, LED lighting products and set-top boxes, along with automotive electronics.

The sector needs a conducive policy environment and targeted incentives to thrive and prosper in an increasingly competitive global environment. This requires a two-pronged strategy – a) Alleviate structural bottlenecks that affect the industry in general, like infrastructural deficiencies, high cost of finance, etc., and b) Make targeted policy interventions and provide fiscal incentives in identified areas where investment is needed such as electronic components and semiconductors. The Government could ensure quality infrastructure to manufacturing players by using existing and upcoming industrial corridors and promoting new clusters. It could encourage startups in this space through technical assistance and financial incentives such as tax holidays and import duty exemptions on capital requirement. Setting up incubation centres while encouraging startups in emerging technologies such as 5G, IoT/sensors, artificial intelligence (AI), machine learning, augmented reality (AR) and virtual reality (VR), gaming and entertainment and support for generation of intellectual property and patents would also give the sector the required push. R&D support for concept-to-market innovation can add immense value in all sub-sectors of electronics along with simplified clearance procedures for import of goods required for R&D.

GOAL I: Jobs and skills for the future

To make full use of the demographic dividend of its growing workforce and create sufficient employment opportunities, India needs to ensure continuous improvement in workforce participation rates, the number and type of jobs, and earnings potential for workers. A detailed discussion of how digital technology will affect the workforce appears in the next chapter. Here are outlines of three digital themes that can help address overall labour market challenges in the context of rising digital adoption:

Theme 28: Skill building for the future.

Any nation preparing its workforce for the future first needs a clear demand driven approach to skill planning, complete with data backed forecasts of the skills required for each industry. Some countries do this through a centrally driven exercise encompassing econometrics, big data, and analytics that involves planning entities as well as market participants and organisations. India also needs a demand-driven training ecosystem, because industry demands are rapidly evolving. Demand is increasing for executives trained in emerging fields — including big data analytics, machine learning, artificial intelligence, and blockchain — who also are trained in interpreting digital dashboards and using digital marketing techniques.

The current education and training ecosystem in India is not reflective of these changing industry needs, which risks creating a large number of educated but unemployable job seekers. A study conducted by Aspiring Minds, a New Delhi–based employability evaluation and certification company, suggested that only 7 percent of engineering graduates are employable.[231] Another study found that around 93 percent of MBA graduates of Indian business schools (those ranked in the bottom 80 percent of each class) are unemployable.[232] There is a need to align courses offered by universities and instruction offered by training institutes with evolving industry needs to create a workforce equipped with job-generating digital tools and capabilities.

This can be achieved if educational institutions, training providers, government training agencies, and industrial bodies like the National Association of Software and Services Companies and Sector Skill Councils collaborate to design, develop, and deliver the proper content to current and potential job seekers. Universities and industrial bodies could partner with employers to understand their needs and update curriculums accordingly. A large part of the required digitally skilled workforce will come from retraining and upskilling current employees. To accomplish this, employers could partner with Sector Skill Councils or training institutes to teach selected employees the required skills. To ensure continuous training in new courses, the government could provide skill insurance to certified individuals through its training schemes.

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[230] Phased Manufacturing Programme, Ministry of Electronics & Information Technology, April 28, 2017.

[231] National employability report (engineers): Annual report 2016, Aspiring Minds, 2016.

[232] *B and C category B-schools producing un-employable pass-outs*, The Associated Chambers of Commerce and Industry of India, April 27, 2016.

Digital technology can be leveraged to improve the quality of skill training. Educators of all types can use digital technology to train more students and job seekers. They could make massive open online courses available to everyone and explore the use of augmented reality and virtual reality tools to train skill seekers in how to use high-end machines at work. Training providers and universities can collaborate to conduct webinars and live, faculty-assisted video lectures that can not only train a large number of students at one time but also help to address the problem of a shortage of good trainers. The Ministry of Human Resource Development is in advanced stages of drafting regulations for online learning and revising the Open and Distance Learning policy.

Accelerated implementation of this initiative would generate better-educated and -trained job seekers with better employment prospects. In addition, there would be significant improvement in job seekers' productivity because they will face much less risk of losing their current jobs.

Theme 29: Online talent marketplaces to connect employers with work seekers.

India has always relied on informal networks for job matching. Small and medium-size entrepreneurs hire from their family and local community, and most informal-sector job matching is through word of mouth. In today's fast-evolving economy, with increased urban mobility and disruption of traditional business enterprise models, it is becoming increasingly difficult to rely on informal networks. Efficient demand and supply matching in the job market is critical to boosting India's labour participation rate, increasing the mobility of labour across jobs and occupations, and helping people find better, more productive work.

An online platform aggregating countrywide information on job seekers and vacancies can help to better connect employers with work seekers. This could follow an ecosystem approach, in which a government information platform aggregates data on skilled candidates by sector and geography across the country, including in remote and rural areas. India's numerous private-sector online job marketplaces could then plug into that data layer to connect job seekers with potential employers. Equally important is the need to track the informal labour market, which is not being captured by any private players. Similarly, data on government jobs, while more accessible than that for the informal sector, is often dispersed on different channels, and could benefit from consolidation.

The government's planned Labour Market Information System combined with the National Career Service can be the central aggregated, detailed database on the supply side, especially for those undertaking skills training under government programmes. The LMIS could capture job seekers' education, skills certification, work experience, and personal contact details, and could be digitally verifiable to avoid duplication. Private jobs portals and employers would gravitate to the labour database to find job seekers' information. Moreover, there is no mechanism to capture independent trained candidates' data on a portal or to update candidates' data once they have completed a vocational training course.

Real productivity gains will be achieved only with the large-scale adoption of these digital services. The network of Common Services Centres in rural areas and e Mitra kiosks (45,835 in Rajasthan alone) could serve as decentralised local employment exchanges.[233] They can help to feed local data on labour supply and job vacancies into the Labour Market Information System or directly to online job portals. They also could run local campaigns to encourage candidates to register their online profiles. Local employers would be drawn to CSCs and e Mitra centres to find good candidates, as would job seekers who want counselling services.

Accelerated implementation of online talent marketplaces could generate new and better job matches for 20 million to 28 million job seekers. In addition, there would be significant improvement in the productivity of job seekers, driven primarily by reducing job search time by 7 to 22 percent.

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[233] e-Mitra MIS portal, Department of Information Technology and Communication, as of April 25, 2018; Rakesh Dubbudu, *Number of operational CSCs in India reaches 2 Lakh*, Factly.in, August 25, 2016; Government of Rajasthan Department of Information Technology and Communication.

Theme 30: Digitally enabled jobs.

Digital technologies can be associated with job losses but can also be leveraged to create new and improved employment opportunities in different parts of the country.[234] These digitally enabled jobs allow people to work from wherever they are, and increase access to the supply of talent and new places to work. A growing army of freelancers worldwide want autonomous, project based work, typically in the work from home model. This is a particularly attractive opportunity for trained women professionals who may drop out of the regular workforce for a while due to family obligations. Online platforms like Truelancer, Flexing It, and Peopleperhour enable these independent professionals to find work by connecting them with potential employers across the world. Around 15 million freelancers are currently registered in India.[235]

- **Digitally enabled remote processing centres in semi-urban and rural areas.** IT enabled processing centres and digital service centres like CSCs can be job-creation engines in semi-urban and rural parts of the country. Several private-sector business-process outsourcing companies, including RuralShores, are opening BPO centres in rural India to take advantage of lower wage costs there.[236]

- **Tech-enabled services.** A new job category of technology enabled on the-ground workers in various domains (such as healthcare, logistics, agriculture, fisheries, and animal husbandry) is emerging. They use the tech enabled delivery models of organised firms to serve local consumer and community needs, similar to the way that banking correspondents operate in the financial services industry.

India has the potential to create about 20 million new jobs (many of them part time) through these models, as discussed in detail in the next chapter.[237] Beyond new jobs, workers can experience significant benefits by gaining access to improved quality of work, raising their income earning prospects, and reducing the hassle and cost of commuting or relocating in search of jobs.

To accelerate progress on this theme, several steps could be taken. Rural business-process outsourcing companies need help to achieve the requisite standards of data privacy, quality, human resource training, and workload and capacity management. The government could outsource some its data processing work to semi-urban and rural BPOs. Freelancers, who are usually not eligible for employer-paid benefits like medical insurance and pensions, need to be recognised as an important job category to help them secure loans, insurance, and other products available to workers in the organised sector. Standard assessment tests are needed to differentiate the quality of individuals seeking work on various online platforms.

Overall, the sharing economy needs to be recognised for its important role as an engine of growth for not just the economy, but jobs, in the India of the future (see Box 4, “Embracing the sharing economy”).

■ ■ ■

These are exciting times for Digital India, as the adoption of new technologies accelerates and propels the country into the forefront of global trends. Working with investors and private companies, India can build on the dynamism already created to deepen, widen, and scale new capabilities and ecosystems, with the goal of achieving a $1 trillion digital economy by 2025.

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[234] *India’s labour market. A new approach to gainful employment*, McKinsey Global Institute, July 2017.

[235] Sruthin Lal, “Thanks to internet, India has most freelance professionals after US”, *Hindustan Times*, December 8, 2015.

[236] RuralShores website, as of April 2018.

[237] A labor market that works: Connecting talent with opportunity in the digital age, McKinsey Global Institute, January 2015.

Box 4. Embracing the sharing economy

The sharing economy refers to an economic ecosystem in which individuals and businesses share underutilised assets, resources, skills, and capacities with one another. Users benefit from gaining access to resources they need without actually owning them, and resource providers benefit from the additional income generated by sharing idle resources. The sharing of products and services usually happens via a web- or mobile-based digital platform that facilitates better and faster matches by bringing together resource providers and potential users on a single platform. Multiple use cases demonstrate the importance of the sharing economy, for businesses as well as individuals.

Individuals

Accommodations. Airbnb, HomeAway, FlipKey, and HomeExchange are some of the online platforms that list individual properties such as houses, apartments, individual rooms, and other overnight accommodations across the world on their websites or mobile apps. Travelers can approach property owners directly and book stays in different locations for the required period of time through these digital platforms. This not only helps in providing convenient and cheaper accommodations to travellers but also generates additional income for property owners. Airbnb has arranged stays for over 200 million guests in more than 65,000 cities across 191 countries.[1]

Personal vehicles. Numerous examples of the sharing economy are found in mobility sector, including car sharing, ride sharing, parking space rental, and on-demand car and bicycle rental. For example, digital platforms like Uber and Ola connect people in need of transport with part-time or full-time drivers. Uber recently completed 500 million rides in India.[2] Another example is BlaBlaCar, which facilitates sharing of personal commutes.

Movable goods. Everyday functional objects such as furniture, kitchen appliances, washing machines, air conditioners, refrigerators — even meals and clothes — can also be shared through platforms like Shareyourmeal, SnapGoods, IRentShare, and Rentomojo.

Farm equipment. Various private-sector platforms such as Mahindra & Mahindra's Trringo and FarMart enable people to share tractors, harvesters, and other farm equipment. This allows farmers to gain access to efficient and expensive farm equipment without having to shoulder the costs of buying or leasing. This can further improve farmers' productivity and income.

Media content. Spotify, Deezer, YouTube, Netflix, and other online platforms enable people to share all manner of music, videos, and other entertainment and information. Different platforms operate on different business models. YouTube not only provides access to wide range of content on its website, it also allows registered users to upload their own content and enables them to reach a global audience. Contributors also can earn advertising revenue based on the number of times their content is viewed and shared. Netflix charges users a monthly fee to share its content, which includes movies, previously broadcast television series, and a growing list of original content.

Peer-to-peer lending and crowdfunding. Online platforms can connect investors with credit seekers. Kickstarter is an online platform that enables community-based financing by connecting creative professionals like musicians, artists, designers, and dancers with potential investors from the same community. Funds raised on Kickstarter must go toward developing a specific project. In India, Wishberry, a crowdfunding platform, helps people raise funds for creative projects by connecting them with prospective investors. Other online platforms such as US-based Lending Club and UK-based Zopa facilitate consumer-to-consumer lending by connecting prospective investors with loan seekers.

Wi-Fi connectivity. Users can share Wi-Fi access to high-speed internet without needing to install separate routers, modems, or other hardware. For example, businesses or individuals who sign up to a service called Griggi agree to allow strangers to use their Wi-Fi routers for a fee, which is split between Griggi and the router owner. Meanwhile, TRAI has launched a pilot programme, the Wi-Fi Access Network Interface, to help small entrepreneurs and shop owners set up Wi-Fi hotspots (called public data offices, or PDOs) by reselling bandwidth acquired from big internet service providers — an approach that will help PDO operators avoid having to register as telecom providers. The WANI pilot will accept any company, proprietorship, society, or NGO to help set up paid public Wi-Fi access points across the country.

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[1] Airbnb Fast Facts, 2017; Airbnb website as of April 25, 2018.

[2] Uber hits 500 Million rides milestone in India, UBER Blog, August 3, 2017.

Energy. Community financing of renewable energy sources like wind, solar, virtual power plants, and electricity storage solutions can not only help India overcome energy shortages but can also help keep the environment clean. Energy from decentralised energy producers can be used by the producers or shared with state distribution companies or other purchasers. Notable examples include the wind farm in the Hvinde Sande Harbor in Denmark, which was partly funded by the local residents, and the community solar projects created by the Mosaic Power and Canadian Solar Share companies. India should investigate which incentives are needed to initiate and scale up this kind of effort in the country.

Businesses

Logistics. Various online truck aggregators such as TruckSuvidha, BlackBuck, TruckMandi, and Quifers provide businesses with an opportunity to share trucks and other light commercial vehicles to transfer goods from one place to another. Sharing vehicles allows businesses to avoid having to buy and maintain their own fleets, enabling them to focus on their core operations. Businesses can conveniently book vehicles through online platforms to deliver their products throughout the country. Companies providing the trucks also benefit from improved utilisation of their fleets. TruckSuvidha, the first online marketplace for truck transporters in India, lists 16,215 transport contractors and 10,877 fleet owners on its platform.[3]

Production capacity. Businesses can reduce their need for capital by sharing production capacity. Shared production capacity will also make better use of underutilised machinery, offering a better return on assets. The pharmaceutical sector offers an instructive use case. Drug makers are eager to begin manufacturing new medicines as quickly as possible because patents guarantee exclusive rights for a limited time, but the highly uncertain process of drug development raises concerns about underutilisation of expensive-to-maintain manufacturing capacity. Merck Sharpe and Dohme (MSD) and MedImmune LLC, the biologics arm of AstraZeneca, have signed a long-term manufacturing capacity–sharing contract which should enable them to strike a balance between underutilisation and nonavailability of manufacturing capacity.[4]

Office equipment. Businesses can share office equipment such as computers and furniture to cut overall operational and capital costs and improve utilisation of resources. Governments can do the same. Six local governments in Michigan are already sharing equipment through a service called MuniRent. This helps them get needed equipment at a lower cost and generate income from resources they already own but do not fully utilise. Other digital platforms, such as Coffice and instaoffice, offer similar services to businesses and individuals.

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[3] Kanika Bansal, StartupUrban titled TruckSuvidha "The Ola of trucking Industry"!, Truck Suvidha, December 10, 2017.

[4] Patricia Van Arnum, Manufacturing Capacity-Sharing Model: Merck & Co. and MedImmune LLC, PharmTech, April 4, 2012.

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4. Digital ecosystems can create $1 trillion of economic value

Key Highlights

01

India's digital economy could rise from $200 billion currently to as much as $ 1 trillion by 2025

02

$385–$505 billion of economic value will come from the new and emerging eco-systems, which use digital to increase efficiency

03

Under a business-as-usual scenario, digital economy could only get to $500–$650 billion

04

Digital interventions could imply the need to redeploy 40-45 million workers and create about 20 million new tech enabled jobs

Successful realisation of India's digital vision can unlock significant economic value, in the range of $800 billion to up to $1 trillion, up from about $200 billion today, and sustain 60 million to 65 million digital-economy jobs by 2025. At this rate, the Indian economy could generate revenue of more than $1 trillion by 2022 by adopting the 30 digital themes described in the previous chapter. Nonetheless, realising this vision is not automatic or predetermined. Reaping the potential benefits of digitisation is contingent on India's ability to generate efficiencies in production and distribution on a mass scale, which will require regulatory and policy changes coupled with a significant increase in digital investment by government, private enterprise, and individual stakeholders. Without decisive and speedy action to enable digital transformation across sectors, the economic value created would be significantly lower, estimated at $500 billion to $650 billion by 2025 as opposed to the full-potential case of up to $1 trillion. Estimating the size and value of the digital economy is complicated and fraught with methodological challenges. This chapter explores the potential utility and economic value of key digital themes in terms of the sector efficiency, organisational productivity, and individual welfare they could yield if scaled up. The chapter concludes with a short discussion of the nature and magnitude of shifts in work and employment patterns.

Several conceptual approaches are possible in measuring the size of the digital economy

Over four billion people globally have access to the internet.[238] But despite its reach and undeniable impact on businesses, work, and lives, there is still no consensus on how to estimate the size of the global digital economy (see Box 5, "Measuring the digital economy", for an overview of some challenges and approaches).

In this report, the potential value of India's digital economy is estimated by focusing on 19 digital themes (of the 30 themes previously outlined) and deriving the potential incremental productivity possible from them by 2025. Only those themes capable of being sized for economic value over an eight- to 10-year period have been considered (for example, themes pertaining to digital land records, though of critical importance, have not been sized in this exercise because their economic

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[238] Digital in 2018: Global overview, We Are Social, January 29, 2018.

Box 5. Measuring the digital economy

The logical starting point when setting out to measure the digital economy is to define the term. The Organisation for Economic Co-operation and Development describes the internet economy as "the full range of our economic, social and cultural activities supported by the internet and related information and communications technologies", underscoring the concept's sweeping nature and scope.[1] Multiple factors figure into measuring the size of the digital economy — methodological challenges, the highly fragmented nature of digital interactions, the rapidly falling cost of technology, and how those industry-shaping influences are rapidly changing competitive behaviour.

Methodological challenges start with the idea of GDP itself — measure of national output, not well-being — and the System of National Accounts, the internationally agreed-upon standard for measures of economic activity. This system recognises only market-based, priced interactions as economic goods and would not value activities previously provided as services by paid intermediaries, such as directly booking air tickets or hotel rooms online rather than going through a travel agent.[2] Another issue is the method of accounting for quality improvements — technological innovations that reduce costs are deemed to have positive economic impact, but those that make a product or service better for the consumer are not counted.[3] Compilation practices for GDP accounting may not be robust enough to measure the size of the sharing economy, as peer-to-peer transactions, especially small-ticket ones, may not be adequately captured. Finally, many digital products (such as email, web search, data storage, software, and apps) are offered free or at very low marginal cost to the consumer, while even prices of paid offerings like smartphones, tablets, and connectivity are crashing. This implies more surplus for consumers of these goods but potentially less GDP accounted for by their producers. It is not clear how large this effect is — one research study has concluded that the slowdown in US productivity growth (as measured by GDP) over the last decade cannot be explained by the shift in value from measured revenue to unmeasured consumer surplus.[4]

Given all these challenges, researchers have used various approaches to estimate the size of the digital economy. Four broad approaches are highlighted below.

The direct-impact approach is the most straightforward and conservative. It measures GDP value added using the expenditure method, assessing private consumption expenditure, public expenditure, private investment, and trade balance that are closely related to digital products and services. Estimates vary, but studies show that the size of the digital economy is 1 to 7 percent of GDP across the countries considered.[5] The McKinsey Global Institute's iGDP estimated measure of the size of the internet economy, using the expenditure method, was 2.1 percent of GDP in 2013.[6]

The dynamic-impact approach looks at the statistical relationship between a country's digital profile and economic development. Since this is an econometric approach, it does not focus on the precise sources of efficiency in specific sectors. One cross-country study estimated that a 10 percent rise in broadband penetration results in a 1.2 percent increase in per capita economic growth.[7] India-specific studies using state-level data by the Indian Council for Research on International Economic Relations has concluded that a 10 percent increase in internet penetration results in a 2.4 percent increase in the growth of a state's per capita GDP, and a 10 percent increase in India's total internet traffic delivers a 3.3 percent increase in GDP.[8] In a recent study, the Institute for Competitiveness ran a state-level regression of GDP per capita on capital, labour, and internet penetration and found that a 10 percent increase in internet penetration results in a 3.9 percent increase in GDP per capita.[9] Internet penetration is taken as a proxy of how digital applications affect economic activity. In reality, the pass-through is via easier access to basic services like education and health, and via increased transparency in land and labour markets that enables more efficient use of these scarce resources.

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[1] "Measuring the internet economy: A contribution to the research agenda", OECD Digital Economy Paper number 226, OECD, 2013.

[2] Nadim Ahmad and Paul Schreyer, *Are GDP and productivity measures up to the challenges of the digital economy?* OECD, 2016.

[3] Martin Feldstein, "Underestimating the real growth of GDP, personal incomes and productivity", *The Journal of Economic Perspectives, American Economic Association*, Spring 2017.

[4] Chad Syverson, "Challenges to mismeasurement explanations for the US productivity slowdown", *The Journal of Economic Perspectives, American Economic Association*, Spring 2017.

[5] "Measuring the internet economy: A contribution to the research agenda", OECD Digital Economy Paper number 226, OECD, 2013.

[6] *China's digital transformation: The Internet's impact on productivity and growth*, McKinsey Global Institute, July 2014.

[7] Christine Zhen-Wei Qiang and Carlo M. Rossotto, "Economic impacts of broadband", in *Information and communications for development 2009: Extending reach and increasing impact*, World Bank, 2009.

The indirect-impact approach, which is based on the expenditure method or econometric relationships, captures the effect of digitisation on consumer surplus and other welfare gains such as environmental benefits in addition to added economic value. Because of their complex data requirements, studies of this type assess a part of the total consumer surplus, focusing mostly on consumer benefit arising from affordable internet access.

This report uses a value-impact approach and focuses on the potential effect of digital adoption on aggregate productivity based on microevidence from sectors and firms. Discrete use cases are identified and their potential impact, in terms of greater output, time, or cost saved, is estimated to come up with a macro picture of potential economic gains. Reports based on research by the World Economic Forum (2016) and MGI (2015) are examples.[10] In this report, we adopt the value-impact approach for analysis. This is not a complete estimate, in light of the accounting challenges outlined above, but nevertheless a useful exercise to give a sense of the order of magnitude of the potential economic value of digitisation.

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[8] Rajat Kathuria et al., *Quantifying the value of an open internet for India*, Indian Council for Research on International Economic Relations, 2016; Rajat Kathuria et al., *Estimating the value of new generation internet based applications in India*, Indian Council for Research on International Economic Relations, 2017.

[9] Dr. Amit Kapoor, Chirag Yadav, Neera Vohra, Impact of Reliance's Entry, Institute for Competitveness, March 2018.

[10] *Digital transformation of industries: Consumer industries*, World Economic Forum in collaboration with Accenture, January 2016; *The internet of things: mapping the value behind the hype*, McKinsey Global Institute, June 2015; UNICEF survey to measure the economic impact of sanitation, 2017 (forthcoming); *Digital transformation of industries*, World Economic Forum, January 2016.

impact is hard to estimate in the absence of benchmarks). The selected themes have been classified into two categories: existing ecosystems (digital businesses and activities that have already been scaled up meaningfully, such as IT-BPM, digital communication services, e-commerce, and electronics manufacturing) and emerging or new ecosystems (digital businesses and activities that could scale up meaningfully by 2025). Each theme is also categorised based on whether it is fundamentally cost-reducing or output-enhancing, to ensure that we can assess their employment dynamics.

For each sized theme, this study's approach models two factors: the potential productivity gain of the new digital model compared with the current nondigital one, and the potential level of adoption of the new digital model across the economy.

- The first assumption, on productivity gain, is arrived at based on credible studies that document gains experienced in similar field-level digital applications, using the lower range of estimates available, to be conservative. For example, for precision agriculture, a number of studies estimate productivity increase of 15 to 60 percent due to the application of digital technologies, and the analysis considers the lower bound of 15 percent productivity gain for estimates.[239]
- For the second assumption, on the rate of adoption, we leveraged the global adoption curve estimated by McKinsey Global Institute after analysing adoption patterns of more than 50 technologies globally. MGI found that adoption rates can vary significantly, from as low as 20 percent to as high as 80 percent of the addressable set of users over a seven- to eight-year period.[240] Adoption time frames can also shrink rapidly — while it has taken India close to 15 years to get mobile handsets into the hands of 70 percent of its population, the government's Mahatma Gandhi National Rural Employment Guarantee Act programme took just four years to shift the payment of virtually all wages from cash to electronic channels.[241] The speed with which an application will be adopted depends on whether an at-scale use case already exists and whether users have some experience using digital tools and see value in that specific use case, among other reasons. Based on these broad criteria, sized themes were classified into three groups based on potential adoption rates — 20 to 40 percent, 40 to 60 percent, and 60 to 80 percent (Exhibit 14). Adoption rates are critical assumptions that are contingent on a host of specific policy enablers and capability-building measures, which are outlined in the next chapter and detailed in Section 2 of this report.

Reaching these levels of adoption presume speedy and decisive action by the government to put in place the enablers and prerequisites of digital innovation in each of the areas we identified. If implementation of the interventions takes longer or is incomplete, it could reduce adoption rates achieved by 2025, and lead to lower productivity and efficiency gains compared to full potential. The sensitivity of adoption rates of various digital themes to government action depends both on whether the theme is primarily led by the private sector or by the government, and on whether the government action (for example, the new policy or platform required) is a critical precondition for the digital theme to take off. To estimate the value creation likely in a scenario where government does not act decisively and speedily enough, lower adoption rates were considered based on which of the following conditions are met. Three examples below help illustrate the meaning:

- **Led by the government or private sector with significant dependency on government or regulator action:** One example of this type of digital theme is flow-based lending. In the full-potential case, flow-based lending and advanced credit underwriting are assumed to reach 60 to 80 percent of the addressable market. However, this depends significantly on government and regulator-led action, in the form of policies and other enablers, since public-sector banks predominantly serve MSME customers, and the financial services sector is subject to regulation. Again, it is assumed that if government and regulatory actions do not speedily remove barriers to the generation and use of flow-based data to support credit, the effective reach of flow-based lending will be just 25 percent of what is assumed in the full-potential case.
- **Led by the private sector or government with moderate to high dependency on government or regulator action:** One example of this type of digital

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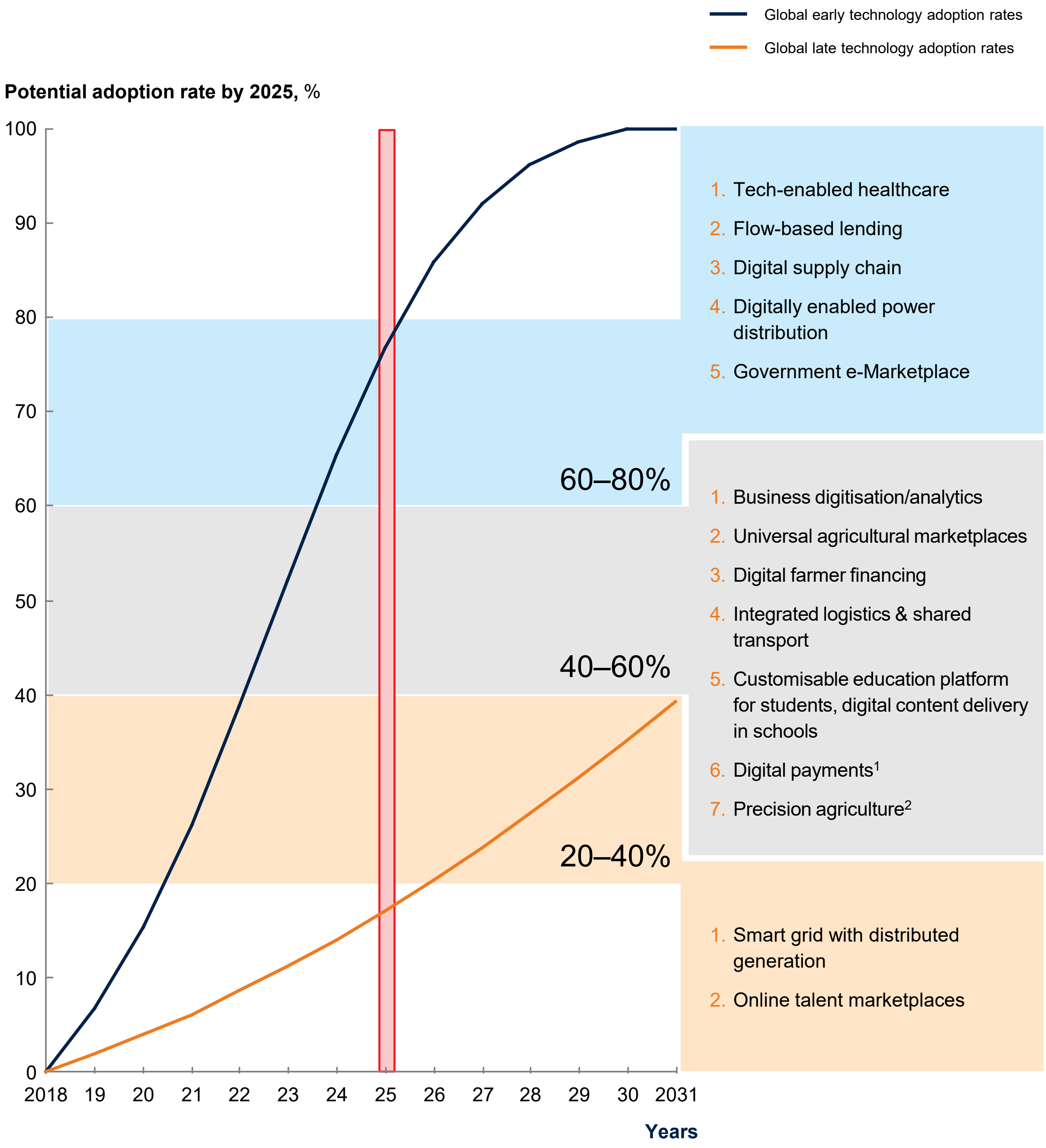
[239] *Digital transformation initiative: Unlocking $100 trillion for business and society from digital transformation*, World Economic Forum, January 2017; *Rapid Introduction and Market Development for Urea Deep Placement Technology for Lowland Transplanted Rice*, International Fertilizer Development Center, 2017.

[240] *A future that works: Automation, employment, and productivity*, McKinsey Global Institute, January 2017.

[241] The Mahatma Gandhi National Rural Employment Guarantee Act provides a temporary or part-time public-works job to any Indian who applies.

EXHIBIT 14

The value realisation is contingent on digital applications permeating deep in most of the sectors of the economy by 2025



1. Tech-enabled healthcare
2. Flow-based lending
3. Digital supply chain
4. Digitally enabled power distribution
5. Government e-Marketplace

1. Business digitisation/analytics
2. Universal agricultural marketplaces
3. Digital farmer financing
4. Integrated logistics & shared transport
5. Customisable education platform for students, digital content delivery in schools
6. Digital payments[1]
7. Precision agriculture[2]

1. Smart grid with distributed generation
2. Online talent marketplaces

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[1] Value of retail transactions that will be intermediated through digital.

[2] Assumed to vary with size of the landholding. Adoption rate of 20–40% is assumed for landholdings of less than 1 hectare, 40–60% for landholdings of 1–4 hectares, and 60–80% for landholdings of more than 4 hectares.

SOURCE: *A future that works: Automation, employment, and productivity,* McKinsey Global Institute, January 2017

theme is electronics manufacturing, an initiative primarily led by the private sector, but one that needs some enabling policies from the government and a constructive approach to attract investment. Here, it is assumed that without decisive government action, about 50 percent of the full potential value would not be achieved, and only half of it would actually be realised. Similarly, innovation in tech-enabled healthcare delivery can and will proliferate in the private sector focused on more urban and affluent consumers, but its takeoff in rural or semi-urban areas and in the public health delivery system is contingent on the government putting in place key enablers such as clear tripartite policies between central government, state government, and healthcare providers.

- **Led by the private sector with relatively lower dependency on government or regulator action:** In this category, themes such as business digitisation, which companies are using to improve their top line and bottom line were considered. The initiatives are essentially led by the private or business sector, with the government limited to a facilitator's role, for example by laying out the guidelines for interoperable IoT devices to pave the way for broad and seamless applications. Similarly, there are elements of existing digital value (such as the gross value added of the IT-BPM sector), where the government can support investment and growth but the actual creation of value is largely driven by the private sector. In such cases, it is assumed that even without speedy and decisive government action, the theme could likely reach 75 percent of its full potential value.

The above discussion on adoption rates is a set of scenarios rather than predictions — it is really not possible to clinically separate out the impact of government interventions on overall growth and value creation. But the scenarios illustrate the fact that creating value from digital transformation needs clear accountability on the part of government and regulatory stakeholders.

Digital themes have the potential to add $800 billion to $1 trillion of economic value to India by 2025

India's digital economy is currently valued at about $200 billion, or about 8 percent of India's GDP. This is largely the economic value contribution of IT-BPM, digital communication services (including telecom services), e-commerce, digital payments, electronics manufacturing, and DBT. As India moves toward its digital goal, the value could grow rapidly, to between $800 billion and $1 trillion in nominal terms by 2025, or approximately 18 to 23 percent of national GDP in that year. While existing digital ecosystems, as outlined above, are likely to generate a significant amount — between $410 billion and $510 billion — new digital ecosystems could spring up to contribute as much, between $385 billion and $505 billion, driven by active business participation across all major national priorities. It is worth noting that economic value of $800 billion to $1 trillion gives rise to digital revenues of approximately $1.4 trillion to $1.8 trillion (Exhibit 15).

To reach this estimate, the potential contribution of each digital theme is sized separately and aggregated (Exhibit 16). For simplicity's sake, no second- and third-order multipliers are taken into account. It is, however, important to realise that these are not the only potential sources of value creation from India's digitisation. These are merely what seem to be the most pressing and promising, based on current priorities and capabilities. It is possible that many other "green shoots", such as emerging technologies, new types of technology exports, or technology-oriented inbound investment in breakthrough areas, can create value.

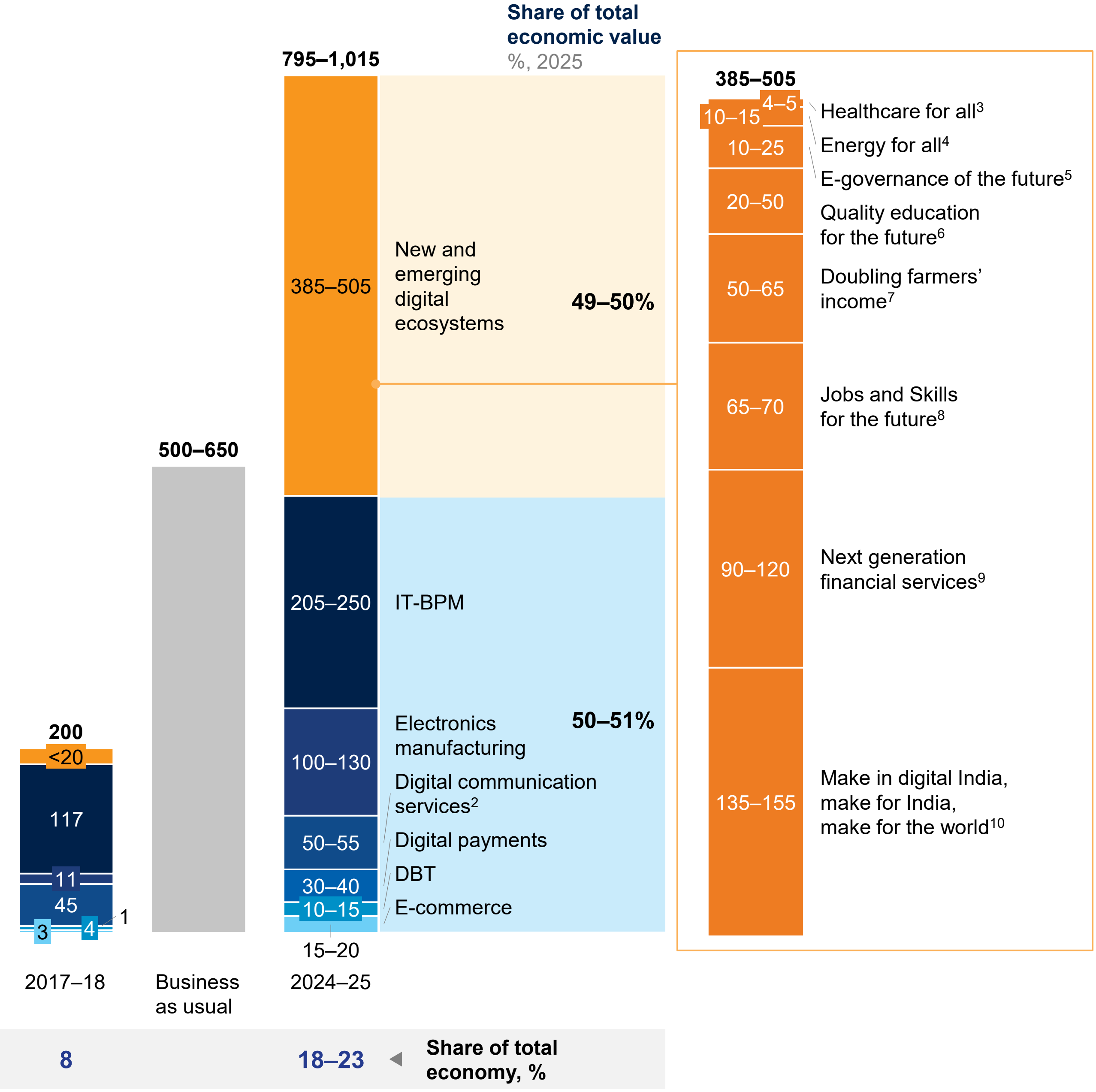
It is interesting to note that this detailed bottom-up aggregation of how digital applications create value of up to a $1 trillion is strikingly close to some recent studies that have tried to estimate the digital economy using a dynamic regression-based approach (refer to Box 5). As part of this study, it is estimated there would be an increase in internet subscribers from 33 percent of the population in December 2017 to about 65 percent by 2025, representing 9 percent annual growth. A 10 percent increase in internet penetration results in a 3.9 percent increase in per capita GDP. Applying this ratio, per capita GDP increases by $600 to $650 during this period. With an estimated population base of approximately 1.4 billion by 2025, this translates into incremental value creation of $850 billion to $900 billion.

Also, the incremental productivity estimated is agnostic regarding who appropriates the value — the technology supplier, user organisation, or ultimate consumer, depending on the market dynamics and the specific industry structure. For example, the introduction of the internet of things and dynamic routing in commercial truck fleets could reduce the cost of logistics and hence create value on the order of magnitude that has been estimated. However, it is difficult to anticipate who will benefit most — logistics firms, which may reduce the

EXHIBIT 15

India's digital economy could contribute 18–23% of overall economic activity by 2025, with more than half the potential coming from scaling up new and emerging digital ecosystems

Size of India's digital economy, $ billion, nominal



1 Figures may not sum to 100% because of rounding.
2 Estimation for 2025 includes value addition from visual broadband services, plus digital media and entertainment.
3 Tech enabled healthcare.
4 Digitally enabled power distribution and smart grid with distributed generation.
5 Government e-Marketplace and DBT.
6 Customisable education platform for students, digital content delivery in schools.
7 Digital farmer financing, precision agriculture, and universal agricultural marketplace.
8 Online talent platforms.
9 Flow based lending.
10 End-to-end digital supply chain, efficient transport and logistics, and business digitisation and IoT.

SOURCE: *India energy security scenarios, 2047,* Government of India; US Energy Information Administration; *Public Procurement Observations in India (English). Washington, D.C.: World Bank Group*; Planning Commission, Government of India; *A labour market that works,* McKinsey Global Institute, 2015; Prabhat Barnwal, *Curbing leakage in public programs: evidence from India's Direct Benefit Transfer policy,* Michigan State University, 2018; *Economic survey, 2015–16,* Ministry of Finance, Government of India; *A future that works,* McKinsey Global Institute, 2017; Montenegro and Patrinos, *Comparable estimates of returns to schooling around the world,* World Bank, 2014

EXHIBIT 16

Economic value potential of sized digital themes

National goals	Sized digital theme	Potential economic impact, $ billion, 2025[2]	Potential scope and scale of impact by 2025	Potential productivity and efficiency gain by 2025
21st-century IT infra-structure and services	**Vibrant IT-BPM capabilities**	205–250	▪ Industry revenue assumed to grow between 8%–11% and become $280–$350B by 2025, with "digital services" accounting for about 40% of overall revenue	▪ Value addition assumed to be broadly stable at current level of 70% of sector revenue
	Digital communication services[1]	50–55	▪ >800M smartphone users in India by 2025, up from 350M in 2018	▪ Data consumption to rise by about 60 times between 2015 and 2025, doubling every 18 months
E-governance of the future	**Government e-Marketplace**	10–25	▪ 60%–80% of government procurement that is feasible to be bought electronically, procured though electronic channels by 2025 (government procurement of goods and services is equivalent to 13% of GDP)	▪ 10% efficiency gain through lower prices on value through e-procurement compared to traditional tenders
	Direct Benefit Transfer	10–15	▪ 80% of government subsidies transferred directly and digitally to beneficiaries' accounts after real time verification (government subsidies and welfare payments including food, fertiliser, and MNREGA currently account for 1.8% of GDP)	▪ 15% efficiency gain through reduced leakage and better targeting using DBT compared to traditional means
Healthcare for all	**Tech-enabled healthcare**	4–5	▪ Potential for tech-enabled healthcare services to subsume 30%–40% of all in-person consultations by 2025	▪ Around 30% efficiency gain possible through lower cost of teleconsultations compared to in-person meetings
Quality education for the future	**Customisable education platform for students, digital content delivery in schools**	20–50	▪ Potential for 40%–60% of new entrants into the labour force (65M–70M new entrants between 2017 and 2025) to be taught and skilled with digital tools and technologies	▪ One to three years of incremental effective schooling possible due to digital technology platforms, and each additional year of schooling estimated to result in about 8% higher wages
Energy for all	**Digitally enabled power distribution**	10–12	▪ Potential for 60%–80% of the entire power distribution network to be revamped with smart metering and supervisory control and data acquisition systems	▪ 10 percentage points efficiency gain possible as commercial losses decline to 10% from 20% of billings through (smart) metering, pricing, and recovery with targeted subsidy transfers where warranted
	Smart grids with distributed generation	1–2	▪ 20%–40% of grid upgraded with power quality management and demand side management infrastructure by 2025	▪ 1–2 p.p. efficiency gain in terms of technical losses reducing from 10% to 8-9% by monitoring voltage fluctuations and managing peak load demand
Next-generation financial services	**Digital payments**	30–40	▪ Potential for 55%–60% of the value of all retail transactions to be non-cash by 2025	▪ Savings of 0.7%–0.9% of GDP possible through better cash management, time saved, lower interest forgone
	Flow-based lending and advanced credit underwriting for MSMEs	90–120	▪ Potential for 60–80% of the unmet credit need of worthy micro, small, and medium enterprises to be fulfilled through advanced credit products leveraging digital data enabled by new sources like GSTN, digital payments	▪ Additional MSME output possible in proportion to credit provided, assuming an incremental capital-output ratio of ~2 for the MSME sector

1 Projections based on economic value from visual broadband, plus digital media and entertainment.
2 Potential economic impact is not comprehensive; includes potential impact of sized applications only. Figures may not sum to 100%, because of rounding.

National goals	Sized digital theme	Potential economic impact, $ billion, 2025[2]	Potential scope and scale of impact by 2025	Potential productivity and efficiency gain by 2025
Doubling farmer incomes	**Digital farmer financing and insurance payouts**	10–15	▪ Potential for 40%–60% of overall non-institutional credit to farmers moving to the banking sector/organised finance by 2025	▪ 10 percentage points of interest savings possible as credit moves from non-institutional to organised sources
	Precision agriculture	20–25	▪ Potential adoption rates ranging from 20% for smallholders to 60% for large farm owners	▪ 15% increase in productivity possible as a result of using farm advisory services
	Universal agricultural marketplace	20–25	▪ Potential for 40%–60% of agricultural surplus to be transacted through digital marketplaces by 2025	▪ 10% improvement in farmers' price realization, possible by selling produce through electronic channels, compared to agricultural mandis, or local wholesale markets
Make in digital India, make for India, make for the world	**End-to-end digital supply chain (both traditional retail and e-commerce)**	5–10	▪ 60–80% of industrial sector (manufacturing, mining, construction) output connected with digitally enabled supply chain by 2025	▪ 2 p.p. cost saving on account of inventory costs falling from 5%–3% of turnover
		15–20	▪ E-commerce GMV to rise to about 15% of trade output (wholesale and retail trade) by 2025 in line with countries like China, implying a growth of 25%–30% till 2025	▪ 20% of GMV is assumed to make up for the revenue, accruing to the platform provider; value addition assumed to be 70% of revenue, similar to traditional retail
	Efficient transport and logistics	20–25	▪ Post-GST, no physical stops for state and city taxes, with universal digital verification and sample audits by 2025 ▪ 40%–60% of freight capacity enabled with RFID by 2025, enabling dynamic routing and predictive maintenance ▪ 40%–60% of all hired rides (e.g., taxis) mediated on online platforms by 2025	▪ Complete elimination of tax-related stoppage cost and 40%–60% fall in tolling-related stoppage cost ▪ 50% reduction in fleet turnaround time leading to lower logistics costs ▪ 40%–50% higher utilisation of passenger vehicles with real-time online supply-demand matching
	Business digitisation and IoT-based analytics	105–120	▪ Potential for 40%–60% of manufacturing sector output to be IoT-enabled by 2025 ▪ Potential for 5% of today's work being digitized by 2025	▪ 7%–11% higher manufacturing productivity from IoT-based data analytics
	Domestic electronics manufacturing	100–130	▪ Potential for share of domestic electronics manufacturing to rise from 4% of the overall manufacturing sector currently to 10%–12% by 2025, driven by demand for smartphones, LED lights, medical devices, etc., based on benchmarks in Japan and Germany	▪ Value addition estimated at 25%–30% of sector revenue
Jobs and skills of the future	**Online talent platforms**	65–70	▪ 35% of workforce assumed to use online talent marketplaces by 2025 ▪ Increased employment of 20M–28M as the labour force participation rate rises, better job matches for 6M–8M workers, and reduced job search time by 7%–22% based on benchmark results from large global talent platforms	▪ 6–7% higher wages for workers finding work on online platforms through better matching of demand and supply
Sum of sized potential economic impacts		**795–1,015**		

[2] Potential economic impact is not comprehensive; includes potential impact of sized applications only. Figures may not sum to 100%, because of rounding.

SOURCE: *India energy security scenarios, 2047,* Government of India; US Energy Information Administration; *Public Procurement Observations in India (English). Washington, D.C.: World Bank Group*; Planning Commission, Government of India; *A labour market that works,* McKinsey Global Institute, 2015; Prabhat Barnwal, *Curbing leakage in public programs: evidence from India's Direct Benefit Transfer policy,* Michigan State University, 2018; *Economic survey, 2015–16,* Ministry of Finance, Government of India; *A future that works,* McKinsey Global Institute, 2017; Montenegro and Patrinos, *Comparable estimates of returns to schooling around the world,* World Bank, 2014 cost of service and improve profitability; their customers, such as retailers and manufacturers, which may be able to expand markets and enhance margins; or the ultimate consumer, who may pay a lower price for the products shipped. This is essentially a question of value appropriation, which this study has not examined.

The potential five-fold growth in economic value from digital transformation by 2025 will create a rapidly growing market for a host of digital services, platforms, applications, content, and solutions. This represents an attractive opportunity for global and local businesses, startups, and platform-based innovators who will be investing in emerging technologies (for example, artificial intelligence, blockchain, drones and robotics) customised to India's needs across domains such as education, healthcare, agriculture and financial service,

Businesses, governments, and households must commit to significant investment to create the requisite digital infrastructure and social capital — that is, the training, quality education, and skills — that are required to use the new digital applications. This process of preparing for digitisation itself will create a virtuous cycle of growth and employment even as productivity gains arise. The whole ecosystem will find ways to participate, from technology companies that will need to build IT and telecom infrastructure to education and training institutes that need to ensure that sufficient human capital, in numbers and quality, is ready with the new-age digital capabilities to service providers that can be engaged in the process of digital data conversion and new content creation.

Digital interventions could imply the need to redeploy 40-45 million workers and create about 20 million new tech-enabled jobs

Digital adoption is usually associated with job losses, but the growth and productivity it enables also makes it a source of new and improved employment opportunities — a pressing priority for India.[242] The value created through digitisation could enable 60-65 million direct jobs by 2025. In the process, some 40-45 million workers would need to be retrained and redeployed in new jobs as digital technologies reshape their current work. Digital platforms can actually help find opportunities that are better suited to many workers by better matching the demand for and supply of labour. For example, millions of working-age people, many of them women, may prefer to work part-time, but may have given up searching for part-time work or job shares long ago due to the rigidity of and lack of transparency in the labour market. This section discusses the nature of redeployment together with some of the new types of jobs and an illustrative list of industries where they can emerge (Exhibit 17).

The redeployment of labour into new jobs and new types of work will be unavoidable. One of the many benefits of digitisation is that it creates efficiency by freeing up labour time that was until now used in relatively low-productivity activities. This would create significant redeployment opportunities for organisations and individuals alike. Workers such as data-entry operators, bank tellers, clerical staff, and insurance claims and policy-processing staff will find their routine, predictable work being digitised, enabling them to spend time learning new skills and deploying them in a different area, such as customer-facing activities. Other value-creating digital themes would result in new ways of doing business — for example, adopting digital benefit transfers implies that the work of physical intermediaries involved in processing cash payments must be redefined. Realising the full value of digitisation is contingent on the economy's ability to retrain affected workers and redeploy them in more productive jobs.

Four types of opportunities for new kinds of work are described below as illustrations:

- **High-tech workers trained in the digital technologies of the future.** India's IT-BPM industry currently generates almost $170 billion in revenue annually and employs approximately four million people. As global IT industry spending shifts toward new digital technologies and away from legacy systems, the industry has the potential to generate $285 billion to $350 billion in revenue in 2025[243].
  In the past few years, employment growth has represented about two-thirds of revenue growth, with productivity (as measured by revenue per worker) accounting for the rest. Based on a range of scenarios for productivity growth, the IT-BPM industry could employ 5 million to 6 million workers by 2025. Since the bulk of future revenue (40 percent by 2025) is likely to be from digital technologies, this implies a large

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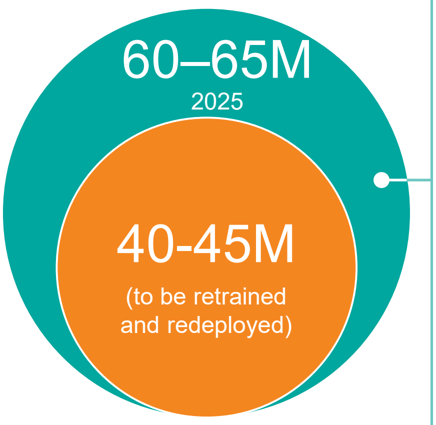
[242] *India's labour market: A new approach to gainful employment*, McKinsey Global Institute, July 2017.

[243] Catalysing the Ecosystem for A Trillion Dollar Digital Economy, NASSCOM, February 20, 2018.

EXHIBIT 17

The value created by the digital economy of the future could support 60-65 million jobs by 2025

Direct jobs enabled by the digital economy[1]



Full-time equivalent jobs supported by the digital value addition in key sectors[1, 2]

Million jobs

Million jobs	Sector	Examples
5–6	**Transport and logistics**	Radio taxi drivers, big data experts optimising platforms, drivers of IoT-enabled trucks
7–8	**IT-BPM, finance, media, and telecom**	Professionals adept in new-age digital skills like social media, cybersecurity, cloud computing, big data analysis, network engineering; business correspondents
10–12	**Trade and hotels**	Delivery agents in e-commerce companies, workers in hotels linked to shared accommodation platforms
16–18	**Agriculture**	Agriculturalists (men and women) doubling up work as digitally enabled field agents for input companies, basic services providers to local populations
10–12	**Manufacturing and construction**	R&D technicians, hardware design professionals, electronics assembly workers for new device ecosystems, shop floor workers (re)trained in Industry 4.0 to use factory analytics and automation tools

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1 Estimate based on estimated labour productivity in 2025 of each broad sector; assumes that workers remain in the same sector where value is created (though in reality, they may shift to other sectors depending on demand); includes some 40-45 million workers who would need to be retrained and redeployed as labour-displacing technology fundamentally transforms their current work.

2 Other sectors like public administration and defence, mining and quarrying and construction explain the difference

SOURCE: National Sample Survey Organisation demand for IT workers trained in areas such as big data analytics, artificial intelligence, and blockchain.[244]

- **Work enabled by new digital marketplaces.** Digital marketplaces, or online platforms that enable the sale of goods and services, are changing labour market dynamics by creating new value chains of workers linked to organised, digitally enabled businesses. E-commerce in India currently generates between $30billion to $35 billion in merchandise value annually and employs more than 100,000 people, mostly in goods delivery and logistics.[245] In line with expected internet penetration for India by 2025, the e-commerce market is likely to become three to four times its current size and could create about 500,000 direct jobs, largely based on today's job intensity. Similarly, cab aggregators such as Uber and Ola book three million to five million rides daily, providing employment for 600,000 to 700,000 drivers. With the biggest 30 cities accounting for more than 90 percent of their market, there is large scope to expand.[246] In China, the biggest cab operator 'Didi' has been booking around 25 million rides per day, providing work for 1.37 million drivers.[247] If India reaches half that level by 2025, more than a million drivers could be engaged in the trade.

- **Digitally enabled remote processing centres and value chains in semi-urban and rural areas.** Workers could find employment opportunities by advising urban and rural residents on such matters as accessing government services online, facilitating teleconsultations, internet banking, and e-commerce. This could take the form of full-time or part-time employment, in a physical outlet or in the field. For instance, covering 20 to 40 percent of the rural population through digitally enabled field agents for basic services such as banking, healthcare, and agricultural know-how could create work opportunities for two million to three million people.[248]

- **Digitally enabled on-demand work for independent workers.** Digital technologies and the platforms they enable make work divisible and help workers access opportunities remotely. A growing army of freelancers worldwide wants autonomous, project-based work, typically in the work-from-home model. This is a particularly attractive opportunity for women professionals who may drop out of the regular workforce for a time due to family obligations. Currently, around 15 million freelancers are registered in India[249], and platforms such as Flexing It are providing them with employment opportunities.

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244 *Perspective 2025: Shaping the digital revolution*, National Association of Software and Services Companies, 2015.

245 *India's labour market: A new approach to gainful employment*, McKinsey Global Institute, July 2017.

246 Expert interviews.

247 Xinhua, DiDi completes 7.43n rides in 2017, ChinaDaily, January 9, 2018.

248 Expert interviews.

249 Anand J, Shalina Pillai, New-age techies turn freelancers for big pay, Times of India, October 24, 2017.

GOVERNANCE

5. Supportive policies, platforms, and partnerships are needed

Key Highlights

01

A thriving digital economy needs a creative balance between regulation, compliance, and innovation

02

Realising the value of India's digital economy requires prerequisites and interventions

03

The right governance architecture is an important element of the road map

India has huge potential to transform its economy by 2025 through digital capabilities and ubiquitous internet access. But realising that potential is not an automatic process. Large businesses, small enterprises, individuals, and state agencies alike will need to invest in technology, acquire new knowledge and skills to use technology creatively, and participate in digitally enabled value chains. The government must execute key digital initiatives as well as enabling the private-sector innovation and investment behind many themes. This chapter provides an overview of the enabling stance that the government needs to adopt in its role as regulator, the specific interventions required — in terms of policies and rules, new platforms, and partnerships — and what steps the government can take to create the right governance and execution architecture over the next few years.

A thriving digital economy needs a creative balance between regulation, compliance, and innovation

The digital world is essentially borderless, with capital, innovation, data, and design capabilities flowing to countries that offer the fewest pain points. If India does not position itself well in the global digital diffusion race, it could face a widening digital deficit in an adverse balance of trade, capital, and intellectual property. However, if essential steps are put in place to encourage innovation and investment in intellectual property within India, the country could emerge as the digital factory of the world and yield a significant digital surplus.

Traditional approaches to policy making and regulation, which typically involve strict, prescriptive requirements around narrowly defined activities, can be dissonant with rapidly changing technologies that tend to break down silos in the real world. In this context, how can the government actively foster innovation and mitigate the risks of a digital deficit? Five overarching principles could be adopted:

1. **Drastically improve the ease of operations and reduce the cost of operations for digital businesses.** India could aspire to be among the easiest places in the world for entrepreneurs to build digital businesses. Setting concrete, time-bound goals is an important first step toward achieving this. For instance, the government could aim to enact

purely digital compliance requirements that involve less than one day per year of the founder's time and cost less than 0.1 percent of the startup's revenue. Or it could commit to making it possible to start, change, merge, or sunset a digital business within 24 hours, completely online. Digital businesses provide a good test bed for government efforts to streamline, standardise, and digitise compliance processes and procedures. Meeting this aspiration requires satisfying two conditions: having a clear definition of a "digital business", and knowing why they need to be given preferential treatment over traditional businesses.

Currently, no formal definition of a digital business exists. One potential way to define digital businesses could be as those that encompass any of the following characteristics in their core product or service: disintermediation (cutting out a middle layer and linking suppliers and consumers directly through digital platforms); disaggregation (turning huge assets into many pieces, converting them into services, and serving fragmented consumer bases); and dematerialisation (changing products or processes from physical to virtual, enabling consumers to receive products or services anywhere, anytime).

India is in a liftoff phase in terms of digital adoption, with new and emerging digital ecosystems likely to proliferate in the next five to seven years, encompassing all walks of life, such as education, healthcare, agriculture, and more. Many established players have already started experimenting with digital initiatives; for instance, Reliance Jio and the Andhra Pradesh government are coming together to provide digital content access and remote teacher training. However, being new, these initiatives are inherently risky and experimental in nature; if successful, they scale up quickly or fail. Hence it is important for digital businesses to be nurtured carefully.

The government could also work with business entities to develop market-friendly regulations, standards, and platforms within specific domains, as the Reserve Bank of India has done in the payments space by setting up the National Payment Corporation of India with the involvement of private- and public-sector banks as stakeholders. Frequent and wide consultation with startups, incumbent businesses, technology innovators, and researchers can help policy makers understand new trends and ideas, on-the-ground challenges, and grey areas. One approach gaining currency in Europe is to set up policy labs, which are forums where policy makers meet with stakeholders (researchers, businesses, and consumers) to quickly identify and analyse a problem, and cocreate and test a policy solution. Similar to a technology product development life cycle, testing of new approaches in the policy lab context is done on a relatively small scale to get quick feedback and limit the costs of failure. The approach is then scaled into new policy design or implementation.

Another approach that governments can implement is regulatory sandboxes, which create an environment for experiments while being able to contain the consequences of failure. They have been used, especially in fintech, by the UK and Singapore governments. Emerging financial products or services may face uncertainty over whether the innovation meets regulatory requirements. Specific legal and regulatory requirements are relaxed for the sandbox duration. Both countries open sandbox applications to all financial institutions and fintech players.

2. **Unlock the flow of domestic capital into digital businesses.** Domestic savings can be a strong complement to the foreign direct investment, foreign institutional investment, and foreign investment driven by high-net-worth individuals (HNIs) into India's technology sector. The flow of domestic capital into digital businesses enables the assets and wealth created by these businesses to be retained in the country and ploughed back into the growth of the digital economy. Increased financial support from the government and creating an environment that encourages HNIs to invest in startups is required to give impetus to domestic funding.

   Domestic investment capital for digital businesses can be from government funding programmes or private sources. The largest government equity finance fund of funds managed by the Small Industries Development Bank of India has received $15 million to invest in startups, as defined under the Startup India programme in 2016–17.[250] The bank could take more leadership initiative in venture capital fundraising as a cornerstone investor,

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[250] "Startup India" scheme, Press Information Bureau, December 27, 2017.

providing domestic investors more confidence to coinvest, especially since digital is at a relatively nascent stage in the country. A Government-backed investment can amount to 15 to 20 percent in any typical venture capital fund, which could be raised for specific sectors such as digital businesses to kick-start the virtuous cycle of investment and growth. For example, the Israeli government-backed fund of funds Yozma Group, established in 1993, provided half the capital in the ten venture funds it invested in, a rapid deployment of capital that spurred Israel's venture capital industry to grow 60-fold by 2000 and led to Yozma's losing its relevance and closing.[251] Another model is the Singapore government, which directly invests in startups, matching investments made by accredited venture capital investors.[252]

Private investment in digital startups is being led by high-net-worth individuals, who invest directly or through angel networks or funds. The current tax structure makes investing in startups a less attractive option compared to investing in public markets. The current tax rules also prevent charitable foundations from investing directly in startups. In developed markets, large family trusts and educational and corporate foundations are important sources of long-term patient capital for innovative technology companies, an approach that is especially beneficial for digital businesses. Israeli tax law allows angel investors to write off 100 percent of their investment in certain startups, up to approximately $1.4 million per investment. The Indian government could revise tax rates for domestic investors to a certain threshold to grow domestic angel capital.

3. **Support Indian digital innovators through strategic procurement.** The government is a large potential buyer of services and can act as a market maker to create scale for the best innovations and technology applications coming out of the country. This can be direct (for example, by procuring telemedicine services from the private sector for its primary health network) or indirect (for example, by purchasing all goods and services on a government e-marketplace platform that encourages all vendors to become digitally enabled). Transparent mechanisms would be required that provide an open system for Indian innovators to propose and build products to solve national needs. These could take the form of technology and product purchasing councils, with open competitions to find the best innovation to serve a national need. The top two consortia could win, say, 60 percent of the expenditure of that solution for a period of five to seven years.

4. **Unshackle centres of higher education and innovation.** The competitive advantage for the digital economy of the future will lie in developing the workforce's design, creativity, and innovation skills. For this, it will be vital for India have vibrant higher education institutions that collaborate closely with industry in innovation clusters and tinkering labs. China, Singapore, and other countries have invested

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[251] "What makes Israel's innovation ecosystem so successful", *Forbes*, January 9, 2017.

[252] "200m to help fund local startups", Straits Times, Samuel Chan, March 23, 2017.

in making their higher education institutions among the top 100 in the world.[253] Locations where world-class innovators gather and thrive, such as Singapore, Tel Aviv, Seoul, and the San Francisco Bay Area, are essential nexuses of the digital economy. For this, a significant fraction of investment (including local revenue generated by the city) needs to be ploughed back into the city.

— MeitY set up four committees of industry and academia to draw out roadmap on how new and emerging technologies could be applied in real world. They have incorporated findings from the recently released NITI Aayog's "National Strategy for Artifical Intelligence" as well. To operatiomalise these recommendations, MeitY is working with DIC to set up a National Centre for Artifical Intelligence (NCAI) as an apex body for artificial intelligence.

5. **Facilitate a booming open API ecosystem.** The 30 themes outlined in Chapter 3, and many more beyond this list that will emerge as technology evolves, all suggest a potential explosion of fintech, agritech, healthtech, edutech, and other tech-based innovation from India. To facilitate innovation, every government digital initiative needs to conform to the MeitY open API guidelines in the National Data Sharing and Accessibility Policy. Ideally, all data sets not on a negative list, i.e., data that departments have declared to be nonsharable, could be uploaded to an open platform, such as data.gov.in.

— Creation of an open API based platform in agriculture which leverages existing and emerging data sources like weather data, soil health cards, crop price, etc. will incentivise creation of an eco-system to address farmers' needs from input optimisation, farming practices, warehousing, finance, thus increasing their income. Using rainfall data of 13 districts in Andhra Pradesh collected over the past 45 years, Microsoft, in collaboration with ICRISAT, has developed an application which advises farmers on the best time to sow crops, ideal fertiliser mix, etc. This has shown to increase productivity by 30 percent for the 175 farmers selected for the pilot.

Open API based platforms are also being used in improving the delivery of basic services in urban areas. e-Governments Foundation has developed open source, interoperable technology solutions to connect urban governments with citizens. This has resulted in an increase of 72 percent in property tax revenue collection of Delhi between 2008–9 and 2013–14.

Despite humongous potential, lack of clarity in the national policy leads to varying interpretations by different departments, thus resulting in inconsistent data sharing on the platform. Also, the format on which data is shared is not consistent. Some data, for example, is uploaded in the form of scanned documents, which are not machine readable, and some data pulls require logins or captchas. Adopting standards will ensure flexibility to employ the underlying raw and processed data according to users' objectives and interests, thus fostering an environment of innovation.

Policy makers must streamline guidelines to clearly direct government agencies and departments while uploading data sets to data.gov.in. The guidelines must provide clarity on the criteria for selecting the data sets to be uploaded as well as the data format and file format. The policy must recommend developing an API-based framework for each ministry for pulling specific data sets. In addition, gov.in data must be restricted to open use by Indian organisations and companies only, to act as magnet for researchers and innovators to migrate to India.

With these overarching principles as the guide, a very specific set of steps is required to capture the potential of each of the 30 digital themes. Discussions with more than 90 organisations and more than a fifteen government ministries — all actively deploying digital technologies — have helped identify specific prerequisites for success for each digital theme. Without stakeholders taking action to address barriers and put the enablers in place, the full economic value will not be realised. Several areas need to see concerted efforts and new mechanisms for collaboration between government and business. These are outlined briefly below and presented in detail in Section 2 of this report.

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[253] Ellie Bothwell, Jack Grove, World University Rankings 2018: results announced, Times Higher Education, September 5, 2017.

Realising the value of india’s digital economy requires prerequisites and interventions

Beyond these overarching principles, specific prerequisites are needed to realise value from the individual digital themes. The steps are of three types: putting in place supportive policies and regulations, initiating new-age digital platforms and ecosystem enablers, entering into partnerships to acquire expertise and capabilities (Exhibit 18).

- **Adopting supportive policies and regulations.** New policies and guiding frameworks will be required in several areas. They include, for example, clarified data encryption and governance standards, a clear data-protection policy that meets international standards, active participation in global IoT standard-setting bodies, and the creation of a data interoperability committee for the IoT and beyond. Policies that create legal recognition and incentives will be required for participation in the national document exchange and the national digital land repository, with conclusive titling. Multiple stakeholders need to establish policies to clarify the roles of government and private-sector parties to facilitate remote healthcare and virtual learning and teaching. A clear policy governing the civilian use of drones, and policies supporting the manufacture of a wide variety of electronics, such as LED devices and set-top boxes, are some other examples. In addition, the overall regulatory stance would need to balance risk mitigation with encouraging innovation to solve problems. The government can provide the right environment for private-sector innovation through policy labs, regulatory sandboxes, incubation centres, and other test beds for new fintech and IoT-based applications, for example. Enabling private-sector innovation is critical to achieving Digital India goals.

- **Initiating new digital platforms and ecosystem enablers.** As in the case of Aadhaar and the open APIs it supports, public, societal platforms can play a critical role in triggering and enabling solutions from startups and digital innovators. India will need to create several such catalytic platforms to accelerate capturing the value of the digital economy. Platforms that facilitate digital authentication and data integration of MSMEs, open-data platforms that integrate agriculture data from diverse sources, and a labour market information system to aggregate data on skilled job seekers and job vacancies are important examples, as is an interoperable land records platform that dynamically mirrors on-the-ground realities with land records. All such platforms would need to be created on an open API basis, allowing innovators to create digital apps and solutions that plug into the underlying data in the platform. In addition, necessary digital infrastructure elements include cybersecurity information-sharing platforms, digital dashboards that help monitor national priorities, and improved versions of the Government e-Marketplace platform to support vendor participation.

- **Team India partnerships and collaborations.** Central and state governments, the private sector, and social-sector organisations can bring complementary assets and capabilities to public-private-social partnerships. One example is building digital infrastructure and training healthcare workers in primary health centres. Some of these digital transformations could be government-led and business-enabled, while others could be government-enabled and business-led.

EXHIBIT 18

Examples of actions required

Priority areas	Data platforms with open APIs	Public-private partnership opportunities	Government initiatives (with private sector inputs or execution)
A 21st century IT and telecom infrastructure and services	▪ Facilitate a booming open-API ecosystem by ensuring that every government digital initiative needs to conform to open-API guidelines ▪ Strengthen National Knowledge Network as a backbone to catalyse rapid spread of domain networks	▪ Establish a future-skill platform, in partnership with the private sector, to train and retrain IT workforce in new and emerging technologies like AI, IoT, data analytics ▪ Create PPP framework to bring affordable 'visual broadband' to every home leveraging BharatNet 2 ▪ Set up an expert technical group to lay out India's future architecture and roadmap for next-gen broadband infrastructure	▪ Finalise personal data protection framework with statutory backing to protect personal data privacy while encouraging innovation through appropriate consent frameworks ▪ Introduce regulations to remove obstacles to broadband rollout (e.g., right of way) and declare fibre as critical national infrastructure ▪ Create nodal cybersecurity body to streamline and consolidate multiple existing agencies
B E-governance for the future	▪ Design interoperable land records platform to link and "mirror" data on record of rights, mutations and cadastral maps, enabling a move towards eventual conclusive titling ▪ Host a set of shareable APIs and digital tools that urban local bodies can use with minimum customisation ▪ Push national document and data exchange by setting up a digital trade platform for paperless exchange and verification of documents like purchase documents, letters of credit, bank guarantees, invoices to give further impetus to ease of doing business	▪ Equip Common Services Centres as local employment exchanges by collating demand and supply of labour in the areas they serve ▪ National Government Network	▪ Expand DBT channel beyond bank accounts to reach beneficiaries through BCs, India post, CSCs
C Healthcare for all	▪ Build an integrated Health Information Platform to create and provide access to electronic health records for every Indian ▪ Operationalise a secure digital platform and software for NHPS/Ayushman Bharat	▪ Develop model PPP for setting up digital infrastructure and training for health workers in primary health centres and other medical care facilities	▪ Finalise/implement DISHA Act with National e-health authorities to provide framework for sharing of health information digitally – Frame policies to mandate EHR adoption
D Quality education for the future	▪ Create an open education platform with data on student competency levels to enable individualised learning through customisable, context-ready education solutions	▪ Develop model PPP for setting up digital infrastructure and training for schools and teachers	▪ Clarify rules and policies to recognise distance learning ▪ Prioritise broadband connectivity in schools/educational institutes under BharatNet ▪ Define digital literacy benchmarks for students/teachers

Priority areas	Data platforms with open APIs	Public-private partnership opportunities	Government initiatives (with private sector inputs or execution)
E Energy for all	▪ Complete digitisation of bill payments across DISCOMS	▪ Capacity building to conduct research and proofs of concepts for specific smart grid technologies ▪ Create energy service companies for efficient distribution of electricity, including renewables	▪ Install prepaid meters, especially in areas with low collections
F Next generation financial services	▪ Create platform for sharing data on financial trail (via GSTN filings, MCA21) to push credit to MSMEs ▪ Launch one-stop digitally-verifiable number for easy verification/ authorisation of MSMEs	▪ Implement 100% digital payments by government for all procurement from farm and SME sectors	▪ Uniformity of data across multiple sources in a machine readable format
G Make in digital India, make for India, make for the world	▪ Create an integrated multimodal logistics platform with standardised e-documentation processes to help reduce India’s logistics cost from approximately 14% currently to less than 10%	▪ Invest in IoT and AI incubation centres, resource centres and test beds for new IoT and AI based applications for Indian industry ▪ Link small retailers into digitally-linked value-chains	▪ Expand Phased Manufacturing Programme for electronic devices such as LED, LCD/LED TVs, set-top boxes ▪ Develop action plans for specific electronics verticals (medical, automotive, defense)
H Doubling farmers’ incomes	▪ Create open data platform to enable creation of ecosystems for – Precision advisory on all aspects of agriculture from farming, marketing of agricultural produce and optimisation of inputs, warehousing – Institutional credit leveraging new data sources like bank transactions and asset (digital land) history – Finetune govt. policy	▪ Develop model PPP to demonstrate agriculture data analytics use cases and impact (e.g., soil health cards)	▪ Create institutional market facilitators to incentivise and execute agricultural trade through online markets ▪ Improve accuracy and timeliness of insurance payouts by estimating agricultural yield using satellite/ drone and weather data, reducing reliance on crop-cutting experiments
I Jobs and skills for the future	▪ Create a platform having a profile of all labour, capturing their journey from skill acquisition to job search at a granular level, leveraging channels like the CSCs and Post Offices	▪ Create large-scale national partnership for workforce skill upgrades across industries	▪ Develop policy to encourage and regulate remote training schemes ▪ Outsource government data processing work to semi-urban and rural BPOs

The right governance architecture is an important element of the road map

Beyond a blueprint for the enabling steps required, the right governance architecture is an important element of the road map. Some potential actions follow:

- **Set up sector-specific consultative forums to engage Team India in digital transformation.** These councils would be led by the government with private sector participation for say three-year terms. A few councils could be set up initially: technology infrastructure (data storage and cybersecurity); healthcare; education and skills training; agriculture (and food processing); and transportation and logistics. Each will include representatives from across the value chain. They could be asked to provide inputs to help each sector's digital strategy evolve and to suggest ways to streamline and simplify regulation and compliance to foster growth of the ecosystem.
- **Public digital platforms are important enablers for the vision** — in areas such as GSTN, Education, Agriculture, Health, Land, Logistics, Future skills and Jobs, e-governance App Ecosystem and digital data and document exchange.
- **Create a digital dashboard to measure progress** on outcomes across existing as well as future digital initiatives. It would serve as an important barometer of the evolution of India's digital economy in the years to come and be a tool for reviewing progress, streamlining action, and shaping future policy.

II

9 National goals and 30 specific Digital themes

Goal A: 21st-century IT infrastructure and software capabilities

Laying the foundation for a $1 trillion digital economy by 2025

1. An IT-BPM industry equipped for digital technologies of the future

Vision and potential impact

Global technology spending more than tripled over the last 30 years and now accounts for about 40 percent of total investment by enterprises in the United States and other leading economies.[254] Capitalising on this opportunity, the information technology and business-process management (IT-BPM) industry has played a key role in India's economic growth over the last ten years. From 2009 to 2017, the revenue of the country's technology services sector — which includes third-party businesses such as software coding, engineering services, and help desks as well as global in-house centres — expanded at a compound annual growth rate of 10.6 percent.[255] The rate was approximately 11.4 percent from 2009 to 2015 and tapered to approximately 8 percent between 2015 and 2017 due to substantial changes in global technology spending.[256] The IT-BPM sector accounts for approximately 40 percent of India's service exports, and its continued vibrancy would be pivotal to the country's achieving its digital economy aspirations for 2025.[257]

India's IT-BPM industry revenue is expected to range from $280 billion to $350 billion in 2025, with value addition — profit, wages, and interest cost — broadly stable at around 70 percent of revenue.[258] This would translate into added economic value of $205 billion to $250 billion in 2025.

This potential assumes continued growth in global enterprise spending on technology and business services at the historic rate of 2.5 to 3.5 percent a year, to reach $3.4 trillion to $3.6 trillion by 2025.[259] However, the value pool is fundamentally shifting away from legacy technologies and toward digital — automation, cloud, cybersecurity, mobile, artificial intelligence (AI), 3-D printing, internet of things (IoT), big data analytics, and social media — at a pace even faster than anticipated just a few years ago. By 2025, as much as 60 percent of spending is likely to be on these new technologies.[260] To emerge as an IT-BPM leader, India needs to prepare people to develop advanced capabilities in these technologies.

Globally, enterprises define digital as a set of use cases linked to business outcomes, fundamentally enabled by technology. These outcomes can be used to drive value for companies on several dimensions. Digital channels — for example, chats within apps and web-based self-service — can help to enhance customers' experiences by 20 percent (as rated by customers on a scale of one to seven) while reducing the cost to serve them by 24 to 30 percent.[261] Big data analytics can be used to guide business decisions in areas such as marketing and risk. It also can enable businesses to create products, services, and earnings models using new purely digital platforms that enable peer-to-peer lending. C-level executives increasingly see digitisation as key to driving growth and business transformation; their main digital objectives are acquiring more customers and meeting their expectations of convenience, simplicity, and added value.

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[254] *Perspective 2025: Shaping the digital revolution,* National Association of Software and Services Companies, 2015.

[255] Ibid.

[256] Ibid.

[257] Indian IT-BPM Industry Overview, NASSCOM, 2014.

[258] *Perspective 2025: Shaping the digital revolution,* National Association of Software and Services Companies, 2015; National accounts statistics, Central Statistical Organisation, Ministry of Statistics and Programme Implementation.

[259] *Perspective 2025: Shaping the digital revolution,* National Association of Software and Services Companies, 2015.

[260] Ibid.

[261] *McKinsey 2013 European telecom e-care survey*, McKinsey & Company, June 2014.

Digital native companies — those that have emerged and grown to scale in a digital-only environment — have already captured close to 17 percent of the market on average across multiple industries, from transport, logistics, insurance, and retail to telecom, high tech, and media. Examples include Netflix and Hulu in media, WhatsApp and Skype in telecom, and Uber and Lyft in transport.

This trend is true for the tech services sector as well. Even as incumbents are building digital capabilities, a new category of digital specialists is emerging. There are, for example, EPAM Systems, an automation specialist; Globant, a specialist in digital transformation of customer experience and design; and Palantir and Mu Sigma, specialists in analytics.

Globally, data centre infrastructure investment was $170 billion in 2015.[262] This was driven mainly by the United States and Singapore, with India accounting for 1.3 percent. With the right policies for data governance, data encryption, cloud adoption, and data privacy, India could persuade domestic as well as global investors to set up data centres in India. The country has an abundance of talent that has helped it grow in the IT-BPM sector. Talent can be retrained and redeployed for data centres, and new talent trained in analytics and cloud computing can help data centres to flourish.

Initiatives already under way

Exhibit R1 describes some emerging digital specialist firms that meet changing industry needs.

Exhibit R1

Digital specialists are gaining prominence in the IT-BPM industry

Organisation	Context	Solution	Impact
EPAM Systems	▪ Established in 1993, it is a global provider of complex engineering solutions and IT services in new/ emerging technologies ▪ IPO launched February 8, 2012	▪ Key verticals: banking, financial services, and insurance; travel and consumer; information and media; healthcare; retail and distribution ▪ Technologies: social, mobile, analytics, and cloud; user experience (UX) design; consulting; analytics; internet of things (IoT); digital marketing	▪ Employs over 22,900 engineers, designers, and consultants ▪ EPAM has market cap of $6.3 billion (as of April 20, 2018) and reported $1.45 billion revenue in FY 2017, 25% year-on-year growth
GlobalLogic	▪ It is a full life-cycle product development services company ▪ Founded in 2000 as IndusLogic which merged with Bonus Technology in 2006 to form GlobalLogic ▪ Apax Partners acquired GlobalLogic in 2013 for $420 million	▪ Key verticals: media, medical, and retail (increasing focus) ▪ Key technologies: cloud, platform-as-a-service, embedded computing, mobile ▪ Specialises in UX design, product design, content engineering, sustaining engineering, product testing, and quality assurance	▪ Employs over 12,000 people ▪ Exceeded $550 million revenue in 2017 and has a target of $1 billion revenue for 2020

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[262] "Gartner says worldwide IT spending is forecast to grow 0.6 percent in 2016", Gartner press release, January 18, 2016.

Organisation	Context	Solution	Impact
Mu Sigma	- It is a pure-play big data analytics and decision sciences company founded in 2004 - One of two profitable unicorn companies in India	- Specialises in analytics, which includes risk analytics, retail analytics, marketing analytics, supply chain analytics, big data, IoT, decision sciences, and data sciences - Developed a range of products for decision sciences (muPDNA, muESP, muMix, and muLearn) and data sciences (muXo, muHPC, and muText) - Main industries served: technology, pharmaceuticals, and retail	- Employs over 3,500 professionals - Works with more than 140 Fortune 500 companies

SOURCE: EPAM Systems; Mu Sigma; *Economic Times*, February 20, 2018.

Potential actions to ensure accelerated progress

The shift toward advanced digital applications — automation, cloud, cybersecurity, mobile, AI, 3-D printing, IoT, big data analytics, and social media — implies that India's IT-BPM companies will need to pivot their business models and capabilities in the following ways to capitalise on new opportunities:

- **Build new digital offerings and identify focused microverticals for growth.** New digital offerings could be led by both horizontal and vertical use cases with a goal of capturing a disproportionate share of the enterprise digital spending pool. This would call for a shift from delivering point technology solutions to supporting end-to-end customer journeys with agile product development cycles, new delivery models anchored on a clear return on investment, and a marketing plan that communicates value. India's IT service providers and executives who seek to shepherd platforms from buzzwords to scalable, profitable offerings must be able to answer the following questions:

  A. Have you identified the pockets of opportunity where platform-based delivery is the game changer?

  B. Does the platform incorporate advisory; proprietary applications; cloud infrastructure; and machine learning?

  C. Is the platform mostly plug-and-play with the ability to add functionality via external and internal ecosystems of other apps and platforms?

  D. Is the go-to-market model geared to pursue the most rapidly growing or profitable client segments — for example, midmarket vs. the largest players?

  E. Is the value proposition based on being the best use-case-specific industry standard?

  F. Is the cost of (or investment in) building the digital platform directly linked to the business outcomes it generates?

  For example, Afiniti applies artificial intelligence to enable the real-time, optimised pairing of contact-centre agents with individual customers of large companies, and charges clients a portion of the additional revenue generated.

- **Revamp front-end sales and presales capabilities, and enhance delivery models.** This requires design skills, agile processes, and a commitment to DevOps, the software development and delivery process that emphasises communication and collaboration across the entire enterprise. DevOps includes product managers, software developers, and operations professionals, all of whom are closely aligned with business objectives. Horizon 2 or 3 technologies — that is, short-term emerging opportunities and profitable ideas for further down the road, respectively — entail higher investment in cost of delivery, marketing and sales, and research and development. They typically have a gestation period of five to seven years.

- **Tap emerging markets in the Asia–Pacific region, Latin America, and Africa while catering to growing domestic demand.** While India's IT-BPM industry has traditionally focused on the North American and European markets, it now has the opportunity to address growing demand in emerging economies, such as China, Japan and Africa as well as its own. The recent success of Chinese digital native companies such as Baidu and Tencent as well as Japan's focus on emerging technologies such as automation and IoT make China and Japan key markets that Indian vendors could target.

- **Reinvent the organisation model.** The IT firm of the future will need to create a three-in-one model under which traditional, transformative, and disruptive organisations — each with distinct leadership needs — coexist and, in fact, map onto similar organisations at the enterprises' counterparts. Each organisation model operates with different key performance indicators and outcomes, requiring different leadership.

- **Build a digitally capable workforce.** This can be accomplished through a combination of retraining current employees and hiring digital natives. Digital talent has some distinct traits. The field requires nonlinear and lateral creative thinking that sees beyond processes and methodologies. It also requires a strong technology bias to be able to solve problems creatively using technology. Third, it requires an open-source mentality to stitch together multiple sources to resolve a problem. Examples of digital talent include design skills, digital marketing, mobile app development, data science, and artificial intelligence. Digital leaders have acquired disruptive talent to build capability, which might be a valid strategy in addition to retraining.

- **Buy, fund, incubate, or collaborate with digital startups and product companies.** Create an ecosystem of partners by leveraging innovative partnership and incubation models. The American seed accelerator Y Combinator, for example, has backed nearly 1,500 companies, including Dropbox, Airbnb, Coinbase, Stripe, and Reddit.[263]

> "Roll out a skilling programme to train and retrain up to 9.7 million people by 2022"

The following tax and regulatory actions also could have a significant impact in setting up data centre infrastructure:

- **Tax incentives.** The Ministry of Finance and the Ministry of Commerce and Industry could use tax policy to reduce the investment burden of setting up data centres. These incentives could be linked to the number of direct jobs the data centre creates.

- **Simplification of licensing terms and conditions for data centres.** The government has no regulations specifically for data centres, leaving them covered by telecom-centric guidelines for "other service providers". At the same time, there is a lack of clarity about whether data centres need an internet service provider license to connect directly to the internet. The Ministry of Communication could create a regulatory category specifically for data centres, clearing ambiguity and freeing them from rules for "other service providers".

- **Cloud computing–related legislation.** Unlike the Australia, Japan, the United Kingdom, and the United States, India does not have legislation that directly addresses the confidentiality and privacy issues around cloud computing. India could create an accommodating legal framework, including a separate cloud-computing law to govern cyberspace, as well as a strategy to foster international collaboration on issues involving data centres.

- **Data governance framework for the cloud.** A related issue concerns the rules that must govern what government data must be stored on cloud platforms. This would include standards for confidentiality, integrity, and availability of data. The Ministry of Electronics and IT could develop separate data governance and classification frameworks for different types of cloud platforms to ensure the cost-effective provision of services.

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[263] Lizette Chapman, Peter Thiel out of Y Combinator, two-year partnership dissolved, Economic Times, November 18, 2017.

DATA
ANALYSIS

Even as individual IT-BPM companies reinvent themselves along these lines, the industry as a whole, guided by the National Association of Software and Services Companies (NASSCOM) and the government, can focus on the following:

- **Branding:** India could brand itself as a digital factory of the world, and that image could be promoted internationally and championed by high-profile backers. Industry groups such as NASSCOM could organise road shows and other events in client countries to showcase Indian companies' innovative digital offerings. Indian companies can also take the lead and run developer conferences to showcase their work. An example is Dreamforce, a week-long conference that Salesforce.com organises to promote its products and allow users to share experiences and network.

- **Capabilities:** Roll out a skilling programme to train and retrain up to 9.7 million people by 2022.[264] Industry players and education leaders, with government facilitation and support, need to reshape and develop a national curriculum for technology education that aligns with the skills that will be required in the future to embrace Industry 4.0, the new wave of emerging technologies such as IoT, AI, and 3-D printing. A first step would be to revamp coursework to emphasise digital technologies ahead of legacy technologies, for instance by adding classes in smartphone application development and IoT and eliminating those in outdated computer languages, like Basic and COBOL. In addition, the country could create education and training modules that focus on business applications and introduce specialisations in digital technologies. India's engineering and technology colleges, industrial training institutes, other vocational training centres, and secondary school boards can all play a role in this retraining and transformation process.

As part of the effort to enhance the quality of instruction, industry certification programmes such as the NASSCOM Assessment Certificate could be expanded to include social, mobile, analytics, and cloud technologies, and could be enhanced in collaboration with industry to ensure that they meet the highest global standards.

The government could actively invest in R&D and innovation to help industry develop capabilities in emerging technologies and enable it to create breakthrough software products that generate their own demand. This would allow industry to do more than compete for business in fields crowded with competitors. Fostering innovation could be done by organising a large number of national-, regional-, and local-level hackathons (like the Smart India Hackathons), setting up incubators with cutting-edge resources, and establishing policy labs to ensure parallel evolution of a regulatory framework and overall ecosystem. The announcement by the National Institution for Transforming India (NITI Aayog) that it will establish a national programme for artificial intelligence is a promising step in this direction.[265] Israel, a hotbed of technical innovation, is an example of successful investment in capabilities; it spends 4.3 percent of its GDP on R&D, with information industries accounting for 56 percent of total business R&D.[266] Multinationals investing in Israel often acquire startups, turning them into R&D centres.

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[264] Skill Action Plan, NASSCOM.

- **Structure:** India could open innovation clusters and incubation centres focused on emerging digital technologies and could launch and fund research centres. It also could establish networks for sustained global collaboration. The effort to build an innovation cluster focused on digital technology could be led by an umbrella organisation that would plan development and monitor progress. Having an umbrella organisation would help facilitate collaboration among stakeholders and build consensus around specific objectives. In planning the development of an innovation cluster, India could draw inspiration from examples such as Silicon Alley in New York and Silicon Roundabout in London. The key ingredients for the success of these clusters include access to a solid talent base, strong infrastructure, research centres linked to leading "anchor" technology institutes, and the support of government and other stakeholders.

  Vibrant internal and external networks can keep businesses in the cluster up to date on the latest technological developments, help identify funding and recruitment possibilities, and enable cross-pollination among disciplines or industries. ProductTank, for example, is an initiative that a product management specialist started in London in 2010 to bring together managers, designers, and developers in informal gatherings; it has since expanded to more than 140 cities.[267]

- **Entrepreneurship:** The government made a step in the right direction by creating the Startup India campaign. While this programme has come up with initiatives such as a Startup India Hub — a single point of contact for the entire startup ecosystem that enables the exchange of knowledge, a 100 percent tax deduction for startups for three years, and a scheme to finance new companies — a stronger push is required to turbocharge the startup ecosystem. Setting up interest groups and certification programmes for emerging technologies is essential to boost startups. India also could consider having entrepreneur competitions and connect winners with potential investors, emulating the Seedcamp programme in London and Y Combinator in Silicon Valley. Applicants could prepare business plans and pitch them to a panel of venture capitalists. Such competitions provide networking opportunities to entrepreneurs, and even unsuccessful applicants can tout their participation when seeking funding elsewhere. In India, the states of Gujarat, Karnataka, Kerala, Rajasthan, and Telangana have devised plans to nurture local startups by setting up incubators. Private players also need to open more incubators to create an atmosphere conducive to startup growth. For instance, Tata Group launched T-Hub, PayPal set up PayPal Incubator, and Infosys launched an incubation programme as part of the Infosys Innovation Fund.

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265 *'NITI Aayog and ABB India Partner to Make India AI-Ready'*, Business Wire, May 23, 2018.

266 UNESCO Institute for Statistics (UIS), data.uis.unesco.org, extracted on April 25, 2018; *Highlights from the OECD science, technology and industry scoreboard 2017 — The digital transformation: Israel*, Organisation for Economic Co-operation and Development, November 2017.

267 Mind the Product website, as of June 22, 2018.

SERVER #2 - IP 8920103122
if state <> blnAlarmState then
if(blnAlarmSignal = true) then
transmit(false)
else
transmit(true)
end if
oldstate = state
end if
end if
loop until 0 = 1
end.
ACCESS GRANTED
EXIT
Synchornising 33%

2. State-of-the art cybersecurity and data protection

Vision and potential impact

The ubiquity of smartphones, the popularity of social media, and successful digital inclusion projects by the government have markedly increased Indians' digital presence — and their overall privacy risk exposure. In 2015, Honourable Prime Minister Shi Narendra Modi said the world faces a "bloodless" cyberwar threat.[268] Merely having an online presence can be a source of risk for the broad population of internet users, particularly vulnerable segments. For instance, women and children are typically more exposed to online bullying, defamation, and stalking than adult men. Internet users who have only basic literacy or low educational attainment may not be proficient enough to make use of tools that protect them from cybercrime and data misuse.

> "In 2015, Honourable Prime Minister Shi Narendra Modi said the world faces a 'bloodless' cyberwar threat"

The growth of online shopping, web surfing, and internet services has resulted in a huge inflow of personal data to businesses and governments, an increase that opens more scope for privacy breaches. These potential violations are real threats to the success of digital technology–led initiatives. Moreover, the borderless nature of digital technology makes Indian consumers vulnerable to attacks from cybercriminals around the globe. The Computer Emergency Response Team India (CERT-IN) handled over 50,000 cybersecurity incidents in the fiscal year ending March 31, 2016, and the number of attacks expanded at a compound annual growth rate of 6 percent from 2014 to 2016.[269] Cyberattacks are getting increasingly sophisticated and arise in different ways. Given recent changes — Indian citizens' greater online access, the increased amount of personal data online, and the growth of the data analytics industry — cybersecurity, data anonymity, and data privacy will be critical regulatory elements to protect citizens and businesses.

Cybersecurity is vital to ensuring a strong foundation for India's digital economy. The International Telecommunication Union ranked India 23rd among 195 countries on commitment to cybersecurity in 2017, but there is room for improvement.[270] With digital technology playing a growing role in the lives of individuals, cybersecurity is fast becoming as important as physical security. Just as one safeguards cash and valuables against miscreants, it's important to keep digital wallets and online accounts safe from cybercriminals.

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[268] PM remarks at the launch of Digital India week, July 1, 2015, pmindia.gov.in.

[269] *Technology to stop cyber crimes*, answer to Rajya Sabha question number 891, February 9, 2018.

[270] *Global Cybersecurity Index (GCI) 2017*, International Telecommunication Union, 2017.

India's cybersecurity strategy is based on three pillars — the National Cyber Security Policy, the Information Technology Act, and state- and sector-specific regulations. Since the cyberattack landscape has evolved significantly since the government adopted the National Cyber Security Policy in 2013, an update is essential. India needs a constantly evolving and up-to-date approach and implementation architecture for cybersecurity.[271] It also needs to refresh the IT Act, which addresses data privacy, considering how much the threat landscape and the nature of data have changed since the measure was enacted in 2000 and amended in 2008.[272] Other countries are already either instituting new data-protection laws or modifying existing statutes to better secure citizens' personal data. The European Union, for example, reformed its data protection rules in January 2018.[273] Japan recently amended its Act on the Protection of Personal Information to expand its applicability.[274]

> "India's cybersecurity strategy is based on three pillars — the National Cyber Security Policy, the Information Technology Act, and state- and sector-specific regulations"

Initiatives already under way

In India, the Supreme Court recently endorsed privacy as a fundamental right of every citizen.[275] Many government bodies currently play roles in cybersecurity, from surveillance and regulation to education and awareness; they include CERT-IN, the National Critical Information Infrastructure Protection Centre, the National Security Council, the Ministry of Home Affairs, the Defence Research and Development Organisation, the National Technical Research Organisation, the Department of Telecommunications' security wing, the Ministry of Electronics and Information Technology, the Data Security Council of India. Ensuring a robust system of cybersecurity in India will require these agencies to work together, potentially through an apex body.

With the increasing risks in cyberspace and data privacy, the goal is to provide security by adopting appropriate regulation while also keeping enough of an opportunity window open for the growth of digital innovation and a home-grown industry. Singapore is considered the world's leader in cybersecurity.[276] Exhibit R2 highlights some of Singapore's cyber security policies.

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[271] *Notification on National Cyber Security Policy — 2013*, Ministry of Communication and Information Technology, July 2, 2013.

[272] The Information Technology (Amendment) Act, 2008, Ministry of Law and Justice, February 5, 2009.

[273] "Commission publishes guidance on upcoming new data protection rules", European Commission press release, January 24, 2018, europa.eu.

[274] Amended Act on the Protection of Personal Information, Personal Information Protection Commission, Japan, December 2016.

[275] *Data protection laws of the world: Full handbook*, DLA Piper, September 19, 2017.

[276] *Global Cybersecurity Index (GCI) 2017*, International Telecommunication Union, 2017.

Exhibit R2

Singapore builds best-in-class cybersecurity

Organisation	Context	Solution	Impact
Government of Singapore	▪ Singapore ranked number 1 among 195 countries on the International Telecommunication Union's 2017 Global Cybersecurity Index ▪ Singapore's high ranking reflects the government's focus on cybersecurity and cybercriminal laws, cybersecurity standards, and the establishment of the Singapore Computer Emergency Response Team (SingCERT), which responds to cybersecurity incidents	▪ Key initiatives behind Singapore's best-in-class cybersecurity ▪ Law enforcement and education – The 2016 National Cybercrime Action Plan sets the Government's strategies in combating cybercrime, that includes public education, capability building, strengthening the laws, and stepping up partnerships with the private sector – The Personal Data Protection Commission, which acts against organisations in breach of privacy obligations set out in the Personal Data Protection Act ▪ New and updated cybersecurity policy – Under Singapore's Smart Nation Initiative, the Ministry of Trade and Industry created Industry Transformation Maps (ITMS) for 23 key industrial sectors that make up over 80% of the country's GDP – ITMS promote growth and competitiveness by encouraging innovation, digitisation, and training, among other things The Cyber Security Agency of Singapore (CSA) and Infocomm Media Development Authority (IMDA) are collaborating with Singtel Innov8 and the National University of Singapore (NUS) to build Singapore's first cybersecurity startup hub. The program's goal is to accelerate as many as 40 cybersecurity startups by 2020	▪ Spending on cybersecurity in Singapore is expected to be $551 million in 2018 and has the potential to grow to around $654 million in 2020

SOURCE: Singapore Ministry of Communications and Information, as of March 2018; Unlocking the cybersecurity growth potential, Singapore's cybersecurity industry outlook, pwc, December 2016.

Potential actions to ensure accelerated progress

The rapid growth of digitisation in India makes ensuring cybersecurity and keeping up with data protection measures an urgent priority. Potential actions fall into four areas: cybersecurity skilling and awareness, regulation and data protection, incentives to grow the cybersecurity industry, and metrics to measure progress. These actions are detailed below:

- **Develop workforce cybersecurity skills and improve public cybersecurity awareness.** The omnipresence of IT will lead companies to hire cadres of cybersecurity professionals; companies can work with universities and government agencies to develop these specialists. Indian businesses have relatively low awareness of cybersecurity, which adds to their risks as they adopt more digital processes. Companies will need both core IT system developers and experts who can translate cybersecurity solutions to sector-specific applications. Additionally, as the cybersecurity product and services industry grows, India will need trained cybersecurity professionals to meet global demand.

  Educators must include cybersecurity training in any reskilling initiative they develop for IT workers. Both the Centre for Development of Advanced Computing and the National Institute of Electronics and Information Technology have cyber courses that could be more widely publicised.[277] Engineering students could be required to take basic cybersecurity courses. The government is also planning to open dedicated institutions such as a university to teach full course modules in cybersecurity and cyberlaw.

  The National Digital Literacy Mission could also incorporate best practices to create awareness and teach about cybersecurity along with digital literacy. The Ministry of Electronics and Information Technology is in Phase 2 of an Information Security Education and Awareness Project that can keep scaling up its programmes.[278]

- **Regularly update regulations to keep up with new security threats while meeting evolving needs in cybergovernance and cyberjurisdiction.** New security risks, many of them not covered in detail by the five-year-old National Cyber Security Policy, emerge regularly. As the Ministry of Electronics and IT updates this document, it could involve industry, academia, and think tanks, and could adopt clear implementation steps with a road map for future initiatives. All other relevant policies need to reflect cybersecurity elements; for instance, regulations on the IoT and machine-to-machine communication must include security elements.

  Policy making would benefit from deeper private-sector engagement. In recent years, regulators such as the Reserve Bank of India, the Securities and Exchange Board of India, and the Insurance Regulatory and Development Authority of India have actively created a cybersecurity framework and guidelines.[279] Such efforts benefit from comprehensive engagement with the private sector in the initial policy-formulation phase, or at least in subsequent rounds of updating policy.

  The time has come to refresh the IT Act, which was last amended in 2008.[280] Public officials need to address the following: (1) ubiquitous coverage and applicability that covers the gamut of personal data and applies to all data-gathering organisations; (2) strong enforcement of data protection laws through a central body; (3) the right to recourse and the right to seek compensation, which are crucial for personal data providers but not currently included in Indian law; (4) provisions that address confidentiality, privacy, and governance framework around cloud computing issues.

  The Ministry of Electronics and Information Technology has released a white paper for public consultation on the key principles of a data protection law. The draft framework includes the seven principles of technology agnosticism: holistic application to the private sector and government, informed consent, data minimisation, controller accountability for processing of data, structured enforcement through a high-powered statutory authority with sufficient capacity, and deterrent penalties.[281] Another principle in the data protection law could be for all data on Indian citizens to be stored in data centres within the country.

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[277] Centre for Development of Advanced Computing (C-DAC) website, National Institute of Electronics and Information Technology website, as on April 24, 2018.

[278] Information Security Education & Awareness (ISEA) Project Phase – II, National Institute of Electronics & Information Technology, as of April 24, 2018.

[279] "Financial sector: Regulation and development", in *Financial stability report*, Issue number 16, Reserve Bank of India, December 21, 2017.

[280] The Information Technology (Amendment) Act, 2008, Ministry of Law and Justice, February 5, 2009.

After updated policies and protections are in place, based on comprehensive engagement with private-sector technology users, the government will need to turn its focus to enforcement. In year 2016–15, 7,990 persons were arrested for cybercrime and 254 were convicted.[282] With cyber-related crime increasing globally, there is a strong need for law enforcement personnel and jurisdictional bodies to have a fair understanding of cybersecurity issues and how to deal with them. The Ministry of Home Affairs, in liaison with the Ministry of Electronics and Information Technology, could provide cybersecurity training to police at all levels, down to local stations, enabling them to provide citizen support. Judiciary professionals will also need courses to prepare for cybercrime cases. The emerging field of cyberforensics is establishing standards for admissible evidence in cybercrimes. Law enforcement professionals will need to understand these new standards.

Finally, government can keep apace of the evolving cybersecurity threat by creating sectoral and state-level emergency-response squads (computer emergency readiness teams, or CERTs) and a cyber crisis management plan. Security operation centres (SOCs) dedicated to particular sectors or states could complement the national CERT response team. So far, the government has proposed four response teams for the power sector and one for the financial sector.[283] Plans must be formulated for countering cyberattacks in all central and state ministries and departments, which must conduct regular drills.

Government could make this task easier by creating an apex body for cybersecurity that would combine efforts now scattered among multiple bodies for different IT infrastructures at the state and sector levels. The apex body also could more easily identify gaps in governance and standards, both proactively and reactively. It would also be the nodal agency for setting standards for the IoT, mobile data, and cloud infrastructure; these duties are currently spread among the Bureau of Indian Standards, the Standardisation Testing and Quality Certification directorate, and the Department of Telecommunications. The central body also could work with other government actors and private institutions to develop programmes to improve citizen awareness. For policy makers and private institutions, it would be the information destination for incident responses.

- **Provide incentives for a home-grown cybersecurity industry.** Cyber Security Task Force (CSTF) which consisted of the Data Security Council of India (DSCI) and NASSCOM, chartered out a vision to grow the Indian cybersecurity products and services industry to $35 billion and create one million cybersecurity jobs and 1,000 cybersecurity startups by 2025.[284] The government expects the Indian cybersecurity market to grow at a double-digit rate over the next five years.

  To foster a domestic cybersecurity industry, the government needs to review education, awareness, and incentives with private partnerships. To develop cybersecurity skills in the labour force, it could mandate cybersecurity education through partnerships with universities, employer-funded programmes, or cybersecurity Sector Skill Councils. The government also can help cybersecurity startups: NASSCOM and the Data Security Council of India are engaging with the government to allot $1.5 billion from the Startup India fund for cybersecurity.[285]

- **Cybersecurity metrics.** The government could require each department to prepare an annual cyber-risk assessment with cybersecurity metrics that would allow senior officials to track each department's performance and progress. The government could set a clear baseline for all departments by designing a simple index based on the framework the Reserve Bank of India and Institute for Development and Research in Banking Technology released in June 2016.[286]

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[281] *White paper of the committee of experts on a data protection framework for India*, Ministry of Electronics and Information Technology, 2018.

[282] Parliament questions, CERT.

[283] "Teams to check cyber security threat in power sector", *Business Standard*, March 20, 2017; "Comp Emergency Response Team proposed to check cyber frauds", OutlookIndia.com, February 1, 2017.

[284] Growing Cybersecurity Industry, Roadmap for India, DSCI, NASSCOM, 2016.

[285] "Establishment of fund of funds for funding support to start-ups", Government of India press release, June 22, 2016.

[286] *Cyber security frameworks in banks*, Reserve Bank of India, June 2, 2016.

3. Real-time data visualisation and deep analytics

Vision and potential impact

More data has been created in the past two years than in the entire previous history of the human race. By 2020, about 1.7 megabytes of new information will be created every second of every day for every human being on the planet.[287] It will come from the web, billions of phones, sensors, payment systems, cameras, and a huge array of other sources. As data grows more voluminous, distilling it and bringing it to life through visualisation is becoming critical to helping make data analyses digestible for decision makers. Data analytics industry growth will depend on factors such as data availability, utility, innovation, anonymity, and privacy. McKinsey Global Institute estimated that demand for visualisation grew roughly 50 percent annually from 2010 to 2015.[288] Visualisation is vital to meeting the last-mile challenge of discovering value in massive data sets, and if India is to build a trillion-dollar digital economy, it needs to make the discipline a national priority.

> “McKinsey Global Institute estimated that demand for visualisation grew roughly 50 percent annually from 2010 to 2015”

Indeed, India has launched several initiatives to create aggregated data portals and visualisation tools. The government created a national open data portal (data.gov.in) in 2012 to increase transparency in public affairs and make data available to the public to encourage its innovative use. Currently, the portal offers access to data from more than 170,000 resources, including data and documents published by various government departments and agencies, and has registered 5.72 million downloads and 15.73 million views.[289] The site is comparable to national open-data platforms launched elsewhere. In the United Kingdom, for instance, the government portal data.gov.uk contains more than 40,000 data sets from 1,411 publishers.[290] The UK government portal also enables users to mark a region on a map and ask the portal to search for data sets for that region.

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[287] Åse Dragland, *Big data, for better or worse: 90 percent of world’s data generated over last two years*, SINTEF, May 22, 2013.

[288] *The age of analytics: Competing in a data-driven world*, McKinsey Global Institute, December 2016.

[289] Open Government Data (OGD) Platform India, April 25, 2018.

[290] Speech on open data, Francis Maude, delivered at Open Data Innovation Community event in Birmingham, March 14, 2012.

Government agencies can expand the coverage and scope of open data and dashboards in the future, and they can harness data for specific applications and use cases to improve the economic and social lives of citizens. For example, so-called JAM data — from the Jan-Dhan financial-inclusion scheme, Aadhaar ID cards, and mobile phones — can be used to better target the allocation of government subsidies.

Government agencies around the world are achieving analytics-based impact. A South American country used machine-learning algorithms on geospatial data to predict patterns of disease transmission and developed proactive measures against the Zika virus.[291] It allowed optimised actions by identifying transmitter municipalities and ensured proper assessment of all municipalities.

Beyond the government, private-sector enterprises in India will be active users of data analytics and visualisation. Companies are likely to invest more aggressively in data and analytics capabilities, building data centres, cloud storage solutions, and analytics software platforms, and in hiring or upskilling employees knowledgeable about using data and analytics to drive business impact. Innovating to serve such clients will enable India's digital companies to evolve to address an international need for data-driven analytics. In fact, India could emerge as a global hub. The value of India's data analytics industry is projected to rise to $16 billion by 2025.[292]

The right policy framework and adequate collaboration by stakeholders are necessary to lay the groundwork for the development of new and innovative use cases to deliver value to the government as well as its citizens.

Initiatives already under way

In addition to establishing a national open data portal that can be used by a wide variety of private-sector and civil society entities, the government has initiated several data visualisation efforts for its own agencies and arms. For example, the Electronic Transaction Aggregation and Analysis Layer, or eTaal (etaal.gov.in), captures state-level data on e-services from 21 central ministries.[293] It offers analysis of transaction counts in tabular and graphical forms to give a quick view of e-governance projects. Another data visualisation initiative, the Ministry of Power's UJALA dashboard (ujala.gov.in), provides live updates on a government programme to reduce energy consumption by distributing LED light bulbs. The data includes the total number of LED bulbs distributed statewide and what it means in energy and cost savings, greenhouse-gas reduction, and avoidance of peak electricity demand.

Several state governments have launched data visualisation platforms of their own. In Andhra Pradesh, for example, the CORE (Chief Minister's Office Realtime Executive) dashboard displays data from each state department in charts, tables, and maps. These and other data visualisation initiatives are outlined in Exhibit R3A. Exhibit R3B displays a visualisation tool designed for policy makers to identify the impact of multiple policy scenarios on citizens and the economy. The government body uses social media sentiment analytics to understand citizens' perceptions of any policy change. An interactive visualisation dashboard was developed to enhance the decision-making experience.

> "India could emerge as a global hub. The value of India's data analytics industry is projected to rise to $16 billion by 2025"

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[291] *Combating Zika and future threats, A grand challenge for development*, USAID.gov webpage.

[292] *"Big data analytics to become $16 billion industry by 2025"*, Economic Times, July 3, 2017.

[293] *User and technical document: Electronic Transaction Aggregation and Analysis Layer (eTaal)*, National Informatics Centre.

EXHIBIT R3A

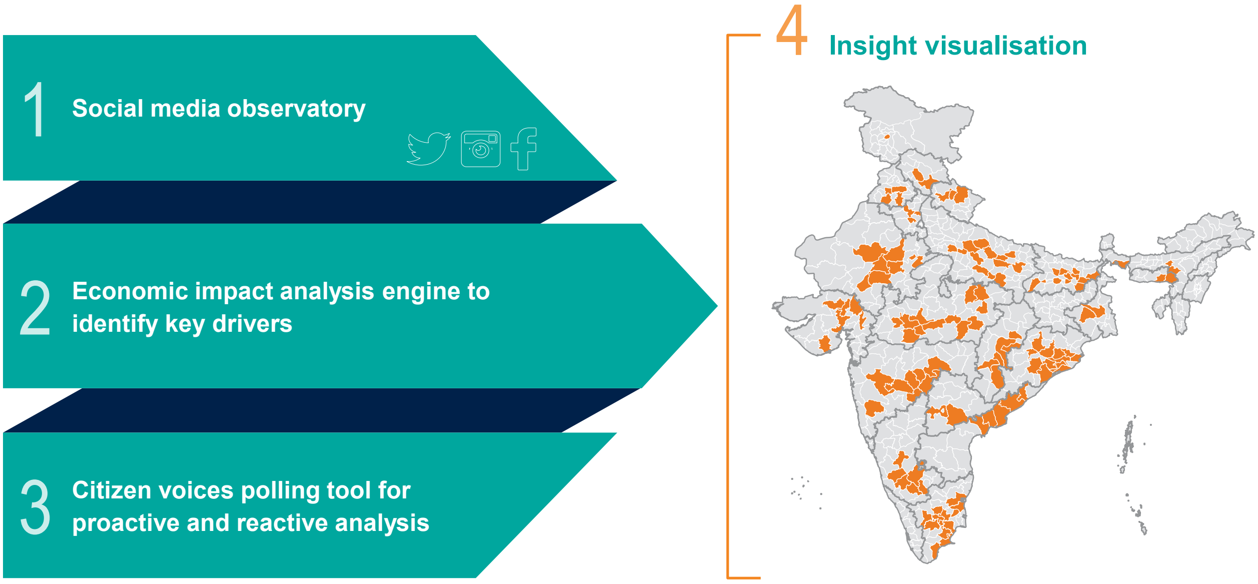
Government initiatives for real-time data visualisation and analytics

Organisation	Context	Solution	Impact
Government of India	- Open Government Data (OGD) Platform India, data.gov.in, is designed to increase transparency and enable innovative use of government data	- Government ministries and departments use the portal to publish data sets, documents, tools, and applications for public use	- More than 213,698 resources from 135 departments uploaded on the portal, which has recorded 17.1 million page views and 6.2 million downloads
Ministry of Electronics and IT	- The eTaal web portal distributes statistics on national- and state-level e-transactions, such as tax payments, utility bill payments, passport enquiries, and Direct Benefit Transfers as well as statistics about national and state e-governance activities, including mission mode projects	- eTaal presents analyses of transaction counts in tabular and graphic form to give a quick view of e-governance transactions - The portal aims to capture the quality and quantity ofe-transactions from central government to panchayat level	- The portal captures data from 3,630 e-services across 36 states and UT's, 22 mission mode projects, and 52 central government projects
Ministry of Power	- UJALA (Unnat Jyoti by Affordable LEDs for All) is an initiative to promote the efficient use of energy and encourage the use of energy-efficient LED lights by reducing their initial cost	- UJALA dashboard gives statistics such as total LED bulbs distributed statewide, energy and cost savings, CO2 reduction, and the avoidance of peak electricity demand, all in real time	- As of mid-April 2018 more than 296.2 million LEDs had been installed, saving 38.5 billion kWh of electricity and $2.3 billion per year
Government of Andhra Pradesh	- CORE (Chief Minister's Office Realtime Executive) dashboard displays and arranges every department's information in a single frame	- Data is displayed in form of charts, tables, maps - Frequency of data update varies with department - Dashboard refreshed daily to reflect latest information	- CORE dashboard integrates data from 33 state government departments
Government of the United Kingdom	- Data.gov.uk, which first appeared in January 2010, contains 45,067 data sets from 1,416 publishers	- Option to search and mark a region on a map and look for datasets for the selected region - The portal can generate graphical presentation of site analytics, page views, and annual data use statistics for different data sets	- Platform contains 425 apps made using data available on platform; one uses house price and gross disposable household income data sets to compare cost of living and quality of life in any two UK cities

SOURCE: Open Government Data Platform India, as of October 1, 2018; Ministry of Electronics and Information Technology; eTaal, as of October 1, 2018; National UJALA dashboard, as of May 2, 2018; CORE dashboard, as of May 2, 2018; data.gov.uk, as of April 23, 2018.

Exhibit R3B

Digital dashboards to enhance understanding of policy implications



1 Social media observatory

2 Economic impact analysis engine to identify key drivers

3 Citizen voices polling tool for proactive and reactive analysis

4 Insight visualisation

SOURCE: Expert interviews; research team analysis.

Potential actions to ensure accelerated progress

Data visualisation and analytics can scale rapidly with private and public collaboration, as long as the government acts to ensure that the following prerequisites are in place:

- **Clear definition of data sets to be shared and in what format and set open API framework.** To facilitate innovation, every government digital initiative needs to conform to the MeitY open API guidelines in the National Data Sharing and Accessibility Policy. The National Data Sharing and Accessibility Policy was designed to govern the release of government information. Ideally, all data sets not on a negative list (that is, data that departments have to be shareable) must be uploaded to an open platform, such as data.gov.in. But in practice, a lack of clarity in the national policy leads to varying interpretations by different departments and inconsistent data sharing on the platform. Also, formats are not consistent. Some data, for example, is uploaded in the form of scanned documents, which are not machine readable, and some data pulls require logins or captchas.

  Policy makers could streamline instructions to clearly direct government agencies and departments while uploading data sets to data.gov.in. The guidelines could clarify the criteria for selecting the data sets to be uploaded on the portal as well as the data format and file format. The open data must be machine readable, real-time and fine grained for good quality characterisation. The policy could recommend developing an API-based framework for each ministry for pulling specific datasets. It is worth mentioning that gov.in data could be restricted to open use by Indian organisations and companies only, to act as magnet for researchers and innovators to migrate to India.

- **Encourage interested parties to share data sets and develop use cases.** Currently, many government departments and private users are not aware of the benefits of having an open data platform and easy access to potential use cases. For example, approximately 400 apps use data from data.gov.uk.[294] The "Is the grass greener?" app, for example, uses data on house prices and gross disposable income to compare the cost of living and quality of life in any two UK cities. Citizens use this information while making relocation choices.

Usage of data.gov.in can be increased by developing specific use cases showing the value of data sharing and analysis, which will motivate private-sector and government entities to not only share data, but also develop apps using the data available. The not-for-profit National Institute of Smart Governance, incorporated by the Government of India and NASSCOM in 2002 to extend e-governance services in the country, is working on identifying and developing analytics use cases in government.

- **Public and private infrastructure to support open data policy.** Many government agencies and departments lack stable internet connections, up-to-date equipment, a variety of statistical tools, and workers with the background and aptitude to run analysis and troubleshoot. The situation is similar at some private-sector organisations.

  Ministries and agencies in association with the national policy's project management unit must take steps to ensure adequate infrastructure and capabilities in different departments to support the use of data. A central agency can be assigned the responsibility of monitoring the availability of infrastructure and skilled labour at every relevant organisation.

- **Concerted action to create a pipeline of trained data scientists working on real projects.** The government could set up one or more Centres of Excellence to leverage its big databases, such as the Goods and Services Tax Network, digital payments, health records, and the census. These could be established as academies for applied data sciences, set up in collaboration with universities and IT industry partners such as NASSCOM, to build a pool of high-calibre data scientists and promote R&D in data-driven analytics for companies in India and the world.

- **Commitment to creating open dashboards and using them to accelerate momentum in priority areas.** Both central and state government departments and agencies could be more committed to creating digital dashboards to track projects and identify bottlenecks at an early stage. The CORE dashboard launched by the government of Andhra Pradesh helps the chief minister's office track all projects in the state across departments. Different states and central departments can use similar dashboards.

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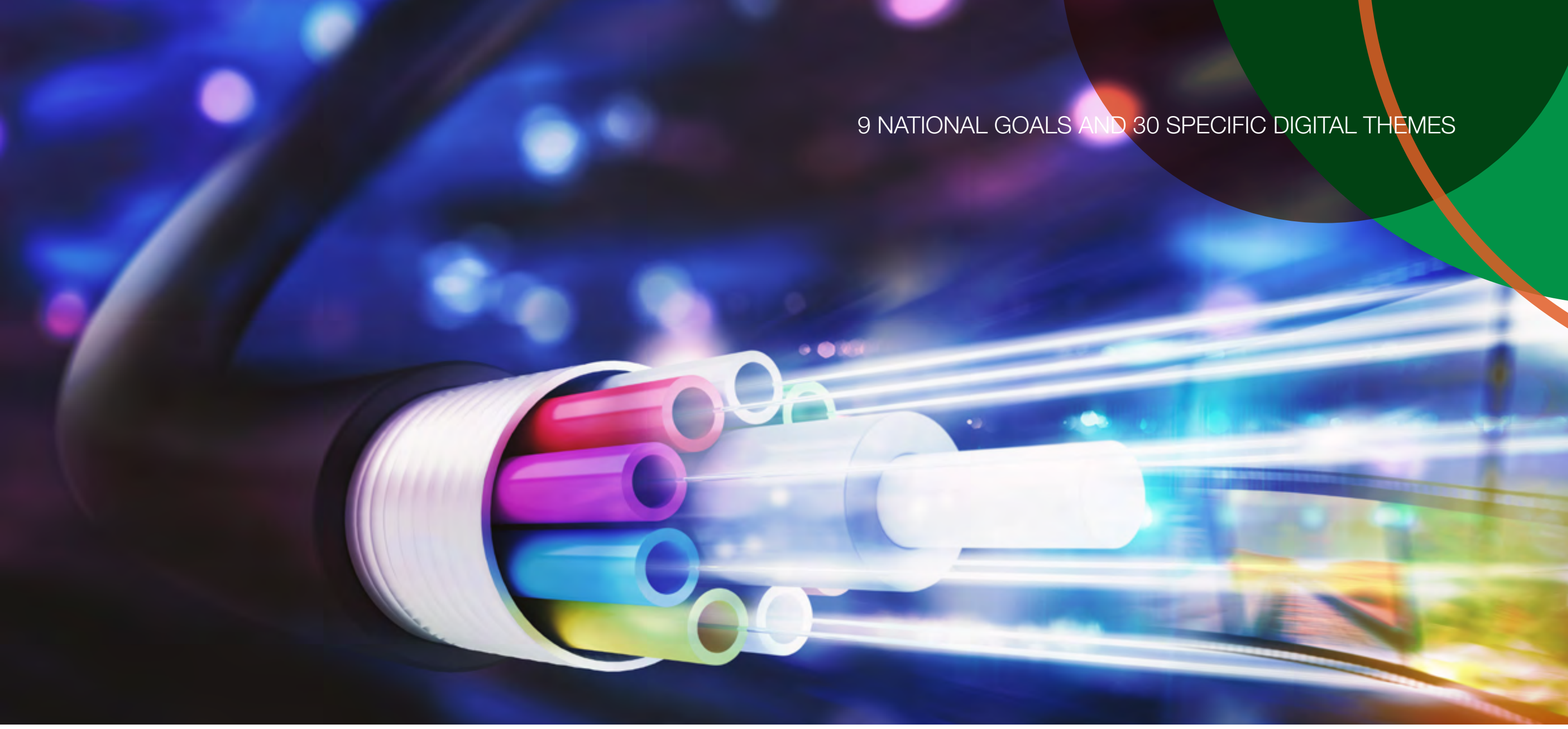
[294] *Almost 400 apps that use UK gov open data",* a case study by LinkedData.Center.



4. Visual broadband for everyone

Vision and potential impact

Realising value from digital applications is contingent on three prerequisites — high-speed internet connectivity at affordable rate, availability of smart devices to every Indian, and digital applications that add value for consumers in a variety of areas. In this chapter, the focus is on the first condition. The vision of ubiquitous, affordable, reliable high-speed internet connectivity can be achieved by:

- Setting a new aspiration of visual broadband for all: two-way, 20-megabits-per-second (Mbps) data transmission speed for each household using fibre-to-home technology by 2025
- Developing a public-private partnership framework to bring new visual broadband access to homes, using BharatNet infrastructure and current multisystem operators and local cable operators
- Encouraging investment by both the government and private operators, depending on feasibility, following recommendations from an expert body on overall broadband architecture
- Setting fibre optics as the core infrastructure layer for all delivery technologies (Wi-Fi, 4G, and 5G)
- Sharing fibre-optic infrastructure with national and local operators or cooperatives for last-mile broadband access
- Supporting policies, regulations, and enforcement mechanisms to elevate the status of fibre and internet infrastructure and provide rights-of-way

All stakeholders can benefit from better connectivity: consumers can gain access to high-quality services, making every citizen — even in the most remote areas — both a service consumer and a service provider; state governments can roll out use cases that matter the most to their citizens; and telecom players and other local operators can participate in a new wave of provider services on attractive terms, with their biggest barrier of initial fibre infrastructure addressed. The steps outlined in this chapter can enable India's digital economy of the future, but if they do not come together, a significant portion of the potential value may remain unrealised.

India needs to set an aspiration of visual broadband for all

India's considerable progress on mobile internet adoption through 3G and 4G notwithstanding, the country still has a long way to go before every citizen can leverage the transformative power of digital applications. India's average mobile download speed is 9.9 Mbps, but developed countries have long since targeted and achieved higher speeds.[295] In the United Kingdom, the current average mobile download speed is 29.2 Mbps, Germany is at 31.7 Mbps and the United States is at 32 Mbps.[296] In terms of establishing a goal, the European Commission's broadband policy sets its strategic objective for 2025 as “access to download speeds of at least 100 Mbps to be upgraded to one gigabit per second (Gbps) for all European households”.[297] Sweden has envisioned a bandwidth speed of 100 Mbps by 2020 to 90 percent of households.[298] Taiwan has an aspirational speed of one Gbps by 2020 to all rural areas, and Israel of one Gbps to 70 percent of all homes and businesses by 2020.[299] Emerging economies such as the Philippines have also envisioned a bandwidth speed of ten Mbps by 2020 to 100 percent of households.[300] China started its broadband strategy study in 2009, and in its 12th Five-Year Broadband China plan it envisioned fixed broadband service to 50 percent of homes and businesses by 2015, and 70 percent by 2020. China has set data-speed goals of 50 Mbps in urban areas and 12 Mbps in rural communities.[301]

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[295] Speedtest Global Index by Ookla, November 2018.

[296] Ibid.

Public Wi-Fi hotspots can also offload mobile data overload to fulfil users demand of internet on the go. The CISCO report estimates that Wi-Fi and mobile devices will account from 51 percent of IP traffic in 2016 to 63 percent in 2021. The number of public Wi-Fi hotspots are set to increase from 94 million in 2016 to 541.6 million in 2021 globally.[302] There are currently only 31,000 public Wi-Fi hotspots in India, compared to 13 million in France and 10 million in US.[303] National Digital Communications Policy 2018 has also set a goal for 5 million by 2020 and 10 million public Wi-Fi hotspots by 2022.[304]

What, then, should India’s aspiration be for ubiquitous, affordable, reliable high-speed internet connectivity, consistent with the trillion-dollar digital opportunity? To achieve that aspiration, India will need to ensure affordable access to a new visual broadband standard, which this report defines as two-way 20 Mbps per household, by 2025. The new goal of providing visual broadband to all is far more ambitious than the current broadband target of 512 kilobits per second, in keeping with the continuing evolving digital needs and opportunities of the future.[305]

The convergence of voice, video, and data services is already a well-recognised reality among India’s telecom policy makers. Telecom networks will increasingly be used to deliver video and video-on-demand services. India’s trillion-dollar digital opportunity only underscores the need to raise aspirations. Some digital applications in the future will, no doubt, be delivered through simple text and unstructured supplementary service data (USSD) on basic feature phones, but many important opportunities can be tapped only if digital product and service innovators are able to deliver interaction-intensive and visual content–rich services that require fast, high-definition video transmission capability in a highly personalised and inclusive way. Over time, most critical services relating to education, health, and business are likely to move from high-definition to always-on virtual reality.

Some examples of such applications appear in the relevant sections of this report, which discuss the expansion of service consumers and how home entrepreneurs also become service providers. The examples are: high-definition video-based tutorials from world-class faculty for students in higher education; video-based tutorials and face-to-face coaching for students who need assistance in areas such as reading; interactive game apps involving 3-D computer-based environments to help preschool students develop early literacy skills; video-based consultation and diagnosis by medical specialists, including access to high-resolution images; and internet-based video chatting systems that allow pregnant women to consult obstetrician-gynaecologists in real time.

Beyond providing services to individual consumers, a range of small and medium-size enterprises (SMEs), including women entrepreneurs working from their homes, can become service providers using high-quality video calls to learn new skills, access e-commerce platforms, and build remote relationships with suppliers and customers. SMEs that use the internet intensively could have more financial growth than those that use it less. An SME that uses ten gigabytes (GB) of Internet data per month on average realises 7 to 32 percent more revenue, 8 to 43 percent higher profit, 13 percent higher employment, 22 percent higher employment growth, and 18 percent more customers than an SME using only five GB.[306] Many home-based women entrepreneurs find they can leverage technology to earn more money. For example, internet access enables women in a Jordanian village to find new markets for their handicrafts. In Senegal, women farmers were able to access market prices and get inputs for their food processing activities.

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[297] *Connectivity for a European gigabit society*, European Commission, October 19, 2017.

[298] Letter from the secretary of the Telecom Regulatory Authority of India to the secretary of the Department of Telecommunications, May 24, 2016.

[299] *Digital Israel — national initiative*, Embassy of Israel in India, February 3, 2014.

[300] *National Broadband Plan*, working draft, Department of Information and Communications Technology, Republic of the Philippines, March 3, 2017.

[301] *12th Five-Year Plan for the internet sector*, People’s Republic of China, May 2012; Phillippa Biggs and Youlia Lozanova, *The state of broadband: Broadband catalyzing sustainable development*, Broadband Commission for Sustainable Development, September 2017; China Academy of Information and Communications Technology.

[302] *The Zettabyte Era: Trends and Analysis*, CISCO, June 2017.

[303] *Report on TRAI Public Open Wi-Fi Pilot*, TRAI, April 2018.

[304] *National Digital Communications Policy 2018*, Department of Telecommunications, May 1, 2018.

[305] *Consultation paper on data speed under wireless broadband plans*, Telecom Regulatory Authority of India, June 1, 2017.

Along with their social and consumer relevance, superior broadband platforms are essential to foster the emergence of online giants in gaming, social networking, and e-commerce, and for advancing healthcare, education, and other areas pivotal to the digital economy.

High-definition (HD) videos from massive open online courses such as BYJU, national programme on technology enhanced learning (NPTEL), and Khan Academy require high-bandwidth connections for students to easily read from display boards or virtual whiteboards. HD cloud gaming content with streamed video and ultra-low latency requirements necessitates download speeds of 20 Mbps. Regular telemedicine applications require ten to 100 Mbps of bandwidth, while HD requires 100 Mbps to one Gbps.[307] Low latency is also essential to ensure no noticeable delay in exchanging information — this is important for applications that depend on real-time communication and high-resolution images, such as remote medical diagnostics and remote-assisted surgery.

India's demographics make a further case for the need to rapidly leapfrog the text-based internet environment and embrace one based on voice and video. With access to HD video, India's massive young population — children who typically learn or study at home for several hours a day — can be given a head start on learning quality, with much less fatigue and eyestrain. Similarly, the segment of Indians with low reading proficiency is quite large — as a proxy, some 52 percent of the population has just primary education or less.[308] In such a context, the audiovisual medium would be much more inclusive and empowering than one expecting users to read text-heavy content online.

It is important to recognise that the goal of visual broadband implies a continually moving target. While HD video streaming can take five to eight Mbps of bandwidth (according to the US Federal Communications Commission), over time bandwidth need could more than quadruple to about 125 Mbps per person, in line with the delivery of 4K or 3-D experiences, and newer immersive augmented reality and other technologies.[309] Therefore, while India plans to achieve the immediate goal of 20 Mbps for all households, it must not lose sight of how quickly the target will become 100 Mbps or 500 Mbps over the next decade or so, as the virtual and real worlds truly start merging.

To achieve the aspiration of visual broadband for all, a fibre backbone is essential

The need to provide the new standard of visual broadband at an affordable price — and make "affordable supply" the trigger for explosive adoption of digital services — cannot be overstated. India's experience has shown that exponential growth in data consumption comes when bandwidth availability goes up exponentially at very low cost. Data consumption has increased by almost 33 times over the last four years, primarily because data prices have declined 96 percent since 2013. The average consumer in India pays less than 0.31 cents a month for mobile data and voice, down from $12.45; this can be considered the affordability benchmark for even lower-income segments of Indians.[310]

A range of technological options exist to provide consumers across the country with high-speed broadband, including laying fibre to the home, using a mix of fibre and wireless depending on the usage and terrain, and relying predominantly on wireless technology. The two main criteria to determine the optimal technology strategy could be the cost of infrastructure and its scalability for the future. In any scenario, fibre will play an essential role. Experts have estimated that investing in fixed fibre infrastructure is more cost-effective than a capital-intensive tower infrastructure setup for

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[306] *Unlocking the potential: Internet's role in the performance of India's small and medium enterprises*, Federation of Indian Chambers of Commerce and Industry, July 18, 2013.

[307] *Broadband: The lifeline of Digital India*, Deloitte, November 2014.

[308] *Education for all 2000–2015: Achievements and challenges*, UNESCO, 2015.

[309] Broadband speed guide, US Federal Communications Commission.

[310] Analysys Mason, as on January 09, 2019.

4G technology, at current costs, and based on certain technology architecture assumptions.[311]

A range of broadband roll-out models have been used in different countries to deliver broadband service, whether through fibre or a mix of fibre and other technologies. Government-driven models tend toward fibre-based deployments, complemented by copper wire or mobile in lower-density and lower-income areas. More market-driven models see a coexistence of technologies (fibre, wireless, mobile, and cable) deployed by private players. The broadband roll-out models in use are:

- **Infrastructure-based competition.** In this model, private providers build independent infrastructure platforms and compete with one another, similar to the mobile industry in India. Competitors undertake investment in their own infrastructure, so investment flows naturally to areas where customers with the potential for high return on investment are concentrated (for example, urban or high-value consumers). South Korea's government designed an infrastructure-based competition model with heavy private player involvement, as 83 percent of its population was in urban areas where private competition was viable.[312] South Korea offered new licences to private players that competed on price, with Korea Telecom emerging as a leader. The United States has also adopted an infrastructure-based competition model where three or more broadband providers are available to 85 percent of the population.[313]

- **Government-funded operator deployment.** This model is considered where demand for broadband is sufficient to attract the private sector but where creating an acceptable investment case requires additional support, such as investment incentives, regulatory relief to incentivise existing operators, or a split in ownership and risk sharing between the public and private sectors. Malaysia has established a public-private partnership majority owned by Telekom Malaysia (of which the government owns less than 30 percent).[314] Indonesia has $207 million invested in public-private partnership projects such as the Palapa Ring project for high-speed broadband access in urban and rural areas, which the Finance Ministry funded through the Universal Service Obligation Fund.[315]

- **National fibre company.** The national fibre company model may be appropriate in countries where the government wishes to exercise control over key technical decisions, or local innovation is important. Australia, New Zealand, Qatar, and Singapore have created national fibre companies to deliver nationwide high-speed broadband. Singapore has separate consortia that operate passive and active infrastructure on an open-access basis. The government owns infrastructure (dark fibre) and has partial ownership in operating consortia.

India has adopted a state-sponsored model for national broadband connectivity through its BharatNet programme. In BharatNet's second phase, the Government of India aims to lay fibre to all 250,000 gram panchayats by the end of 2018, providing at least one Gbps access up to that point.[316] It then plans to lease out the connection to private businesses to roll out local networks for last-mile connectivity.

Initiatives already under way

Meanwhile, state governments in India and private companies also have run broadband roll-out plans in Exhibit 4.

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[311] Expert analysis: Lalitesh Katragadda, Chief Architect of AP FiberNet

[312] Urban population (percent of total), World Bank Open Data; *World urbanization prospects: 2014 revision*, UN Department of Economic and Social Affairs, 2015.

[313] National Broadband Plan website, Federal Communications Commission.

[314] Capital structure, Telekom Malaysia Berhad, as of January 31, 2018.

[315] Elly Burhaini Faizal, "Palapa Ring project to bring faster internet to Indonesia", *Jakarta Post*, March 21, 2016.

[316] "Govt starts BharatNet Phase 2, aims 100% connectivity by 2020", *Times of India*, November 3, 2017.

EXHIBIT R4

Countries have adopted multiple models for providing high-speed broadband connectivity

Organisation	Context	Solution	Impact
AP FiberNet	▪ Andhra Pradesh incorporated AP State FiberNet Limited in October 2015 to establish an optical-fibre network in the state, covering all 13 districts, to provide affordable end-to-end broadband connectivity of 15 Mbps for households and 1 Gbps for institutions.	▪ Optical-fibre networks consist of overhead cables laid on the existing electricity infrastructure; this arrangement has helped keep the overall project cost under $51 million ▪ Local cable operators, multisystem operators, and telecom service providers have equal access to this infrastructure to provide last-mile service in a non-discriminatory manner through telecom, internet, and cable boxes to every household in the state	▪ By 2016, AP State FiberNet had laid 23,000 kilometres of aerial fibre and enrolled over 12,000 local cable operators and 1,200 multi-system operators as business partners. ▪ For $2.30 per month, the basic service plan provides 15 Mbps speed and a 5 GB usage limit.
Infocomm Media Development Authority (IMDA), Singapore	▪ Wireless@SG programme by IMDA is a government initiative that offers free broadband Wi-Fi to the public ▪ The service provides tourists, students, business travelers, and others with seamless indoor and outdoor wireless broadband service	▪ Local wireless operators developed and run the system ▪ Initial speeds offered were of up to 512 Kbps. Revised to 1 Mbps in 2009 and to 2 Mbps in 2014 ▪ Free basic service will be available until March 2019, two years longer than initially planned ▪ Paid enterprise solutions also available ▪ Users can sign up via a mobile app, web browser, SMS/OTP, customer service centres, or by using a SIM-based login. In April 2017, extended automatic login to non-SIM devices, thus eliminating the need for usernames and passwords	▪ Currently, five operators (Singtel, M1, Starhub, Y5Zone, and MyRepublic) participate ▪ 10,000 hot spots running at 5 Mbps are available at public spaces such as train stations, libraries, shopping malls, and restaurants ▪ IMDA plans to double the network of hotspots to 20,000 by 2018
Skanova, Sweden	▪ Skanova, the broadband access arm of Sweden's TeliaSonera, offers a wide range of open-access models, where an infrastructure provider grants access to all service providers on equal terms ▪ This has laid the foundation for a vibrant and competitive broadband to increase fibre-to-the-home (FTTH) penetration	▪ Skanova provides network capacity to internet service providers, telecom operators, and municipalities, which are free to choose their own third-party service providers ▪ These companies provide services such as fixed and mobile telephony, cable television, and broadband to businesses and individuals ▪ Skanova also offers advice on building networks, such as how to align a planned FTTH build with existing utilities infrastructure so as to make more efficient use of ducts, reduce costs and minimise disturbance to the local community	▪ Skanova provides wholesale broadband access nationwide to 160 service providers, including TeliaSonera and municipalities ▪ The goal is to equip 90% of Swedish households with 100 Mbps access by 2020

SOURCE: Andhra Pradesh State FiberNet Limited website as of April 25, 2018; Info-communications Media Development Authority; "Case Studies Collection", FTTH Council Europe, 2015.

> “The government needs to define a differentiated approach for fibre roll-out to every household across three archetypes: cities, urban hinterlands, and rural areas”

Potential actions to ensure accelerated progress

A differentiated fibre roll-out strategy with policies to support government and private-led investment is essential to accelerate progress. The public-sector implementation body could be in a special purpose vehicle structure similar to the Unique Identification Authority of India or Delhi Metro. This would have the advantage of enabling the best talent to lead the roll-out and manage major costs and timelines rather than relying on a pure government-led initiative.

Urban and rural areas have distinct challenges, such as different physical constraints in setting up infrastructure, different levels of market demand, and varying types of internet applications, and so they must be addressed in different ways. High-density urban areas have a high demand for broadband with a proliferation of use cases and the ability to pay, but may still face inadequate supply due to high deployment costs and lack of investment. Rural areas have an urgent need for broadband, at both the gram panchayat and household levels, but current ability to pay is relatively low, meaning low return on investment for private infrastructure providers. Yet rural areas can represent much higher demand in the future, as the supply of affordable broadband increases.

The following principles can help ensure meaningful participation for all types of players and service for all types of consumers:

- **Cross-cutting enablers.** The government needs to define a differentiated approach for fibre roll-out to every household across three archetypes: cities, urban hinterlands, and rural areas. Some cross-cutting enablers would be relevant to all three. For example, the government can:

  - Establish a committee of leading technology experts, innovators, and engineers in broadband technologies. National roll-out is an expensive exercise and needs an optimised system design plan. An expert body would be better able to objectively evaluate design and technology specifications, policy matters, bid documents, and guidelines than designated managers under a conventional approach based on consensus.

  - Set up an independent organisation to track key broadband access metrics such as average current speed, penetration rate, and number of mobile and fixed broadband users.

  - The committee could look to develop a broad modular or phased-in approach for each geographic archetype (city, hinterland, and rural) that first builds on existing infrastructure and then upgrades. For instance, an overhead fibre-laying plan leveraging existing electricity poles can be used immediately as a first phase, and later augmented with a deeper and more expensive civil construction-intensive effort to provide broadband. Loops may be closed in villages using electrical lines if road loops are impractical.

  - Policy that the design of all new infrastructure projects (electricity, road, rail, and water) incorporates underground ducts with fibre laid in them. This distributes the high cost of laying underground fibre through parallel instalments using structures such as honeycomb ducts. A policy mandate would be required for the pertinent ministries to work together to deploy multiple utilities.

  - Increase sanctions for tampering with fibre infrastructure. Tampering with roadways or rail lines is a criminal offence, but tampering with overhead fibre is treated as a minor act of mischief. Along with legal provisions and regulations, the government could make clear whether enforcement falls under central, state, or municipal jurisdiction in order to improve accountability.

  - Ensure that building codes include minimum fibre elements, as they do for electricity, water, lifts, fire, and safety. Every building must pull fibre from an interconnect to every dwelling, store, or other unit. Occupation certification inspection will require fibre at minimum speeds to be mapped and certified digitally.

  - Encourage indigenous buildout of both fibre and electronics, while adopting best-in-class open protocols, open standards, and APIs.

  - Introduce quality certification of internet providers to ratify telecom and cable operators on technical parameters. This would allow for multiple players to provide quality service to consumers in a fair competitive market.

- **Approach for urban roll-out.** The private sector could take the lead in providing fibre to every urban home in the Phase 1 roll-out, enabled by transparent right-of-way rules. The high price of rights makes the creation of infrastructure economically unviable for private players. The process of securing right-of-way permission is complicated and varies between states. To address this, the government can:

  - Reform and standardise right-of-way guidelines, with an enforcement body at the state or city level regulating access to a defined area. Mandating timely decisions on right-of-way applications, having defined periods of clear access, and offering simplified and transparent payment options will all support urban fibre deployment.

  - Encourage states to emulate best practices — for instance, Rajasthan has a clear policy direction on right-of-way access that could be adopted by other states.

- **Approach for rural roll-out.** In rural areas, the difficult task of ensuring a minimum of 20 Mbps broadband in every household requires the government to take a lead role. The current BharatNet programme is rolling out the fibre infrastructure backbone up to the gram panchayat level. In this first national roll-out phase, different technology options can deliver required connectivity speeds of 20 Mbps to every rural household based on local geographic and market conditions. For this, the government can:

  - Extend services over the so-called last mile (from gram panchayat to household) in a range of ways, regardless of medium, through technologies customised for local factors. Last-mile connectivity models depend on internet uptake levels (fibre can deteriorate over time when it is not used), so demand and application usage patterns are factors to consider. Technologies such as 3G, 4G, Wi-Fi hotspots, coaxial cable, and aerial or underground fibre can be used, based on topography, weather conditions, existing tower infrastructure, and housing density. Private-sector telecom companies, internet service providers, and cable operators can modify technologies once rural market demand is discovered.

  - Expedite installation of high-quality fibre on mission mode to the gram panchayat level, which is scalable for higher data use, bandwidth, and fibre-to-home service in Phase 2 of the roll-out. Fibre reaching the gram panchayats under the National Optical Fibre Network programme can be of inadequate quality or capacity, meaning that last-mile connectivity is not established or that it quickly reaches maximum capacity. High-quality fibre of adequate capacity could be laid via high-tension power lines, sewers and canals, surface infrastructure like roads and rail lines, and ultimately the digging of ducts — in order of priority — to optimise speed and cost.

Increasing broadband connectivity will increase demand for digital content, especially in the media and entertainment industries (see Box R1, “Digital in media and entertainment”).

Box R1. Digital in media and entertainment

Improved digital infrastructure and increased mobile penetration have had a profound impact on the media and entertainment industry. Digital video and music streaming as well as gaming are all growing rapidly, and mobile is the primary channel. Moreover, technologies such as augmented reality, virtual reality, artificial intelligence, and natural language processing are all helping to customise and enhance the user experience.

Advertising is the primary source of revenue for digital media and entertainment, contributing $1.2 billion in 2016, and is expected to grow 30.8 percent annually.[254] Going forward, newer revenue streams, such as subscription fees for video and music streaming and in-app purchases for gaming, will also pick up pace.

Over the top (OTT) video streaming

With the growing popularity of so-called over-the-top (OTT) video — direct-to-consumer transmission via the internet and music has transitioned from a niche market to a mass entertainment option. In India, this has been possible on the back because of the nationwide roll-out of 4G services and the declining price of 3G/4G broadband internet. Mobile is emerging as the primary screen for watching video because it offers personalised viewing at lower costs, whereas TVs are household goods with significant investment.

The ecosystem for OTT video is evolving rapidly. Major global platforms such as Netflix and Amazon Prime Video are also independent video-on-demand platforms producing or coproducing local original content. Broadcast networks in India have developed captive OTT video platforms such as Hotstar, SonyLive, and VOOT. Traditional production companies have also launched their own OTT platforms, such as Balaji ALT and ErosNow. Recently, telecom players have launched integrated on-demand services such as Reliance Jio's Jio Play and Airtel's Wynkto to build their distribution reach and promote data usage.

Original content is becoming an important differentiator and driver for OTT players. Major platforms are investing significantly in acquiring digital content, sometimes by partnering with independent content creators. The lack of censorship and predominantly young, urban, and educated audience are pushing creative boundaries beyond what is seen on TV.

There are two OTT business models. The ad-supported "freemium" model Advertising Video on Demand (AVOD) currently dominates due to Indian consumers' reluctance to pay for services. Subscription Video on Demand (SVOD) has worked well elsewhere — Netflix had 104 million streaming subscribers in 2016 — but it has not gained traction in India.[255] However, several growth enablers could lead to wider SVOD adoption in the future. These include the diversity of languages in India, the preference for regional content, the growing popularity of mobile as a medium, and a young demographic. OTT players can capitalise on this opportunity by providing personalised content, frictionless onboarding, and seamless digital payment options.

SVOD offers several benefits to content creators, distribution channels, and viewers. It opens up an alternate revenue stream for studios; film makers and other content creators are not limited by viewership numbers and time slots on specific TV channels; and it limits piracy as the latest content becomes widely available sooner.

For OTT platforms to survive in the long term, they will need to have a strong content and distribution capability. Telecom companies have direct access to consumers and are a key drivers of data consumption. They also have established payment networks. Combining the distribution strength of telecom operators with the content creation capabilities of media players could help to provide a superior experience to users.

Digital classifieds

The digital classified ad market is expanding at a compound annual growth rate of around 22 percent and is expected to reach $1.4 billion by 2021. This growth has been driven by increased internet access on mobile phones and affordable tariffs. The classified market comprises many segments at varying levels of development. The recruitment and matrimony segments are mature, while e-services, automotive, and horizontal classifieds are young and growing. Recruitment and matrimony, which contributed 25 and 17 percent of total digital advertising revenue, respectively, in 2016, are expected to fall to 20 and

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[254] Media for the masses: The promise unfolds, KPMG India—FICCI Indian media and entertainment industry report, March 2017.
[255] *Netflix tops 100m subscribers as it draws worldwide audience*, The Guardian, July 18, 2017.

15 percent by 2020. E-services, automotive, and real estate advertising are expected to rise to 5, 9 and 11 percent of revenue, respectively, by 2020, up from 3, 5, and 7 percent in 2016.

The growth will be primarily driven by two things: the introduction of auxiliary services — for example, wedding photography and catering in addition to matrimony ads — and the creation of localised platforms to serve customers in Tier 2 and Tier 3 cities.

Data visualisation tools and advanced analytics can also be leveraged to interpret data patterns and offer differentiated and customised solutions to customers, which can be easily monetised.

Digital gaming

The gaming industry in India was worth $543.08 million in 2016 and is projected to grow at a CAGR of 6.61 percent, in value terms, in the next five years.[256] Mobile gaming is driving growth, helped by the introduction of faster, cheaper internet-enabled mobile phones. Indians downloaded nearly 1.6 billion games for iOS and Android platforms combined in 2017, a 58 percent increase from 2016.[257] India's market is still at an early stage since most of the revenue comes from advertising, not in-application purchases (as seen in global gaming markets). Indians prefer "Indianised" games, such as those based on popular movies and TV shows including Sultan and Chhotta Bheem. There is a big demand-supply gap in this area, as statistics indicate only one out of the top 10 mobile games by downloads are from Indian developers. Domestic game makers can seize this opportunity by building capability to compete with global players in app development.

Augmented reality and other new digital technologies are also enhancing the gaming experience — and raking in revenue. Pokemon Go, a game based on augmented reality, has surpassed 752 million downloads and generated $1.2 billion in revenue for its maker, Nintendo.[258] These technologies could be a key differentiator in the industry going forward.

Digital news

A World Press Trends survey in 2016 reported that at least 40 percent of global internet users read newspapers online, and in most developed countries readership on digital platforms has surpassed that in print.[259] India is expected to follow similar trends in the future, as more mobile devices and faster internet service spreads across the country. Newspapers are increasingly adopting new digital technologies. Currently, Times Internet, the internet subsidiary of The Times of India Group, is the biggest player in this sector, capturing 51 percent market share of digital news consumption in India, and over 250 million monthly users.[260] The Hindustan Times has hired a mobile editor to build a team of over 700 journalists specialising in mobile journalism. Digital news startups such as The Quint, Scroll, The Wire, Khabar Lahariya, Daily Hunt, and InShorts are developing chat apps, podcasts, and other new ways to deliver digital news in India. The key enabler of growth in this sector will be local-language content, which will drive penetration of digital news providers.

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[256] Emerging Trends in India Gaming Industry, TechSci Research, Confederation of Indian Industry, February 2017.

[257] Media for the masses: The promise unfolds, KPMG India – FICCI, Indian Media and Entertainment Industry Report, 2017, March 2017.

[258] Mike Minotti, Pokémon Go passes $1.2 billion in revenue and 752 million downloads, Venturebeat, June 30, 2017.

[259] Rahul Kumar, 40% global internet users read news online, reveals Wan-Ifra's World Press Trends Report 2016 survey, *PrintWeek India*, March 21, 2017.

[260] Times Internet leads digital news usage with 51% share, *Times of India*, July 5, 2017.

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Goal B: E-governance of the future

Delivering an end-to-end digital transformation of the way government spends money and delivers services

5. Government e-Marketplace

Vision and potential impact

India's central government, departmental enterprises, and nondepartmental enterprises procure goods and services totalling about 13 percent of GDP, which amounts to some $300 billion annually. The Directorate General of Supplies and Disposal, which closed in 2017, negotiated the contracts that governed procurement by most central and state government departments, agencies, and Public Sector Undertakings (PSUs).[317] In August 2016, the government set up the Government e-Marketplace to digitise the public procurement process.[318] GeM, as the service is known, was conceived with three primary goals in mind: a) significantly reducing administrative and transaction costs on routine purchases; b) eliminating multiple levels of verification and decision making in order to bring down lead times in procurement; c) adopting a digital channel for financial transactions. As GeM scales up to its full potential, it can play a vital role in catalysing more efficient, inclusive, and transparent procurement, thereby opening up opportunities to many new segments of vendors — both large companies and SMEs — around the country.

GeM is a full-stack open-source application platform, making it easy to expand the system's size and scope as necessary. As of October 2017, GeM had reduced the time required to approve a vendor to just 20 minutes. The portal's features include e-commerce functionalities such as easy search, price comparisons, selection, order placement, e-bidding, reverse auction, demand aggregation, dynamic pricing, integrated payment system, and vendor assessment and rating.

GeM requires vendors to share their documents through DigiLocker. Contracting is done through digitally signed e-contracts between the buyer and the seller. GeM provides contract templates for every product and service category, giving buyers the option to customise them as needed. The government has linked its database of micro, small, and medium-size enterprises to GeM to provide these firms with easy access to benefits such as reduced bank guarantees. Payments have been routed through the government's payments and accounting network, the Public Financial Management System. GeM has also partnered with the Confederation of Indian Industry to raise awareness of the marketplace and encourage CII members to use the system.[319] It has also entered into several other collaborations; for example, with credit rating agencies empanelled by the Securities and Exchange Board of India for supplier assessment and rating; with the Quality Council of India, which serves as a knowledge partner and recommends frameworks for assuring quality in the procurement process; and with Common Services Centres to enable rural suppliers to register as vendors.[320]

GeM has expanded by entering into memorandums of understanding with 20 states and union territories to serve as their exclusive procurement channel.[321] It has also operationalised a pool account with Uttar Pradesh, a key step in making online payments the future standard for public procurement.[322] This step includes linking the state's financial management system with GeM, enabling individual registered and unregistered buyers to be part of the state's pool of buyers.

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[317] National accounts statistics, Central Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India.

[318] *Procurement made smart, Government e-Marketplace*, Ministry of Commerce and Industry press release, January 23, 2017.

[319] *Public procurement through Government e-Marketplace (GeM) to boost MSME sector*, Confederation of Indian Industry website.

[320] *Procurement made smart*, Government e-Marketplace, Ministry of Commerce and Industry press release, January 23, 2017; Memorandum of understanding for ensuring quality in procurement of goods and services through Government eMarketplace (GeM) between Quality Council of India and Government eMarketplace, December 29, 2017.

[321] *GeM 3.0 launched: Government e Marketplace announces national sellers on-boarding campaign*, Ministry of Commerce and Industry press release, January 30, 2018.

End-to-end implementation of GeM across all government departments, agencies, and PSUs in India could lead to annual savings of $10 billion to $25 billion by encouraging competition among vendors and the aggregation of orders. Further savings could be realised by reducing leakage in the value chain of payments.

Initiatives already under way

GeM already has signed up 27,978 buyer organisations and 143,751 sellers offering over 494,951 products and 4,920 services, its ultimate potential is suggested by an existing network, the Korean Online eProcurement System.[323] More than 50,000 public entities use KONEPS to connect with 340,000 suppliers who offer about 400,000 registered items. The South Korean government estimates that KONEPS saves it $1.4 billion per year by shortening lead times and streamlining ordering and fulfilment.[324] More details on KONEPS are in Exhibit R5.

Exhibit R5

South Korea's eProcurement system speeds purchases and saves money

Public Procurement Service, Republic of South Korea

- Korean Online eProcurement System (KONEPS) was established in 2002 to enable electronic procurement across the entire public sector
- To avoid duplication, KONEPS was designed to function as the comprehensive nationwide system

KONEPS has the following features:

- All public bid information is published on KONEPS, eliminating the need for checking other websites or official journals
- Signs and symptoms of illegal bidding practices are detected by using a corrupt activity analysis system and an informant reward policy
  - People who alert authorities to illegal e-procurement receive a reward of up to $10,000
- Through external linkage with central government bodies and local governments, supplier information is instantly updated and disqualified bidders are automatically rejected from participating in bidding
- The Fingerprint Recognition e-Bidding System terminates unlawful bid participation by allowing each user to tender for only one company by using a biometric security token
- To maximise user convenience, e-bidding using a smartphone is available
  - SMS alert service keeps registered users informed
- Through KONEPS e-Shopping Mall, government departments can check product price and quality, and place orders directly
  - Supplies can be sorted in categories such as excellent products, technology-certified goods, and green products

- 52,395 public organisations and 373,833 private firms interact through KONEPS with annual transaction totalling $87 billion in 2017
- Linked with 215 external systems including industry associations, product quality certificate authorities, etc.
- 24,532 items procured through the e-Shopping Mall in 2017
- Expected to save $4.5 billion annually through reduced lead times and streamlined ordering and fulfilment

SOURCE: Republic of Korea Public Procurement Service; as of April 23, 2018.

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[322] Memorandum of understanding, draft memorandum of understanding with state governments on the use of Government eMarketplace, October 9, 2017.

[323] Statistics, GeM website, as of September 27, 2018.

[324] *KONEPS best practice of e-procurement*, Public Procurement Service, Republic of Korea, December 2016.

> “A catalogue management system reducing ambiguity in specifications of goods and services will make buying decisions easier, while a rating feature for goods and services offered on the platform will promote quality”

Potential actions to ensure accelerated progress

GeM is growing and has added many features under GeM 3.0. Standardised bid creation and technical evaluation through tools such as quality- and cost-based selection can make the bidding process more automated and objective. The greater use of data analytics and a comprehensive audit trail made possible by capturing minute user details will make the procurement system more reliable. A catalogue management system reducing ambiguity in specifications of goods and services will make buying decisions easier, while a rating feature for goods and services offered on the platform will promote quality. Other features, including a multilingual platform, price comparison using third-party websites, online vendor assessment, and multiple-cart functionality, will contribute to making GeM more robust. Going forward, GeM can analyse purchasing history and other data in order to forecast demand for individual products and services at the ministry or department level. It also could add a customer relationship management platform to log queries and grievances from buyers and vendors.

GeM can realise its intended benefits if the government possibly acts to ensure that the following key prerequisites are in place:

- **Expand the scope of goods, services, and vendors on GeM.** The marketplace has been ramping up expansion in goods, services, and number of vendors. Along with the Confederation of Indian Industries, the Ministry of Commerce and Industry has launched GeM Samvad, a forum to raise awareness about GeM, seek inputs on the technical specifications of products and contracts of services to be procured by government agencies, and enrol more industry players on the platform.[325] Advertising also could expand GeM’s vendor base and the number of goods and services the platform offers. Further, the marketplace could enter into agreements with various industry associations to encourage their members to join GeM as vendors. The government is also looking at using GeM services for different government programmes, such as outsourcing IT service jobs to rural BPOs.

- **Increase GeM’s user base.** While the General Financial Rules mandate that all central government departments, agencies, and PSUs procure through GeM, not all state government departments, agencies, and PSUs are required to do so. Twenty states and union territories currently use GeM; the rest could also be mandated to purchase from it.[326] Awareness of the usage and benefits of the online marketplace could be created through seminars and workshops with state governments.

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[325] *Launch of GeMSamvad: The GeM-industry forum*, Ministry of Commerce and Industry, August 14, 2017.

[326] *GeM 3.0 launched: Government e Marketplace announces national sellers on-boarding campaign*, Ministry of Commerce and Industry press release, January 30, 2018.

6. Digital Land 2.0 for digitising land transfer, leasing, and tracking

> "To prepare for the next leap of Digital Land 2.0, the government first needs to complete the foundational Digital India Land Records Modernisation Programme, and put in place important enablers to realise the potential of digital land records"

Vision and potential impact

India has far to travel in its journey toward creating transparent, efficient, and deep land markets, a prerequisite to unlocking the economic value of land assets owned by rural and urban Indians. The country climbed in the World Bank's Ease of Doing Business rankings between 2016 and 2017, but on ease in registering property, it fell from138th to 154th.[327]

Digital land records can go a long way toward addressing the shortcomings of the present paper-based system and may raise the economic value of land assets by creating accurate real-time ownership records. Digital records also can benefit the government by making it easier to collect initial stamp duty and maintenance charges. The 2017 Economic Survey estimated that two cities, Bengaluru and Jaipur, are collecting no more than 5 to 20 percent of the property tax potential in their jurisdictions.[328]

Digitally accessible and accurate land records also are the key to achieving many of these objectives because they facilitate the exchange of accurate, up-to-date land records data, save access or legal dispute time, and increase efficiency. The government and private sector can leverage several use cases for digital land records. Banks can use digital land records when underwriting loans, and insurance companies could use them to assess risk when calculating premiums. Digital land records can help town planners by easing processes such as granting building approvals and designing sewage systems. Subsidies and benefits tied to land, such as housing loans and fertiliser subsidies, can be planned more efficiently. Courts can resolve property disputes expeditiously, and land acquisition by government could become simpler.

When the government initiated the digitisation of land records in 2008 under the Digital India Land Records

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[327] *Doing Business 2018*, World Bank, October 31, 2017.

[328] *Economic survey 2016–17*, Ministry of Finance, Oxford University Press, June 2017.

Modernisation Programme, it had four objectives: to have a single window to handle land records, including the maintenance and updating of textual records, maps, surveys, and settlement operations, and the registration of immovable property; to ensure that cadastral records mirror reality on the ground; to confirm that the record of title is a true depiction of ownership status, with automated ownership transfer (mutation) data following registration; and to issue title insurance, which affirms the title's correctness and indemnifies the title holder against loss arising on account of any defect.[329]

The first step toward achieving these objectives is the computerisation of land records. Records of rights, cadastral maps, mutation data, and other land attributes are being digitised though improvements in a digitally accessible and legalised format. So far, 31 of 36 states and union territories in India have computerised land records, including 86 percent of records of rights, 47 percent of mutations, and 46 percent of cadastral maps.[330] To prepare for the next leap of Digital Land 2.0, the government first needs to complete the foundational Digital India Land Records Modernisation Programme, and put in place important enablers to fully realise the potential of digital land records.

The accuracy of computerised land records could be verified, especially where one-time exercises of rapid data entry were followed without adequate verification.[331] Governments are making progress: 26 percent of cadastral maps have been linked to records of rights, and 15 percent of those records of rights are updated in real time. Many states are now conducting cadastral surveys where there are none and resurveying area where existing cadastral records do not reflect actual property boundaries and ownership. Surveys and resurveys have been completed in approximately 56,000 of the country's 640,000 villages. Surveys in urban areas that lack historical land records data could be prioritised. Initial analyses estimate that 55 million urban household surveys are required.[332]

Some simple steps can accelerate completion of land record computerisation and achieve more citizen benefit from computerised land records. For example, the government could financially incentivise the digitalised land-registration outcomes across states, and continue with the task of equipping subregistrar offices with adequate hardware, software, process reengineering, and training, in line with the progress that has been made in 30 of 36 states and union territories.[333] It could merge registration and revenue databases in all states to remove the duplication of effort required in updating each database separately. Also, a combined database could further be linked to banks, insurance companies, and others to simplify ownership verification. The government could also use mobile apps and web portals to enable people to access their digital land records.

Initiatives already under way

Some states have been pioneers in systematically digitising land records. Karnataka created a centralised land records database called Bhoomi and seamlessly integrated it with the Registration Department, Land Acquisition Offices, and banking system. Among the benefits of Bhoomi is a reduction in the time spent initiating ownership record mutations, which fell from 31 days to two days in 2010–11.[334] Maharashtra developed i-SARITA, a web application that centralises the administration and implementation of the registration process, reducing registration time from days to one hour or less.[335] Andhra Pradesh improved citizen access to digital land records with WebLand (webland.ap.gov.in), a first-of-its-kind service; the state also accepts digital signatures on legal records. More details on these initiatives can be found in Exhibit R6.

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[329] Digital India Land Records Modernisation Programme website as of April 24, 2018.

[330] Prachee Mishra and Roopal Suhag, *Land records and titles in India*, PRS Legislative Research, September 2017.

[331] Deepak Sanan, D.B. Gupta, and Prerna Prabhakar, *A pilot impact assessment of Digital-India land records modernisation programme*, National Council of Applied Economic Research, November 2017.

[332] Department of Land Records, Ministry of Rural Development, December 2017.

[333] Prachee Mishra and Roopal Suhag, *Land records and titles in India*, PRS Legislative Research, September 2017.

[334] *Electronic integration of BHOOMI with stakeholders, Karnataka*, National Informatics Centre and the Government of Karnataka Revenue Department, March 2014.

[335] Department of Registration and Stamps, Government of Maharashtra, 2013.

EXHIBIT R6

Digitised land records bring significant efficiency and transparency in the system

Initiative	Context	Solution	Impact
Bhoomi, Karnataka	Before the government digitised land records, farmers in Karnataka relied solely on village accountants to manually change or copy property records, including Records of Rights, Tenancy, and Crops (RTC) that are needed to borrow from a bank or sell property - The manual system had two major shortcomings: - Delays in changing ownership records (mutation) due to large volume of manual records - Inconsistencies in records as different agencies handling them were not linked	The government in 2002 began digitising RTCs and village maps in a centralised database called Bhoomi. In 2010, the database was made interoperable with 3 institutions: the Registration Department, land acquisition offices, and banking system All 3 institutions see the same—the latest—version of the RTC - Integration with registration: Registration change requests are verified with Bhoomi before the database is updated - Integration with banking system: Banks can ask to change RTCs through Bhoomi by placing a lien on a property - Integration with land acquisition: Changes in ownership due to acquisition, including court stays, can be updated on the database by a regional land acquisition office	- 20 million RTCs of 6.7 million farmers have been digitised - Average time required for obtaining RTCs reduced from 2.5 days (5 visits) to ~1 day (~1 visit) - Time taken for initiating mutations reduced from 31 days to 2 days - Total cost of obtaining single transaction of mutation reduced from $47 to $1.80 - 80% of people have to meet only one person at the kiosk compared to manual system, under which 61% of the people met 2–4 officials - 50% of bank branches in the state integrated with Bhoomi - All land acquisition offices integrated with Bhoomi
i-SARITA, Maharashtra	- State Govt of Maharashtra's Department of Registration and Stamps has records as much as 200 years old, having its roots during the British Rule in India - Initially involved only in registering and preserving of the records, the department later started collecting revenue as one of its major functions	i-SARITA launched in 2012 to centralise the whole administration and implementation of the registration process Web-based application developed by the National Informatics Centre (NIC), which connects the state's 480 subregistrar offices - A step forward from mere computerisation of data to complete digitisation of registration process - All the data collected during registration process at any subregistrar office is saved to the central server	- All 480 subregistrar offices in the state of Maharashtra are functional - Registration time has fallen to 1 hour (aspiration is 20 minutes) from days - More than 1 million documents registered statewide annually - Better representation of data on land acquisition for analysis and decision making for department heads and citizens

SOURCE: National Informatics Centre and Revenue Department, Government of Karnataka, April 2014; Department of Administrative Reforms and Public Grievances; Government of Maharashtra, as of July 2012.

Potential actions to ensure accelerated progress

Digital Land 2.0 requires government interventions at different central, state, and intradepartmental levels. Even though many stand-alone records are being computerised, their accuracy needs to be verified by integrating state revenue, survey, and registration databases. Of immediate importance is to ensure appropriate digital infrastructure through all levels, with digital delivery to the citizen. Following are some specific possibilities that could systematically create land records that mirror facts on the ground:

> “The central government could create a property record and services/land governance index to rank states on their absolute level of land record digitisation and year-on-year growth”

- **Financially incentivise states to improve their performance in creating digital records.** Under the Digital India Land Records Modernisation Programme, many records of rights and mutations have been computerised, but they need to more accurately reflect current landholdings. Central funds distributed to states for the digitisation effort could be based not only on the quantity of work but also on the quality of work. The central government could parcel out funding based on the states’ performance. Many other databases need to be linked over time to enhance the accuracy and comprehensiveness of records to move toward a conclusive guarantee system.

  The central government could create a property record and services/land governance index to rank states on their absolute level of land record digitisation and year-on-year growth. This index could measure the quality of electronic land records, ownership information, and land map quality.[336] It could measure two sets of indicators: 1) the computerisation of records of rights, cadastral maps, registration of services, and delivery of service; and 2) the extent to which a record is a “real-time mirror” of aspects of ownership, possession, land use, extent of computerisation, and encumbrances.[337]

- **Design an interoperable, end-to-end platform that links multiple aspects of land records.** An existing goal of the modernisation programme is merging records from state survey and settlement departments, registration departments, and revenue departments into an integrated land management system. More data sources relating to land acquisitions, legal disputes in courts, property collateral used for banking credit, municipal-body records on urban property development, and succession records in genealogical databases exist that could be linked to land records. Real-time API linkages between these different databases will allow for notations in records of rights when a mutation has taken place, and keep the land records more comprehensive and reflective of the current situation. Unification will eliminate uncertainty in land records about such matters as boundary of land, title, title holder, liens, and inheritance holder.

- **Create a social platform where open records are auditable and can be arbitrated.** Bring transparency to the platform to make sure that public records are open to enable anyone to check the ownership of any piece of land, liens on it, and lien holders. The platform must be auditable, traceable to the sources of information, and available in local languages. All future transactions could be permanently tracked in a digital distributed ledger system that is traceable to Aadhar IDs. In addition, a social decision-making chain is required, backed by rapid resolution judicial courts that use the data in the platform to arbitrate.[338]

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[336] DMAT – Digital Land Governance for India. Lalitesh Katragadda and TATA Trusts.

[337] Deepak Sanan, D.B. Gupta, and Prerna Prabhakar, *A pilot impact assessment of Digital-India Land Records Modernisation Programme*, NCAER, November 2017, ncaer.org.

[338] DMAT – Digital Land Governance for India. Lalitesh Katragadda and TATA Trusts.

- **Set up a central body to establish technical benchmarks and standards** for improving records identification and linkage. Currently 86 percent of records of rights are computerised but need to be formatted in a standard digitally traceable format. All states and many state departments have different labels, structures, and identifiers for land records. The Ministry of Panchayati Raj has already started standardising Local Government Directory codes to keep systems interoperable across states.[339] Other parameters such as unique property ID, record of rights structure, and even the use of consistent land area units could be standardised.

- **Computerise all land offices at all levels** to discourage corruption, reduce the loss of records, and cut transaction time. Offices in many states with community ownership systems, including those in the North East region, still have not been fully computerised.

  This would also need to be supplemented with digital capacity-building training for staff. The process of land record-keeping takes place at the village, block, or city level. Estimates by the Department of Land Resources suggest that the government will need to train 100,000 to 200,000 patwaris, or village accountants, and over 50,000 survey staff.[340] Many government survey departments currently have a shortage of trained employees to conduct surveys. Surveyors must be able to understand the latest GIS, GPS, and satellite imaging technologies. This would involve learning skills related to computer operation, maintaining records, and data management. State governments as well as Sector Skill Councils can teach the abilities required.

- Move all states' land registration systems online. Land registration involves a stamp duty process and can be cumbersome to complete. Because land registration is not compulsory, and manually checking records in different land offices is tedious, it is difficult to compile and maintain a comprehensive, accurate database. Maharashtra is pioneering a web-based application called i-SARITA, which centralises the administration and implementation of the registration process. The National Informatics Centre (NIC) has already developed a template registration system which requires adequate financial incentives for states to adopt it. It is easier to administer for short-term categories such as gift, lease, and mortgage, but for change of ownership, the process needs more stringent controls to limit instances of forced transfer.

  Digitised land records must be easily accessible online and legally valid. It is the buyer's prerogative to review all historical land records and be aware of ongoing legal disputes. Farmers have traditionally relied on the village accountant to manually access their paper Record of Rights, Tenancy and Crops, known as RTC, leading to instances of harassment and bribery. Andhra Pradesh has used internet kiosks and Karnataka has used Bhoomi kiosks to improve access and registration, and both states reported an increase in transactions. These web-based records could also have a legally valid digital signature that would expedite transactions, as Andhra Pradesh does through an online service called WebLand. More than 40 million agricultural land records belonging to 15 million land owners are ported to the state data centre, and each record is manually verified and digitally signed by tahsildars, or tax collectors, to grant legal status under state rules enacted in 2011 to govern Electronic Service Delivery.[341]

- **Complete survey or resurvey of all land areas, along with use of satellite technologies.** Many states are still using outdated technologies to conduct surveys, which leads to inaccuracies and increases the time required for surveying. Differential GPS and drone technologies can be used to carry out surveys and resurveys effectively. For example, Maharashtra is implementing a GIS-enabled identity and tax tracking system in cities.[342] Other state governments could also set up similar systems to use satellite technologies, update records of rights in real

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339 Standardisation of location codes and integration with Local Government Directory (LGD), F.No. J-21011/1/2016-e-Gov, Ministry of Water Resources, September 2016.

340 Rita Sinha, "Moving towards clear land titles in India: Potential benefits, a road-map and remaining challenges", Department of Land Resources, Ministry of Rural Development, Government of India, 2009.

341 UN AWARD-Implementation Plan Question No. 4, ap.meeseva.gov.in.

342 *Civic information system*, Maharashtra Remote Sensing Application Centre website.

time, and conduct awareness camps to demonstrate the benefits of using these technologies.

Government also must make it attractive to private contractors to conduct surveys. Private-sector companies, working with states, could expedite the surveying process. Stringent terms surrounding bidding for contracts and slow payment to contractors discourage private-sector participation. Special panels can be set up to address complaints from Digital Land 2.0 vendors. In consultation with vendors, states can consider relaxing the terms and conditions of their requests for proposals and perhaps tie interim payments to agreed-upon project milestones.

- **Encourage the start of title insurance** based on digitised records and integrated platform data, along with private insurance players in a public-private partnership. Land disputes make up 60 to 70 percent of all civil disputes, and the burden is on the buyer to scrutinise all available land records.[343] Title insurance in the United States is led by private insurance companies, which encourages the maintenance of in-depth accurate land records to help them to manage risk. In India, the government could also provide title insurance to farmers as records become more comprehensive. In urban areas, private companies could offer title insurance while also developing land records for nonsurveyed areas.
- Develop a model law that leads to a voluntary public ledger and ultimately to an increase in conclusive titling. In the past, conclusive titling has been passed basis of digitised land records, but not addressed legacy issues. Unclear titles could be resolved by resurveying, which would create its own disputes.

  A voluntary ledger system would encourage individuals with clean titles to migrate and conduct compulsory surveys of property, boundary of records, possession, and encumbrance details. Testamentary and nontestamentary records would also be documented on the public ledger. The guarantee of a clean title and linked benefits would create an ecosystem where people actively seek to perfect the titles to their land.[344]

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343 “India – Land Policies for growth and poverty reduction”, Agriculture and Rural Development Sector Unit, India Country Management Unit, South Asia Region, World Bank, August 2007.

344 DMAT – Digital Land Governance for India, Lalitesh Katragadda and TATA Trusts.

7. National document and data exchange

> "There is a need to create an integrated platform where all three stakeholders — document-issuing agencies, document-requesting agencies, and citizens can transfer documents without the need to generate a paper copy or travel to pick up and deliver the document"

Vision and potential impact

Most of the documents issued by the Government of India today are printed on paper. When citizens are asked to furnish documents to an agency to obtain a service, a photocopy or scan typically is required. Not only is this expensive and inconvenient for the citizen, but it creates a burden on the government to issue, verify, process, and store millions of such documents. Thus, there is a need to create an integrated platform where all three stakeholders — document-issuing agencies, document-requesting agencies, and citizens — can transfer documents without the need to generate a paper copy or travel to pick up and deliver the document. At the same time, there is also a need to create a data highway to securely transfer data between government agencies and private organisations in order to facilitate and simplify beneficiary identification. This integrated platform that can securely transfer data can take the shape of various digital lockers.

To achieve this, the government has envisaged a national document and data exchange. The exchange would be able to access multiple private- and public-sector data repositories and fetch documents requested by users. These documents could be shared with requesting agencies with the user's consent. Strong encryption standards would be ensured through eSign, and login to the exchange would be doubly secured by using a one-time password. The DigiLocker set up by the Ministry of Electronics and Information Technology could be used to create a cloud-based platform that enables sharing and storage of eSigned key identity documents. The government has integrated DigiLocker with 50 issuing authorities and opened the way for users to access important documents such as Aadhaar, driving licences, and 10th- and 12th-grade board examination mark sheets through DigiLocker.[345]

The government established the Digital Locker Authority to license public- and private-sector agencies as digital locker service providers.[346] Together with DigiLocker, these providers could create the national exchange. The providers could build their business model around charging authorities to use the service. Document digitisation, work-flow management, and offline document verification could be other revenue sources.

DigiLocker is also planning to create an electronic exchange to facilitate sharing beneficiary data digitally in a secure and seamless manner across various government organisations and departments based on users' consent. The first phase of the data exchange is being developed in coordination with the Unique Identification Authority of India, using data from the Socio Economic and Caste Census and the Central Board of Direct Taxes. This data would be used to administer the Pradhan Mantri Awas Yojana and liquefied petroleum gas subsidy schemes.

Digitisation of trade documents is also a priority for trade bodies who have requested it for timely payments for trade transactions. A national trade platform is envisaged with the participation of both banks and corporates. The platform would be a central engine of connecting various trade sub-platforms with access to a repository of transport documents like purchase orders, letters of credit, bank guarantees, invoices, and insurance certificates. Another element of this platform could be eStamping which could digitise the stamping process end to end from initial request to unique eStamping number through the platform.[347]

> "A national trade platform is envisaged for the digitisation of trade documents which will be a central engine of connecting various trade sub-platforms with access to a repository of transport documents like purchase orders, letters of credit, bank guarantees, invoices, and insurance certificates"

Once it is up and running, the National Document and Data Exchange can be used to simplify many processes. For example, a bank customer seeking a loan could submit digital copies of documents such as a Personal Account Number (PAN) card and salary slips, and authorise tax authorities and his or her employer to do the same. In another example, telecom companies could issue SIM cards by verifying a customer's details through digital documents. Direct Benefit Transfer payments could be integrated with the exchange and relevant beneficiaries could be identified for targeted subsidy transfer.

Accelerated implementation of the national document and data exchange would lead to greater market reach and lower the cost of customer acquisition for financial services providers by enabling anti-money-laundering e-Know Your Client background checks using digitally signed documents. Fraud and identity theft would decrease through the use of digitally signed and verified documents. Reissuing documents will become easier, and paperless document transfers would lead to reduced costs. Easy exchange of data between ministries could lead to better targeting of beneficiaries and reduce leakage in subsidy transfers.

Current initiatives and global case examples

DigiLocker is currently being used to retrieve and share various kinds of documents. Retrieval of liquefied petroleum gas subscription vouchers through DigiLocker is outlined in Exhibit R7, which also spotlights Estonia's X-Road, a notable example of a full national data exchange.[348]

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[345] DigiLocker website as of April 25, 2018.

[346] Digital Locker Authority website, as of May 2018.

[347] *Digitisation of Trade Process–Discussion Paper*, April 2018.

[348] *Annual report 2017–18*, Ministry of Petroleum and Natural Gas.

EXHIBIT R7

Digital verification and acceptance of documents has proven efficiency gains

Organisation	Context	Solution	Impact
Indian Oil, Bharat Petroleum, Hindustan Petroleum	▪ Liquefied petroleum gas (LPG) subscription voucher has the details of number of cylinders and pressure regulators loaned to the consumer	▪ In early 2017, the Indian Oil Corporation, Bharat Petroleum Corporation, and Hindustan Petroleum Corporation gave customers direct access to their LPG subscription vouchers via DigiLocker, a government-run cloud-storage system ▪ Customers who have linked their Aadhaar biometric ID to DigiLocker can have their vouchers automatically deposited in their DigiLockers each month ▪ Another option is to manually enter their voucher number into an energy company's system each month to have vouchers delivered on demand ▪ Consumers can pull address proof and identity proof documents from DigiLocker when applying online for a new LPG connection	▪ Over 233.4 million LPG subscription vouchers have been issued through DigiLocker
Government of Estonia	▪ Estonia launched X-Road platform, the national data exchange portal, in 2001 ▪ Links nation's various public and private databases and allows them to function in harmony ▪ Allows amending data in multiple databases, transmission of large data sets, and searches across several databases	▪ Data transfer secure; all outgoing data digitally signed and encrypted; all incoming data authenticated and logged ▪ Any public or private organisation wanting to offer automated e-services can simply link its database with X-Road ▪ X-Road is the world's first data exchange platform that allows automatic exchange of data within countries. ▪ In 2017, automatic data exchange between Estonia and Finland established	▪ Currently, over 1,600 services can be used on X-Road; 52,000 organisations are indirect users ▪ 99% of state services are online ▪ 500 million queries are solved on the portal annually ▪ Has complied with European Interoperability Framework and eIDAS requirements for trust services ▪ Analysis suggests that over 800 years of working time has been saved by X-Road

SOURCE: DigiLocker, as on October 1, 2018; Ministry of Electronics and Information Technology; E-Estonia, as of April 23, 2018; Government of Estonia.

Potential actions to ensure accelerated progress

A national document exchange could scale rapidly if the government acts to ensure that the following prerequisites are in place:

- **Increase the acceptance of digital documents by various agencies.** Many public and private agencies in India do not yet accept digital documents. As of April 2018, DigiLocker has only 19 requester organisations.[349] Banks, passport agencies, and telecom service providers have yet to use the platform. There is a further push for colleges and universities to start accepting digital documents for admissions purposes.

  The Ministry of Electronics and Information Technology could educate government departments and private businesses about the legal validity of digital documents, as stated in the Information Technology (Controller of Digital Locker) Rules, 2016.[350] This could be achieved by initiating awareness campaigns to drive adoption in the private sector. Regulatory bodies such as the Reserve Bank of India and the Telecom Regulatory Authority of India could mandate the use of digital documents in the banking and telecom sectors.

- **Onboard more government departments to issue documents through DigiLocker.** Key identification documents such as the PAN card, passports, election cards, and birth and death certificates are not currently accessible through DigiLocker. Encouraging government agencies to distribute such documents through DigiLocker would go a long way toward making the service an integral part of life in India. Additionally, agencies could use DigiLocker to deliver National Skill Development Council certificates and insurance certificates.

  In order to encourage government departments to do more, the Ministry of Electronics and Information Technology could demonstrate the security features of DigiLocker documents, such as eSign and QR codes, and highlight the ease of use for citizens.

- **Accelerate the digitisation of documents to be shared over DigiLocker.** Considerable cost and time would be required to digitise a vast number of papers and other documents before they can be shared through DigiLocker. The Central Board of Secondary Education and state boards, for example, have several decades of paper mark sheets to be digitised. Currently only Bihar, Haryana, and Maharashtra provide 10th- and 12th-grade examination certificates, and they have done so only for the last couple of years.

  Private players can become repository providers and could help digitise and store the data of issuing authorities on cost-per-record basis. Meanwhile, issuing authorities can innovate economic models to fund digitisation and storage by charging requesters for documents.

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[349] DigiLocker website as of April 25, 2018.

[350] The Information Technology (Controller of Digital Locker) Rules, 2016.

8. Improved urban e-governance leveraging digital interventions

Vision and potential impact

The National E-Governance Plan, aimed at making government services accessible to citizens at an affordable price, is one of the cornerstones of the broader Digital India Programme.[351] E-governance has evolved from the simple computerisation of government departments to initiatives that involve qualitative aspects of governance such as more transparency and improved service. The focus today is on designing e-governance applications in such a way that government-related information, services, and grievance-handling mechanisms are accessible online on a real-time basis.

By bringing transparency, efficiency, and reliability to service delivery, digital interventions have the potential to transform the efficacy of governance for India. Digital interventions in cities have the potential to bring about transformative change in services such as emergency response, traffic and water management, safety and security, and grievance redressal. Such interventions go a long way toward improving the liveability of as well as ease of doing business in urban centres.

E-governance has already transformed interaction between governments and citizens in large parts of the world. For example, a network of thousands of cameras, panic buttons, loudspeakers, and other law enforcement systems enables the authorities in Mexico City to react faster to emergencies and crime, reducing the response time to five minutes from the moment an event occurs.[352] Paris applies intelligent controls to streetlights to reduce energy consumption.[353] New York's Leak Notification Programme monitors water consumption and detects inefficiencies, enabling the city to identify leaks, reduce waste, and notify customers of service disruptions.[354]

Recognising this potential, the Government of India has undertaken a number of digital initiatives to improve service to citizens. For example, Unified Mobile Application for New-age Governance (UMANG), which the Ministry of Electronics and Information Technology designed to increase citizen access to government services. The app, which was introduced in 2017, offers more than 200 services from 38 departments, and the ministry aims to expand to many more.[355] Likewise, the ministry of Housing and Urban Affairs (MoHUA) leverages digital applications significantly to run its flagship programmes. For example, MoHUA's Smart Cities Programme is rolling out infrastructure improvements and technology applications to improve the delivery of urban services; its objective is to make 100 Indian cities "smart" by 2019.[356]

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[351] National e-Governance Division website.

[352] *Mexico City: Telmex and Thales selected to double the capacity of world's most advanced urban security system*, Thales press release, April 11, 2014.

[353] *Smart city spotlight: Paris*, Silver Spring Networks case study, silverspringnet.com.

[354] *Water demand management plan*, NYC Department of Environmental Protection, 2013.

[355] Unified Mobile Application for New-age Governance (UMANG) website.

[356] Smart Cities Mission Statement & Guidelines, Ministry of Urban Development, Government of India, June 2015.

Initiatives already under way

Digital applications are significantly transforming the way local governments are run globally. Several examples are illustrated in Exhibits R8A and R8B.

Exhibit R8A

Globally, governments are implementing several initiatives for developing smart cities

City/Country	Context	Solution	Impact
Barcelona, Spain	▪ Barcelona was named European Capital of Innovation in 2014 by the EU	▪ Barcelona's smart city platform, known as the Urban Platform, brings together data from the open-source sensor and the city's information systems, as well as social networks and Web 2.0, allowing it to solve urban challenges across silos ▪ Digital bus stops provide bus arrival times, free Wi-Fi, and USB charging ports ▪ Smart parking system guides vehicles to available parking spaces, reducing congestion and emissions ▪ Smart LED streetlamps activate only when movement is detected ▪ Elderly and disabled citizens are connected to the city's Telecare service, which proactively checks on residents ▪ Sensors monitor rain and humidity to determine how much water is needed to irrigate parks	▪ More than 100 active smart city projects are being implemented ▪ IoT devices installed on streetlamps, leading to 30% energy savings ▪ Over 70,000 elderly residents linked to city's Telecare network
Singapore	▪ Singapore's Smart Nation Vision programme, established in 2014, seeks to harness ICT networks and data to support better living, create more opportunities, and support stronger communities, as a response to growing urban challenges of aging population, urban density, and energy sustainability	▪ Singapore Government has launched the following suite of initiatives as a part of the Smart Nation mission: ▪ Singapore Police Force has implemented ePC (Electronic Police Centre) for citizens to file police reports online and conveniently gather administrative information ▪ MyTransport.SG smartphone application provides real-time information for commuters to track road conditions, traffic news, and parking availability ▪ Surveillance cameras look for traffic accidents; vehicle recovery crews are activated to reach the accident site ▪ Smart monitoring systems equipped with multifunctional water sensors keep water loss low ▪ Smart bins transmit real-time waste fill levels that help in generating optimised collection routes for drivers	▪ 98% of government services are accessible online ▪ 9 in 10 citizens are satisfied with the quality of e-government services

SOURCE: International case studies of smart cities, Singapore Inter-American Development Bank; Enterprise Innovation, (Barcelona figures as of August 2016).

EXHIBIT R8B

Digital platforms in India connecting urban governments with citizens is a win-win

Organisation	Context	Solution	Impact
eGovernments Foundation	▪ Rapid urbanisation is increasing pressure on India's urban local bodies (ULBs), which are understaffed by global standards ▪ The eGovernments Foundation offers technology solutions that understaffed ULBs can use to improve operations, decision making, and the digital delivery of services	The eGovernments Foundation (eGov) has built a suite of state-of-the art open-source, interoperable technology solutions to connect urban governments with citizens eGovernments' solutions are built on the eGov SmartCity Platform and are accessible through enterprise resource planning (ERP) systems, via mobile apps, and on websites Examples of what local governments are trying: ▪ Property tax information system in Delhi and Karnataka to improve internal efficiencies of the assessment and tax departments ▪ Accrual-based accounting and budgeting systems in Vijaywada and Vishakhapatnam ▪ E-governance system in Kanpur ▪ Works and project management solutions in Chennai and Nagpur Features of eGovernments' apps include: ▪ Platform-driven architecture allows for easy additions and modifications of workflows, stakeholders, and data sources ▪ Co-creation ecosystem enables rapid development, configuration and deployment of apps ▪ Open-source approach avoids making a municipality dependent on a single vendor	▪ 72% increase in property tax revenue collection in Delhi ($43.9 million in 2008–09 to $55.3 million in 2013–14) ▪ Time taken to issue birth and death certificates reduced from 2–3 days to 15 minutes in Karnataka ▪ 100% increase in inefficiency of works/project management in Nagpur

SOURCE: eGovernments Foundation.

Potential actions to ensure accelerated progress

Central and state governments can hasten the adoption of digital applications at the local government level by adopting the following prerequisites:

- **Integrate shared digital infrastructure planning into all infrastructure projects.** The availability of digital infrastructure is a prerequisite for digital adoption by local governments. Studies of several cities that have created robust digital infrastructure (including Seoul, Singapore, and Stockholm) suggest that creating an optical-fibre cable network shared by different internet service providers and telecom companies is the fastest and cheapest way to do so.

  Shared fibre infrastructure (multiple-core duct with concrete protection all around) helps to avoid duplicating resources and inconveniencing citizens with the installation and maintenance of separate networks. Moreover, significant reduction in costs could be achieved if the provision of digital infrastructure is included as part of existing projects, thereby eliminating repeated costs and productivity losses due to permits, digging, and labour. Such integrated planning and implementation could achieve over 50 percent reduction in the cost of providing digital infrastructure.[357]

- **Bolster capacity building at the local government level.** Targeted, up-to-date training programmes can help officials in municipal corporations and ministries build capability and capacity to successfully implement smart, intervention-based projects at local government level.

  - Indian cities could create a municipal cadre that would offer attractive and sustainable career paths to attract talent. Statewide tests could be used to screen the pool of applicants from which cities could build this cadre. Clear managerial and technical paths could support the cadre.
  - District administrators could consider retraining block-development officers (implementers of rural schemes) in basic data collection and analysis so that they can monitor education, healthcare, agriculture, and financial inclusion metrics. Progress on these metrics could be shared with key stakeholders, including the local administration. This would promote the transparency of goals and outcomes.

- **Build a management structure to maximise synergies in digital interventions across cities.** Effective digitisation of municipal governance processes and services can lead to a step change in the quality of urban governance. Such efforts often are uncoordinated and not integrated, leading to departmental and agency siloes over time. States have started adopting an integrated approach. For example, Andhra Pradesh has a statewide urban governance platform that gives citizens and businesses digital access to municipal government services in a transparent manner. By taking a pan-state approach, the government has reduced the total cost of ownership across cities, while driving governance efficiencies and breaking down siloes.

- **Maximise the impact of high-potential solutions by sharing best practices.** States can accelerate project implementation and leapfrog the learning curve by sharing knowledge about the challenges and successful interventions encountered on projects. MoHUA, and other key ministries could convene quarterly or semiannual sessions for senior officers to share best practices.

- **Host a set of shareable APIs and digital tools that local bodies can use with some customisation.** E-governance platforms, with the flexibility to allow users to customise, are one of the key enablers for wider adoption. For example, the government's e-office initiative gives departments the ability to customise the tool to suit their specific requirements. Consequently, it is used across 367 departments of the central and state governments.

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[357] Expert interviews.

9. Comprehensive Direct Benefit Transfers

> “To eliminate losses arising from fraud, theft or simple human error and minimise bureaucratic inefficiencies, the government has progressively moved from handing out cash to electronically transferring money directly to recipients’ bank accounts”

Vision and potential impact

Considering its wages, pensions, disability allowances, scholarships, and subsidies for cooking gas, food, fertilisers, and other essentials, the Government of India routinely disburses very large sums of money among millions of beneficiaries. The central government alone spent about 2.1 percent of GDP in 2016 on food, fertiliser, and other subsidies, together with wages paid under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA).[358] Leaking even a small fraction of this amount due to fraud, theft, or simple human error gets costly quickly and keeps the rightful owners from receiving the assistance intended for them. To eliminate such losses and minimise bureaucratic inefficiencies, the government has progressively moved from handing out cash to electronically transferring money directly to recipients’ bank accounts. This process, known as Direct Benefit Transfer, or DBT, not only makes payments more reliable and secure, it also eliminates middlemen and hence rules out the most common types of leakage. It enables the government to digitally verify the identity of the beneficiaries, making it easier to eliminate duplication, unmask nonexistent “ghost” recipients, and discourage other fraudulent activity. Though recipients are not mandated to use the Aadhaar biometric identification system to prove who they are, about 76.6 percent of beneficiaries being paid either in cash or in-kind subsidies are Aadhaar-seeded recipients.[359]

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[358] *Economy insight: Trends in union budget*, Federation of Indian Chambers of Commerce and Industry Research, February 2016.

[359] Direct Benefit Transfer Mission website, as of August 31, 2018.

From the launch of the Direct Benefit Transfer programme in January 2013 through December 2017, the government transferred a total of $70 billion in benefits from 433 schemes to 596 million (non-unique) beneficiaries.[360] DBT transfer has two primary modes: cash transfers to individuals, service enablers, and entities, and in-kind transfers to individuals and households. The focus initially was on cash schemes; however, the scope has diversified to include in-kind schemes as well as Aadhaar-enabled services. Building a comprehensive DBT structure requires a few foundational prerequisites, starting with a secure, near-universal personal identification system like Aadhaar. Per the Unique Identification Authority of India, as on the end of December 2017, 88.5 percent of the overall population had Aadhaar.[361] Seeding of digitally verifiable identity to bank accounts and the beneficiaries' database is the second prerequisite to successfully implementing DBT at a larger scale.

While DBT is primarily focused on central government schemes, DBT Mission, the agency tasked with implementing electronic transfers, estimated in September 2017 that 3,500 central and state government schemes could be added to the programme. These schemes currently disburse almost $90 billion annually.[362]

The Ministry of Finance's Economic Survey for the fiscal year 2015–16 estimated that the Direct Benefit Transfer scheme reduced leakage by 14 percent in the case of MGNREGA.[363] Given the head start in DBT, it is likely that 80 percent of central government subsidies will be transferred electronically by 2025. Assuming that central government subsidies on food, fertiliser, and programmes like MGNREGA together will account for 1.8 percent of GDP, a 15 percent leakage reduction on account of movement toward DBT — a goal that could be achieved as early as 2020 — would help save about $10 billion for the exchequer for the year 2025 while also satisfying millions of legitimate beneficiaries.

Initiatives already under way

Direct Benefit Transfer began by displacing cash payments for a range of government benefits and subsidies. The technology has since been adapted for grain subsidies, discounted cooking gas, and subsidised fertiliser. Two of these alternatives are detailed in Exhibit R9.

EXHIBIT R9

Governments harness digital technologies for improved targeting and reduced leakage in subsidy programmes

Initiative	Context	Solution	Impact
DBT in LPG, PAHAL	▪ PAHAL was launched to: ▪ Tackle diversion of subsidised liquefied petroleum gas to the commercial sector ▪ Improve the availability and delivery of LPG cylinders to correct users ▪ Weed out fake and duplicate connections	▪ Under PAHAL, the government reimburses eligible consumers for the difference between the market price of LPG cylinders and the lower subsidised price, then transfers that amount to the consumers' bank accounts ▪ Oil marketing companies (OMCs) are required to file quarterly claims with the Government of India to confirm subsidy amounts transferred to consumers' bank accounts	▪ 258.6 million beneficiaries in 2017–18 ▪ More than $3.82 billion in subsidies transferred to beneficiaries' bank accounts in 2017–18

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[360] Direct Benefit Transfer Mission website, as of August 31, 2018.

[361] *State of Aadhaar report 2016–17*, IDinsight, May 2017.

[362] Arup Roychoudhury, "3,500 state, central schemes worth Rs 6 lakh cr to come under DBT soon", *Business Standard*, September 6, 2017.

[363] *Economic survey, 2015–16*, Ministry of Finance, Government of India.

Initiative	Context	Solution	Impact
DBT in Fertilisers, Krishna district, Andhra Pradesh	DBT in fertiliser was introduced to ▪ Track the quantity of fertiliser reaching farmers and consequently deciding the fertiliser subsidy to be paid to manufacturers ▪ Prevent leakage in the form of sale of subsidised fertiliser in the black market, with proceeds that go into so-called ghost accounts	▪ Aadhaar Enabled Fertiliser Distribution System introduced in Krishna district in March 2016 to monitor distribution of fertiliser across the value chain ▪ Fertilisers provided to beneficiaries using biometric authentication – Each retail outlet is provided with an electronic point of sale (ePoS) device equipped with fingerprint and iris scanner ▪ Farmer receive fertilisers at subsidised price, and subsidy (calculated from sales data) is transferred to the manufacturer	▪ 71,752 metric tonnes of fertiliser sales in the scheme's first 8 months ▪ 551,000 farmers across 50 blocks benefitted from the scheme, as of November 1, 2016 ▪ Non-famer sale of fertiliser reduced
Kanyashree Online 5.0, West Bengal	▪ Kanyashree Online 5.0 is a flagship programme of the West Bengal government to improve the status and well-being of girls, specifically those from socioeconomically disadvantaged families through conditional cash transfers	▪ Exclusive virtual workspace in Kanyashree online system where girls can share their experiences and take part in e-learning initiatives ▪ Has two transfer components: – Annual incentive of $11.50 to be paid annually to the girls in the age group 13–18 years – One-time grant of $385 to be paid once a girl turns 18, provided that she was engaged in an academic or occupational pursuit and was unmarried	▪ 15,826 registered institutions ▪ Over $600 million disbursed ▪ 9 million applications sanctioned out of 9.4 million applications received ▪ Caters to 4.2 million girls
Krishi Rin Mochan Yojana Uttar Pradesh	▪ Krishi Rin Mochan Yojana is a complete IT-based solution integrating 56 banks to handle loan amount worth $4.7 billion	▪ Intends to waive up to $1,538 of crop loans made to each small and marginal farmer across the state on or before March 31, 2016	▪ Benefitted over 3.4 million farmers ▪ $3.2 billion redeemed to the beneficiaries
Midday Meal Scheme, Himachal Pradesh	▪ National Programme of Midday Meal (MDM) in Schools ▪ Launched as a Centrally Sponsored Scheme to enhance enrolment, retention, attendance and nutritional levels among children	▪ MDM-ARMS software for citizens to send their MDM related grievances online and data collected is reflected on the National Portal on a daily basis	▪ Software implemented in 17 states and covers over 300,000 schools

SOURCE: Direct Benefit Transfer Mission, Government of India, as of April 23, 2018; National Institute for Smart Government; Comptroller and Auditor General of India; National Informatics Centre, Ministry of Electronics and Information Technology.

> “DBT transfer has two primary modes: cash transfers to individuals, service enablers, and entities, and in-kind transfers to individuals and households”

Potential actions to ensure accelerated progress

To increase the chances of successfully scaling up the Direct Benefit Transfer programme, the government could consider the following prerequisites:

- **Adequate banking infrastructure in the states.** For DBT to work well, government needs to work with banks and others in the private sector to ensure sufficient bank branches, ATMs, and business correspondents.

  Public- and private-sector banks alike will need to engage in focused efforts to promote financial inclusion. They also need to be sure to include cooperative banks, large primary agricultural credit societies, and Common Services Centres in the DBT network. The recent integration of the post office could help to expand DBT access and reach.[364] Payment banks such as Airtel and Paytm, which serve low-income and rural customers, can further help to expand the channel for food subsidies through DBT.

- **Foolproof mechanism to identify and authenticate beneficiaries.** While Direct Benefit Transfer has demonstrated its value by delivering payments promptly and precisely, it has not solved the long-standing problem of misidentification that results in the erroneous exclusion of genuine beneficiaries from subsidy and benefit programmes. The identification and authentication mechanism needs to be as foolproof as possible.

  State governments could set up a monitoring body to periodically conduct surveys to identify households below the poverty line. The surveys could be carried out as often as every other year to keep the data fresh. State governments also could drive awareness campaigns to educate households below the poverty line about digital transfers and associated government schemes. They also could use Aadhaar biometric identification to authenticate benefits recipients, and back up Aadhaar with a system that sends a one-time password to applicants’ mobile phones if they are unable to authenticate biometrically. States also could enable on-the-spot registration for beneficiaries without Aadhaar, as Andhra Pradesh does in its Aadhaar-enabled Public Distribution System.

- **Setting up a grievance-redressal mechanism.** To address problems with and queries about benefit disbursal, state governments could set up a grievance-redressal mechanism. This system could have an online presence with responsive design so that the website works equally well on mobile devices and on laptops, and could include dashboards or some other system to review progress. It also could include numbers for mobile helplines through which citizens can receive answers to general queries and lodge complaints regarding such matters as the amounts of various subsidies and the dates of their disbursal.

- **Fast-track method to check the amount of direct benefits at the state level.** Fourteen states have launched their own DBT portals, and another nine are in the process of building portals. As stated above, an estimated 3,500 state-run schemes are being integrated with the DBT platform for better monitoring and implementation.[365]

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[364] Vasumitra, *Direct Benefit Transfer through India Post*, National Council of Applied Economic Research website.

[365] Arup Roychoudhury, “3,500 state, central schemes worth Rs 6 lakh cr to come under DBT soon”, *Business Standard*, September 6, 2017.

10. A profitable Common Services Centre in every gram panchayat

> “Common Services Centres (CSCs) serve as digital access points for delivering e-services to citizens, mainly in rural India”

Vision and potential impact

Common Services Centres (CSCs) serve as digital access points for delivering e-services to citizens, mainly in rural India. CSCs give citizens access to government and other services close to where they live — if not yet in their homes, given that last-mile internet connectivity is still not pervasive, particularly in rural areas. CSCs improve transparency, accountability, and efficiency in the delivery of services by acting as an intermediary between rural citizens and the government. Expanding the Common Services Centres network is integral to the government’s Digital India initiative, which envisages establishing CSCs in all 250,000 gram panchayats in a geographically equitable manner to promote digital inclusion by 2019.[366] As of April 2018, there were 292,748 functional CSCs.[367]

CSCs are owned and managed by local businesspeople known as village-level entrepreneurs. Under Government of India guidelines, these VLEs receive 80 percent of the fees citizens pay for services at CSCs; other stakeholders get the remainder. Anyone can be a village-level entrepreneur, and different profiles for each entrepreneur determine how individual CSCs are shaped. Village-level entrepreneurs are responsible for promoting CSCs and building credibility in the community. The scaling of CSC infrastructure and services depends on the capacity and ability of the local entrepreneur.

To build on the success of the CSC programme, a set of actions are needed to make VLEs sustainable while serving the digital access needs of their local communities. Achieving the vision of a profitable CSC in every gram panchayat will not only help over 250,000 entrepreneurial businesses remain dynamic and generate local employment, but will also ensure that a full spectrum of online services is brought to the populations they serve.[368]

Initiatives already under way

The CSC offers a suite of government-to-citizen and business-to-customer services at prices set by a CSC special-purpose vehicle in consultation with the government. The menu of services offered in each CSC is determined locally, to reflect what customers want. A sampling of the wide variety of services available in rural villages is depicted in Exhibit R10.

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366 *CSC 2.0*, Digital India, Ministry of Electronics and Information Technology, as of April 25, 2018.
367 *National monthly progress report*, Common Services Centre Scheme, MeitY, April 2018.
368 Ibid.

Exhibit R10

CSCs offer key services to the catchment population

Services offered by CSC

- **Aadhaar Services**
  - Aadhar enrolments and print
  - Mobile and demographic updates
  - e-KYC
  - Seeding and authentication
- **Educational Services**
  - Digital education, e.g., Cyber Gram (digital literacy for minority communities)
  - Courses under National Institute of Open Schooling
  - Computer courses under National Institute of Electronics and IT
  - Animation and Tally courses
  - Coaching
    - IIT
    - Civil services
  - Financial/ legal literacy
  - University services/ IGNOU
- **Health Services**
  - Telemedicine
    - Allopathic
    - Ayurvedic
    - Homeopathic
  - JAN Aushadhi (generic medicines at affordable prices)
  - Diagnostic services
- **Financial Inclusion**
  - Banking Services
    - New account
    - Deposit
    - Withdrawal
    - Remittance
  - Insurance
    - Life insurance
    - General insurance
  - Pension
  - Cash withdrawal/ deposits using Aadhaar Enabled Payment System
- **Skill Development**
  - L&T & National Skill Development Corporation courses
  - Others
    - Electronics
    - Motor mechanic
    - Mobile repair
    - National Optical Fibre Network
    - Health adviser
- **G2C Services**
  - **Central Govt. Services**
    - PAN card, passport, income tax return
    - Voter registration
    - Employment services, e.g., labour registration
    - Applications for toilets under Swachh Bharat Abhiyan (clean India campaign)
    - Applications to PM Awas Yojana (affordable housing scheme)
    - Agricultural Services
      - Soil health card
  - **State Govt. Services**
    - e-District/ State e-governance Service Delivery Gateway
      - Land records
      - Ration card
      - Birth/ death certificate
      - Income/ caste/ domicile certificate
- **B2C Services**
  - e-Recharge
  - Tour & travels
  - Sale & purchase of seeds farmer equipment
  - e-Commerce
    - CSC Bazar
    - VLE Bazar
  - Wi-Fi Choupal
  - Products from
    - Patanjali
    - Samsung
    - Crompton Greaves
    - Hewlett-Packard
    - IFFCO
- **Other Services**
  - Electricity new connection and bill payment
  - IRCTC (railways) services
  - Bharat Bill Payment System

Scale of operations

181 million enrolments

588 million authentications

10.5 million people trained under PMGDISHA (digital literacy)

340,000 trained under CyberGram Yojana

21,000 Apollo and CSC tele-consultations done

900,000 health products sold

59.2 million banking transactions

400,000 customers of new insurance policies

120,000 candidates enrolled under skill development schemes

8.5 million transactions under e-district services

7.9 million PAN card applications submitted

500,000 labour registrations

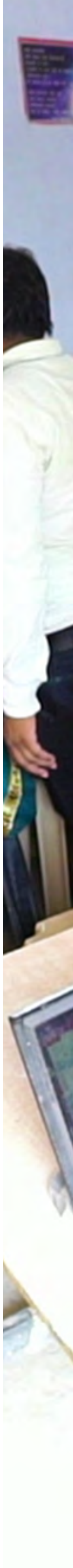
6.8 million e-Recharge transactions

84,000 tour and travel transactions

8.5 million electricity bills collected

14.2 million train reservations made through IRCTC

SOURCE: Ministry of Electronics and IT, Government of India



Potential actions to accelerate progress

The vision of doubling VLEs' incomes could be achieved if Common Services Centres were able to expand their portfolios of services in the following areas:

- **Large-scale data collection.** Service centres could be effective venues for government data-collection activities, such as annual census surveys, quarterly labour surveys, and the routine collection of health demographic information. Tapping this network could help the government gather this kind of data with higher efficiency and lower costs than current methods while also generating additional income for the village-level entrepreneurs who run CSCs.

- **Remote healthcare delivery.** Currently, no clear regulations govern remote healthcare delivery through CSCs. Existing regulations — the Drugs and Cosmetics Act and Medical Council of India Guidelines — are not clear about topics that affect CSCs, such as teleconsultations and online prescriptions. Also uncertain is the legal jurisdiction for medical negligence disputes that arise from advice delivered through telemedicine by a doctor in a different state than the patient. In addition, there are no specific privacy and security standards for storing and transmitting health-related data, such as video and audio recordings of consultations and data collected by remote diagnostic devices.

  The Ministry of Electronics and Information Technology, along with the Ministry of Health and state governments, can develop comprehensive rules for remote healthcare delivery that cover issues such as data privacy, consent, disputes, and jurisdiction, opening the way for telemedicine through CSCs. Moreover, restrictions on the sale of over-the-counter drugs could be modified to allow CSCs to act as pharmacies.

- **Wi-Fi Choupal service.** The goal of the Wi-Fi Choupal initiative, recently launched by CSC e-Governance Services India Limited, is to make Wi-Fi available in all villages via CSCs linked to BharatNet.[369] BharatNet is an infrastructure project designed to make high-speed, low-cost wired internet connectivity available throughout India. Five thousand villages have received Wi-Fi. Scaling this in a phased manner to all active CSCs would help in setting up smart villages.[370]

- **Jobs and learning platforms.** Going forward, there will be growing demand for people to fill low-skill jobs such as digitising data and images, tasks that can be practically and profitably outsourced to rural areas of India. State governments could support local entrepreneurs in setting up rural business-process outsourcing (BPO) businesses to perform simple, standardised digitisation tasks for the government. Many Common Services Centres are being readied to become virtual study centres for the Indira Gandhi National Open University and the National Institute of Open Schooling.

- **Expand state-to-citizen services.** States can increase the number of services they deliver to citizens through CSCs while still adhering to central government guidelines on sharing incentives with village-level entrepreneurs.

- **Devise better business models.** The government could conduct pilot studies in the CSCs of a few districts to develop these as prototypes whose business models could be replicated by village-level entrepreneurs across the country. This would help VLEs to increase their incomes and thrive in the long run. As part of the pilots, the government could investigate to understand the challenges that VLEs might face and explore new opportunities that could augment their incomes; for example, expanding the number of services CSCs offer while al so training and equipping VLEs to add greater value in delivering each service.

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[369] Wi-Fi Choupal website as of June 22, 2018.

[370] Universal Service Obligation Fund, Department of Telecommunications, Ministry of Communications website.

CSC
PRADHAN MANTRI GRAMIN DIGITAL SAKSHARTA ABHIYAN (PMGDISHA)
CSC

Goal C: Healthcare for all

Empowering Indians to reduce morbidity, the incidence of communicable and noncommunicable diseases, and infant and maternal mortality

Over the last few decades, India has made steady improvement in most indicators of healthcare. For example, life expectancy has increased by more than 10 years over the past three decades. In 2015, average life expectancy at birth was 68.3 years, which breaks down to 66.9 years for men and 69.9 for women, according to the World Health Organisation's *World Statistics Report, 2016*.[371]

Government schemes have played an important role in improving health outcomes. The Ministry of Health and Family Welfare's Janani Suraksha Yojana, launched in 2005, is designed to reduce maternal and infant mortality by focusing on institutional deliveries, which is a critical lever for improvement of these outcomes.[372] The share of women with institutional deliveries rose from 38.7 percent in 2005–06 to 78.9 percent in 2015–16, and in the same period, the infant mortality rate went from 58 to 34 per 1,000 births; between 2004–06 and 2011–13, the maternal mortality rate fell from 254 to 167 deaths per 100,000 live births.[373] Another example is the Pulse Polio programme, which focused on immunising children up to age 5. The programme began in 1995, when 3,265 cases of polio were reported, and after sustained effort at the central and state levels, the WHO declared India a polio-free country in 2014.[374]

Despite these improvements over time, there is a long way to go. According to the latest UN's Human Development Index, India ranks 131 among 188 countries globally and falls in the middle cohort.[375] In addition to making big inroads in key health indicators like infant mortality the country needs to provide effective care for infectious diseases and noncommunicable conditions such as heart disease, stroke, obesity, cancer, and diabetes.[376]

India aims to attain the highest level of health and well-being for citizens of all ages by making universal access to quality healthcare services available without causing financial hardship.[377] This requires lowering costs as well as instituting public health goals such as reducing the incidence of communicable and noncommunicable diseases, and infant and maternal mortality. Technology is making significant advances in how healthcare is delivered to people. According to experts, in the next decade, it may become mandatory for doctors to seek a second opinion from a tech or a software solution when deciding patient procedures. It is very much possible that, in the not-so-distant future, a software platform will emerge as the biggest provider of healthcare, creating a bedless hospital. This is similar to what we see today in the fields of mobility and hospitality, where the biggest solution providers — Uber and Airbnb — are not the owners of the inherent assets. While many basic health system gaps need to be filled, including inadequate physical infrastructure and lack of trained healthcare providers, three digital themes can help make better use of available resources to improve health outcomes leveraging the opportunities created by technology.

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[371] *World health statistics 2016: Monitoring health for the SDGs*, World Health Organisation.

[372] National Health Mission, Ministry of Health and Family Welfare.

[373] National Family Health Survey (NFHS-4), 2015–16, International Institute for Population Sciences, December 2017; infant mortality rate (per 1,000 live births), NITI Aayog, Government of India; maternal mortality rate (per 100,000 live births), NITI Aayog, Government of India.

[374] Pulse Polio programme in India, Ministry of Health and Family Welfare; Pulse Polio Immunisation India, Ministry of Health and Family Welfare.

[375] *Human development report 2016: Human development for everyone*, United Nations Development Programme.

[376] Infant mortality rate (per 1,000 live births), NITI Aayog, Government of India; *Country comparison — infant mortality rate*, Central Intelligence Agency.

[377] *National Health Policy*, 2017, Ministry of Health and Family Welfare, Government of India.

Blood pressure
93%
90%
80%

11. A universal electronic health record (EHR) for every Indian

> “Properly implemented and maintained EHRs not only provide a 360-degree view of an individual’s medical history, but also provide valuable insights on epidemiology and public health for effective and timely public health policies and programmes”

Vision and potential impact

The universal electronic health record (EHR) is an important long-term foundational element for providing quality healthcare to every Indian in the most efficient manner. By integrating health data from multiple sources such as healthcare centres, hospitals, and diagnostic labs, EHRs could provide a more comprehensive summary of a patient’s health, which could be particularly helpful in improving healthcare services. Finland, for example, has built a national archive of healthcare information, Kanta, a collaborative undertaking between Ministry of Social Affairs and Health and various social and healthcare organisations.[378] With the consent of their clients, Finnish healthcare providers can access patients’ EHRs and update them after each visit. Patients can view their own medical records, including their history of drug prescriptions, using the My Kanta app. In India, Rajasthan’s government is designing and implementing a similar statewide integrated health management system with a focus on electronic health records that will keep a complete account of patients and their treatments.[379] Patients would be able register and access EHRs through Aadhaar or Bhamashah accounts. Operated with blockchain technology, the EHRs would have open standards and open APIs to enable their integration across hospitals.

Properly implemented and maintained EHRs not only provide a 360-degree view of an individual’s medical history, but also provide valuable insights on epidemiology and public health for effective and timely public health policies and programmes. Comprehensive records are also expected to increase efficiency for healthcare providers and health insurance companies, improve the transparency of health outcomes, and deliver better care to patients. Analytics applied to EHRs could be used to identify at-risk individuals at healthcare centres and make targeted interventions. Children at risk of malnutrition could receive supplements, while adults at risk of developing serious ailments like cancer could be targeted by antismoking campaigns, and rural women with high-risk pregnancies could receive extra attention from accredited social health activists. Governments could use EHRs to mitigate and manage epidemics by, for example, quickly identifying and tracking dengue outbreaks and making sure that primary health centres are stocked with adequate supplies of the medicines necessary to treat it. Similarly, EHRs could be used to target public health spending such as sanitation measures to prevent outbreaks of cholera in areas with vulnerable populations. Health insurance companies could run analytics on anonymised EHRs for different demographics to more accurately price their policies.

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[378] Kanta website, Finland Ministry of Social Affairs and Health.

[379] Workshop on Integrated Health Management System, Government of Rajasthan.

Three enabling elements are key to achieving the potential of EHRs. First, the system needs a comprehensive regulatory framework. This includes templates for data capture (for example, the nature of fields such as age and sex to be captured for a diagnostic test), rules for data sharing and aggregation (such as consent-based sharing of test results as opposed to deemed consent), and rules for usage of EHR data (including the permit process for health data aggregation). The Ministry of Health and Family Welfare (MoHFW) has already approved metadata and data standards developed by the Ministry of Electronics and Information Technology.[380] MoHFW has also released a draft Digital Information Security in Healthcare, Act (DISHA) to enforce privacy and security measures for electronic health data, and to regulate storage and exchange of electronic health records.[381] Secondly, building a technological backbone to securely collect, store, and share data within established protocols is required. Patients should be able to access and share their EHR though a secure web portal or mobile. Each patient needs a unique identifier as a key requirement for achieving interoperability and creation of EHRs. This patient number would be assigned to all public and private health providers to facilitate interoperability among health IT systems. A unique identification number is also being allocated to all public and private health facilities. More than 223,000 public health facilities have received National Identification Numbers, and allocation to private facilities is under way.[382]

> “Three enabling elements are key to achieving the potential of EHRs – a comprehensive regulatory framework; building a technological backbone to securely collect, store, and share data within established protocols; and accelerating the generation of electronic health data”

Lastly, there is a need to accelerate the generation of electronic health data. The entire ecosystem of public and private healthcare providers — including hospitals, clinics, diagnostic labs, and pharmacies — can help by capturing more data to capitalise on the potential of electronic health records. This would require creating or updating software across the healthcare value chain in order to comply with EHR standards.

Initiatives already under way

Many initiatives and small-scale electronic health record pilot programmes are already under way, whether in mobile health centres operated by state governments or a private hospital chain’s software that can analyse records and provide suggestions for treatment and diagnosis. Some examples are outlined in Exhibit R11.

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[380] Standards for eGovernance, Ministry of Electronics and Information Technology.

[381] *Digital Information Security in Healthcare*, Act, Ministry of Health and Family Welfare, November 2017.

[382] Ministry of Health and Family Welfare.

Exhibit R11

Electronic health records help in delivering better healthcare to patients

Organisation	Context	Solution	Impact
Ministry of Health and Family Welfare with NIC	▪ Mother and Child Tracking System (MCTS) is an online information system to monitor timely delivery of pre- and post-natal care services to all pregnant women and immunisation to all children, launched by Ministry of Health and Family Welfare in 2009	▪ Provides alerts to health service providers about services due and gaps in service delivery; sends health promotion messages to beneficiaries via mobile phones ▪ Serves as a ready reference about services status of or vaccinations delivered to pregnant women and children ▪ Also used to promote institutional delivery among poor pregnant women through Janani Suraksha Yojana scheme	▪ Implemented across all 36 states and UTs ▪ 142.6 million pregnant women and 123.1 million children registered on MCTS
Government of Andhra Pradesh	▪ Chandranna Sanchara Chikitsa is an initiative of the Government of Andhra Pradesh, operated by Piramal Swasthya to address core problems of accessibility and availability of primary healthcare in rural areas of Andhra Pradesh through 290 mobile medical units in 13,616 villages across 13 districts of Andhra Pradesh	▪ Each patient is given an electronic health record linked to a unique beneficiary number; EHR meets government privacy standards ▪ Paramedical staff capture EHR details on tablets that work offline and online ▪ EHR statistics are available on a public dashboard to enable tracking of health outcomes and identification of high-risk patients	▪ 9.5 million patients given an electronic health record ▪ 310,123 clinics conducted
Narayana Health	▪ Narayana Health has developed an EHR for diabetology to address the challenge of collating detailed patient histories as diabetic patients receive treatment over several years	▪ The EHR software captures patient history and past procedures in one dashboard ▪ Has an intuitive interface with minimal typing required ▪ Software allows doctors to directly print prescriptions	▪ Currently available for all diabetes patients receiving treatment at Narayana Health, with plans to expand to other disease areas
Microsoft with Apollo Hospitals	▪ Indians suffer nearly 3 million heart attacks every year and 30 million people have coronary diseases ▪ Doctors are unable to identify probability of cardiac ailments when patients come for their regular health checkups	▪ Microsoft AI Network with Apollo Hospitals has developed a health risk score using patients health check-up information ▪ Partnership to develop an India-specific heart risk score and better predict cardiac diseases for general population ▪ Uses data from 2010–2017 consisting of clinical and lab data of 400,000 patients ▪ Brings new insights in predicting population-based heart diseases	▪ Started with 100 risk factors from patient health check-ups, narrowed down to 21 risk factors to build model to predict heart risks for the Indian population

SOURCE: Piramal Swasthaya; Manipal Hospitals; Narayana Health; Ministry of Health and Family Welfare, as of March 2018; Jasmeen Nagpal, Microsoft & Apollo Hospitals to use Artificial Intelligence for early detection of cardiac diseases, Microsoft, March 8, 2018.

Potential actions to ensure accelerated progress

The steps required to create a robust, secure and user-friendly national EHR platform are outlined here:

- **Draw up clear standards for different aspects of EHR and a road map for their adoption.** The Ministry of Health and Family Welfare has been working to make universal electronic health records a reality — it defined EHR standards in 2013 and updated them in 2016.[383] India has also joined SNOMED International, a UK-based international nonprofit organisation that sets standards for computer-readable medical terms (Systemised Nomenclature of Medicine–Clinical Terms, or SNOMED–CT).[384] To facilitate the use, adoption, and implementation of the EHR standards suggested by SNOMED–CT, the government has established the National Resource Centre for EHR Standards. It has also issued 239 SNOMED–CT affiliate licences, deployed free open-source software, and started e-learning courses, physical workshops, and training programmes to sensitise key stakeholders regarding standards.[385]

  While electronic health records offer considerable social utility, they are not yet mandatory — and hence have not been widely adopted — because they impose marginal cost on private operators. To accelerate adoption, the government could mandate the use of electronic records in phases. The immediate focus could be on large public health programmes such as immunisation and noncommunicable disease screening; records generated by existing initiatives like the Mother and Child Tracking System could be extended even after their primary purpose is over. In the long term, efforts could be made to cover all healthcare provision points, such as public hospitals, private hospitals, clinics, and diagnostic labs.

- **Develop an interoperable platform for storing and sharing EHRs.** Currently there is no secure cloud-based platform for electronic health records, and no user-friendly app or web portal for medical providers and consumers to access or update their records. Organised healthcare providers have their own EHR software but have little incentive to invest in new software that works well with other systems. Moreover, a large number of unorganised providers such as small clinics, diagnostic labs, and independent pharmacies would need to invest in IT to prepare for EHR capture, storage, and uploading.

  To address this need, the Ministry of Health and Family Welfare has started thinking about working through a special-purpose vehicle to build and manage an interoperable platform for EHRs, which could be done by leveraging the digital locker framework. The design, development and implementation of this Integrated Health Information Platform is under way.[386] MoHFW has also released a draft Digital Information Security in Healthcare, Act (DISHA) to enforce privacy and security measures for electronic health data, and to regulate storage and exchange of electronic health records.[387] This draft Act could also have recommendations for individuals to store a copy of their EHR data in a repository of their choice.

  This platform would allow for the creation of user-friendly web and mobile applications to enable patients and other stakeholders to easily view EHRs to which they have been granted access. The Centre for Development of Advanced Computing has designed a platform called MyHealthRecord that will enable patients to access their records anytime and make the records accessible to any doctor they visit.[388] The adoption and use of this platform needs to be scaled up and expanded with the addition of a clinical practice management module.

One way to expedite adoption of electronic records is to reduce the cost of procuring software for healthcare providers. The Ministry of Health and Family Welfare plans to help health providers acquire electronic health record and hospital information system software (for example, the National Informatics Centre's eHospital software) to incentivise wide-scale adoption of EHRs. Public and private providers could improve on this by developing cloud-based software, which would enable health providers to opt in and adopt pay-as-you-go models for increasing flexibility to adopt EHRs.

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[383] Electronic Health Records, Ministry of Health and Family Welfare.

[384] SNOMED International website.

[385] Ministry of Health and Family Welfare.

[386] *Electronic Health Records*, Ministry of Health and Family Welfare press release, January 5, 2018.

[387] *Digital Information Security in Healthcare, Act*, Ministry of Health and Family Welfare, November 2017.

[388] MyHealthRecord, Centre of Excellence for Digital Preservation.

123 SYS mmHg
81 DIA mmHg
67 PUL /min
BPM
67
82 BPM, 5m ago

12. Tech-enabled health delivery system for primary, secondary, and tertiary care

> “Technology-enabled e-health centres and e-hospitals, equipped with internet connectivity and communication equipment such as tablets and mobile devices, could provide access to a network of doctors who can consult via voice calls or HQ video”

Vision and potential impact

One of the key challenges to improving health outcomes is the shortage of healthcare professionals. India currently has 0.8 physician for every 1,000 people, which is below the World Health Organisation’s recommended ratio of one doctor per 1,000 people.[389] Further, there is a significant difference in health infrastructure between cities and rural communities: 60 percent of India’s hospitals are in urban areas, serving about 32 percent of the overall population.[390]

While human and physical infrastructure needs to be built to bridge such divides and improve health outcomes, information and communications technology can be a key enabler to alleviate these issues and provide better healthcare. For example, technology-enabled e-health centres and e-hospitals, equipped with internet connectivity and communication equipment such as tablets and mobile devices, could provide access to a network of doctors who can consult via voice calls or HQ video. Likewise, online learning and training courses can help ramp up the supply of healthcare professionals. Technology-enabled e-health centres could take various physical forms — the existing network of 25,354 primary health centres, 155,708 subcentres or health and wellness centres, and 35,416 government hospitals could be equipped to become e-health centres or hospitals,

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389 Global health workforce statistics, World Health Organisation, 2016.

390 *Report on healthcare access initiatives,* KPMG-OPPI, KPMG in India, August 2016.

and 292,748 Common Services Centres could carry out teleconsultations, telediagnostics, and tele-education.[391]

The government is already using technology to issue health advisories: for example, Kilkari, an application that delivers free weekly audio messages on pregnancy, family planning, nutrition, childbirth, and maternal and child care, already has 48.2 million calls.[392] MoHFW designed a doctor-on-call service, the National Health Helpline, which launched with 500 qualified doctors available free to citizens at all hours, every day of the year.[393] The government also has introduced the National Health Portal to provide information in six languages using a mobile app and a toll-free number; more than 2.6 million people have used the web portal, and 2.2 million have called the toll-free number.[394]

Local health and paramedical workers — such as accredited social health activists, or ASHAs; auxiliary nurse midwifes, known as ANMs; and workers in *Anganwadis*, or child-care centres — could be trained to use tablets and video facilities to arrange remote consultations, conduct diagnostic tests, and use supporting software with protocols and escalation procedures. Roughly 75,000 ASHA workers have registered with a mobile academy for free audio training.[395]

Despite immense potential, given the length and breadth of the country, technology-intermediated healthcare delivery and training is at best at a nascent level. These tech-based healthcare models are constrained by the lack of clear regulation. For example, a remote consultation without a doctor present physically is not recognised in India's legal framework. The same is true for e-pharmacies without any physical outlets. Moreover, regulations are lacking on the management of data that will be generated through telehealth activities.

> "Beyond economic value, patients in remote and rural areas can experience significant benefits by reducing their dependency on unqualified medical practitioners, saving time and money spent in travelling to the nearest city or town to obtain expert medical advice"

Telemedicine models have the technical capability to replace up to 50 percent of in-person outpatient consultations. Accelerated implementation of reforms could enable India to tap 60 to 80 percent of this potential by 2025. Telemedicine initiatives globally have shown that virtual consultations cost about 30 percent less than in-person consultations, so at this scale, the improved healthcare delivery model would imply $4 billion to $5 billion of savings in 2025. Beyond economic value, patients in remote and rural areas can experience significant benefits by reducing their dependency on unqualified medical practitioners, saving time and money spent in travelling to the nearest city or town to obtain expert medical advice, and improving overall wellness through sustained follow-up interventions.

Initiatives already under way

Many initiatives and small- and large-scale pilot projects are already under way in technology-enabled healthcare, led by government and non-government healthcare services organisations. Some examples appear in Exhibit R12.

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[391] Sub-centres, primary health centres (PHCs) and community health centres (CHCs) functioning in India, as of April 2018.

[392] Ministry of Health and Family Welfare.

[393] Ibid.

[394] Ibid.

[395] Saleema Razvi, Ritu Srivastava, and Buddhadeb Halder, *Mobile phone: A public tool — analysing the use of mobile technology in civic participation, education, and health*, Digital Empowerment Foundation and UNICEF India, October 2016.

EXHIBIT R12

Using medical technology to deliver healthcare to rural population

Organisation	Context	Solution	Impact
SughaVazhvu healthcare	- SughaVazhvu is a non-profit organisation in Tamil Nadu that uses technology to provide primary healthcare for inaccessible rural population using technology for healthcare management and patient screening	- Local health workers are trained in protocol-based medicine and given tools (mobile phones and tablets with apps) for rapid risk assessment - High-risk individuals are referred to the nearest rural micro health centre for low-cost consultation and treatment - The data analysis capability built into its health information system allows SughaVazhvu to monitor population level health outcomes	- 70,000 patients reached from a network of 7 clinics - 40,000 patients received primary healthcare services
Government of Himachal Pradesh with NHM and Piramal Swasthya	- Telemedicine program launched in August 2015 in Himachal Pradesh to establish telemedicine units at government primary healthcare centres (PHCs) and subcentres to provide specialist care to patients in the neighbourhood	- Helps beneficiaries avoid unnecessary hospitalisation through early specialist intervention - The range of services includes identification, screening, diagnosis, monitoring and treatment; follow-up and referral of complicated cases in the areas of reproductive health, maternal health, neonatal health, child health, adolescent health, communicable and non-communicable diseases	- 24,300 patients have been served with an average of 1,278 consultations per month - 66% of all beneficiaries are women with a total of 4,527 gynaecologist consultations - 3,321 beneficiaries under 5 years of age
Department of Health and Family Welfare, Tamil Nadu	- Health Management Information System (HMIS) aims to integrate all the primary, secondary, and tertiary healthcare centres as well as medical colleges in each state - Comprises two broad divisions — Hospital Management System (HMS) and Management Information System (MIS)	- Every patient is assigned a unique patient identification number (PIN), which can be used across hospitals and pharmacies to access their medical records - HMS helps in computerisation of multiple services in hospitals such as patient registration, inpatient and outpatient records, pharmacy sales, as well as blood bank and lab records - MIS is a unified health reporting system for clinical and ancillary services, health programmes, and administrative information on public health facilities	- As of June 2016, HMS was fully functional across 1,613 primary and over 267 secondary hospitals and 17 government medical colleges - Integrated over 2,000 centres across the state
Ministry of Electronics and IT in partnership with Apollo	- Sehat scheme uses technology to extend primary healthcare services to rural India through the channel of Common Services Centres (CSCs) - Apollo has partnered with the government to implement the scheme	- Apollo converts CSCs into remote medical consultation centres by equipping them with internet, webcam, and audio facilities - CSCs also have the capability to schedule appointments and dispense over-the-counter drugs	- 60,000 CSCs have been equipped for teleconsultations - 7,192 Apollo teleconsultations done as of November 2017 - 13,993 CSC teleconsultations done as of October 2017

SOURCE: Apollo Hospitals; National monthly progress report, Common Services Centre scheme, November 2017; Centre for Health Market Innovations; Ministry of Electronics and Information Technology; Health Management Information System, Department of Administrative reforms & Public Grievances, September 2011.

Potential actions to ensure accelerated progress

As discussed above, digital healthcare can scale rapidly provided it is backed by supportive policies and private-sector innovation. MoHFW has been actively working on a number of catalysing initiatives, such as drafting legislation to clarify and legitimise remote health policy. In the interim, it has been rolling out services like telediagnostics, which have the potential to make a difference in the short term while paving the way for supportive architecture in the long run. The following actions summarise key dimensions that need to be addressed to advance remote healthcare.

- **Legalise remote healthcare delivery and services.** Existing regulations (such as the Drugs and Cosmetics Act and the Medical Council of India Guidelines) do not adequately clarify issues likely to come up in the context of remote healthcare. For example, laws need to clarify the legal validity of teleconsultations and online prescriptions, as well as legal jurisdictions for medical negligence disputes when advice is delivered through telemedicine by a doctor located in a different state than the patient. Privacy and security standards need be set for storing and transmitting health records and advice for remote healthcare delivery — for example, adopting standards for saving data from video and audio recordings of consultations, and setting rules for data collected by remote diagnostic devices. The Ministry of Health and Family Welfare has been actively thinking of these issues, and has drafted a Digital Information Security in Healthcare, (DISHA) Act. This Act has listed powers and functions to the National Electronic Health Authority of India to collaborate and work on standardisation testing and quality certification of digital healthcare system, while also addressing other key issues like data sharing.[396] The Act on has been drafted and is in public consultation provides a robust foundation.[397]

  The digital health landscape is rapidly undergoing disruption, and the field requires an agile and responsive regulator. The act encompasses setting up a National e-Health Authority (NeHA) as a statutory body for the promotion, adoption, and regulation of e-health services. National and state authorities could formulate and adopt a national remote healthcare service policy that would cover data storage, data protection, patient consent, jurisdiction issues, dispute resolution, and other matters. Along with rules on processes, the system needs a quality-control mechanism for telehealth service providers. To address this gap, the e-health authorities, along with the Medical Council of India (or the proposed National Medical Commission, which could replace it), could set up a certification and review mechanism to ensure that doctors and health workers are qualified to deliver e-consultations.

- **Roll out interim healthcare services that don’t require legal clearance.** In order to expedite remote healthcare services and not wait until the digital health authority legislation is enacted, MoHFW is exploring rolling out services that are currently not prohibited under the law. They include providing assisted teleconsultations (remote sessions with expert doctors, conducted while a general physician is physically with the patient) and telediagnostics (such as teleradiology). The Himachal Pradesh state government’s telemedicine programme, launched in 2015, has reached more than 24,300 patients, 66 percent of whom are women.[398] These remote consultations are being leveraged further through BharatNet connectivity to the gram panchayat level, and provision of computer and other IT resources through the National Health Mission.

- **Enable a ubiquitous network of remote healthcare delivery points with adequate digital infrastructure.** India has a tiered structure of providing healthcare, with primary care through primary health centres (PHCs) and subcentres, secondary through community health centres (CHCs), and tertiary through district hospitals. Currently there are about 150,000 subcentres and 25,000 CHCs; while these are fewer than ideal for population thresholds, they still represent a big opportunity to create last-mile telehealth access points for quality remote healthcare delivery to millions.[399]

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396 The Ministry of Electronics and Information Technology is in the process of finalising a bill on Data Protection Framework, which would provide a robust base for creating suitable policies related to sharing and storing of health data in particular.

397 *Digital Information Security in Healthcare, Act*, Ministry of Health and Family Welfare, August 2018.

398 Ibid.

399 Sub-centres, primary health centres (PHCs) and community health centres (CHCs) functioning in India, as of March 31, 2016.

The National Health Policy of 2017 proposes upgrading subcentres to health and wellness centres.[400] The Ministry of Health and Family Welfare is moving from a treatment-based focus to a wellness- or prevention-based focus. These centres are envisioned as having significantly improved infrastructure to provide comprehensive healthcare, including treatment for noncommunicable diseases and maternal and child health services, along with provision of free essential drugs and diagnostic services. An allocation of over $180 million has already been proposed in the Union Budget of 2018 to upgrade the 150,000 subcentres in the country to health and wellness centres.[401] This is a welcome move and could be a catalyst to improve access to care, especially in rural areas.

- **Provide adequate digital infrastructure and trained public health personnel.** Together with the creation of physical infrastructure, at-scale implementation of remote health services also requires trained health personnel at local health centres. Most health extension workers are currently not equipped to use digital devices, nor do they have the training in clinical protocols to enable decision making for remote consultation. Training for all healthcare professionals could be enabled through e-learning. The Ministry of Human Resource Development's SWAYAM platform (Study Webs of Active Learning for Young Aspiring Minds) could offer online courses on healthcare delivery for nurses, paramedics, and other workers. The Ministry of Health is considering establishing a digital national medical library with access to major journals and other resources that could be made available for a minimal charge to medical schools, hospitals, and individual practitioners on, say, UMANG, the multichannel, multiplatform, and multilingual application for accessing central and state government services.

  MoHFW is also looking at developing an e-learning platform for all health workers, which would be especially helpful in training staff in remote areas. This platform could have modules to teach basic and recent healthcare practices, but also could be used to train and certify workers on informatics skills. MoHFW is also formalising partnerships with academic institutions for content development and evaluation.

  Public-private partnerships could be thought of as an effective supplementary strategy to kick-start remote health services in the shortest possible time as the state ramps up its physical and health resources to deliver a large portfolio of, at least, outpatient services through digital means. As an example, in 2016 Andhra Pradesh piloted e-Urban Primary Health Centres, public-private partnerships that enable existing PHCs to use technology to increase the availability and quality of healthcare for the urban poor while reducing out-of-pocket expenditure.[402] The government has set up 164 such e-Urban PHCs in partnership with Apollo Hospitals, a private business based in Chennai.[403] Apollo has equipped the centres with state-of-the-art telemedicine portals and a panel of doctors. Through telemedicine, the PHCs provide access to specialists to manage conditions such as diabetes and heart disease.

- **Create dashboards to monitor health inputs, outputs, and outcomes in real time.** Real-time and convenient tracking of data from various health service points across states can help guide day-to-day operations and long-term planning. Creating dashboard views for all levels of the value chain, from district to state to national, would facilitate decision making and empower administrators to respond to emergencies. This could be combined with administrative data on, for example, funding, infrastructure expansion, and insights from demographic- and geography-level analysis of anonymised EHR data to present a complete view of inputs, outputs, and even outcomes.

  MoHFW is currently building a Central Health Dashboard to monitor key performance indicators in the following areas: 1) sustainable development goals for health; 2) the country health system, covering all health system components, including financing, labour force, service coverage, governance, and access to drugs and diagnostics; 3) programme-specific dashboard, for MoHFW initiatives on such public health concerns as disease control and family planning; and 4) key priority programmes initiated by the central government, such as free drugs, free diagnostics, free dialysis, and the Pradhan Mantri Swasthya Suraksha Yojana programme to increase healthcare in underserved populations.

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[400] National Health Policy 2017, Ministry of Health and Family Welfare, Government of India.

[401] National Health Policy 2017, Ministry of Health and Family Welfare, Government of India.

[402] Request for Proposal (RFP) For Electronic Urban Primary Health Centres, Department of Health and Family Welfare.

[403] *Reforming the public health system – in a PPP with the govt of Andhra Pradesh*, Apollo Tele Health Services website, November 2016.

13. Universal public health insurance platform

Vision and potential impact

With over 70 percent of healthcare expenditure in India being out-of-pocket and 15 to 20 percent of households facing catastrophic health expenditure annually, providing universal healthcare insurance to the vulnerable sections of the society is a key health goal for India.[404] The government has recently introduced the National Health Protection Scheme (Ayushman Bharat) to provide up to $7,500 in medical coverage annually to about 100 million vulnerable families in order to ensure universal healthcare financing is available to everyone.[405]

A digital health insurance platform is essential as a technology backbone for successfully rolling out the National Health Protection Scheme, helping achieve fast onboarding of insurers, lowering the risk of false claims, and efficiently processing claims and settlements. This public digital platform could connect patients, insurers (both private and public), and hospitals. Enrolment, validation, and claims processing could all be done online. Each person insured could have a digitally verifiable database with his or her EHR. Analytics on demographics through access to anonymised medical records and consent-based individual records could help insurance providers determine accurate premiums.

An IT-enabled process could discourage overbilling and fraud by confirming appropriate service delivery, for instance by reviewing pictures uploaded before and after discharge, verifying treatments with patients, and validating costs with patients before reimbursement. Such a platform could lower operating costs by reducing the need for on-premises staff and enable hospitals to settle claims faster through an online verification process.

Initiatives already under way

In addition to the Ministry of Health and Family Welfare's RSBY programme, the government of Andhra Pradesh offers its own scheme to provide health insurance to low-income families and uses a sophisticated IT system to track patients, their records, and their medical bills. More details appear in Exhibit R13.

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[404] *World Bank support to the health sector in India*, World Bank, April 6, 2010; Anamika Pandey et al., *Trends in catastrophic health expenditure in India: 1993 to 2014*, World Health Organisation, November 2017.

[405] Ayushman Bharat (National Health Protection Mission).

Exhibit R13

Government initiatives deliver health insurance to the underserved poor

Organisation	Context	Solution	Impact
Ministry of Health and Family Welfare	▪ Rashtriya Swasthaya Bima Yojana launched in 2008 to provide health insurance to families below the poverty line — planned to cover 70 million households by the end of 2017	▪ Benefits: Over $450 of hospitalisation coverage per family annually ▪ Cost: Premium is shared by the state (25%) and central government (75%); beneficiaries pay 50 cents to enrol ▪ Enablers: Beneficiaries receive biometric smart cards to obtain cash-free services in hospitals	▪ 36.3 million below-poverty-line families enrolled, more than 1 million claims in 8,697 hospitals
Government of Andhra Pradesh	▪ Aarogyasri introduced in 2007 to provide health insurance to citizens earning less than $900 in rural areas and $1,100 in urban areas	▪ Benefits: Up to $3,750 per family annually (covers 1,040 surgeries/ therapies in 31 systems) ▪ Payment: Fully funded by the state government ▪ Enablers: – Sophisticated IT system to track patients, their electronic medical records, hospital bed capacity, claims and reimbursements – Aarogyasri Healthcare Trust oversees the entire program – Aarogya Mithras, or patient advocates, at each hospital act as caseworkers and educate patients – Insurance company for all front-end and back end insurance administration – High-speed internet and PCs for each hospital – Hospitals should have minimum 50 beds to join the network	▪ Health insurance coverage up from 10–15% in 2006 to 85% in 2016

SOURCE: Rashtriya Swasthya Bima Yojana, Ministry of Health and Family Welfare, as of April 24, 2018; NTR Vaidya Seva Trust; B. Suresh Lal, Economic Analysis of thè Rajiv Aarogyasri Scheme: An Empirical Study in Warangal District, January 2017.

Potential actions to ensure accelerated progress

A universal health insurance platform has important prerequisites, and possible actions are required to ensure that they are put in place:

- **Build a secure platform and supporting software for insurance via government schemes.** A digital health insurance platform is being developed for speedy and accurate enrolment, payout tracking, and grievance redressal for the just rolled-out National Health Protection Scheme. Existing government health insurance schemes could be merged onto the platform, and enrolment could be digitally verifiable to avoid duplicate or incorrect enrolments. The health insurance platform could be integrated with each patient's electronic health record to enable insurance companies to assess risk, based on consent of the patient.

  At the same time, there is a need to ensure that all data related to payouts is captured and seamlessly integrated with the platform. This will require software for different players in the health value chain to be interoperable with the platform and aligned with EHR standards so that relevant information can be made available on the platform. Tamil Nadu and Maharashtra have implemented similar systems for state-level schemes, which could be leveraged as a starting point for the national platform.

  Given the large number of people expected to be enrolled in the National Health Protection Scheme, this platform could become a ubiquitous one-stop insurance solution for government. In the future, insurers like the New India Assurance Company and other public-sector insurance companies could consider leveraging the platform for their online processes. The platform could expand use cases to include claims processing, payments, and any other actions, as required. Steps could also be taken to make this platform interoperable with those of private-sector insurance players, especially for facilitating win-win use cases such as insurance underwriting, demographic level analytics, and public health monitoring.

- **Pool data from insurance payouts with electronic health records.** Data related to insurance payouts and premium payments are useful for risk pricing. Insurance companies would find such data a valuable addition to electronic health records. As with all EHR data, any information sharing would need to adhere to the principles of consent-based release or anonymisation. The data to be shared with the insurance company would have to fit the guidelines of the national digital health authority and be approved by the patient. A mechanism could be devised to establish interoperability between different health insurance software solutions in order to link this data with EHR.

MAIN
300
2000
WWW
CLOUD
30%
15%
7%
48%
iDeA 45%
25%
TEAM
internet
MARKETING
SUCCESS

Goal D: Quality education for all

Enable all Indians to get a better education and significantly improve learning outcomes

With 1.5 million schools, 8.7 million school teachers, 260 million students in schools, about 800 universities, 41,000 colleges, and about 30 million students in higher education, India has one of the largest education systems in the world.[406]

Over the years, India has invested heavily to improve access to education, and this has resulted in increased enrolment. Elementary education has become nearly universal, with a gross enrolment ratio of 96.9 percent in 2015–16.[407] Trends at the secondary and higher-secondary levels also show significant improvement: The gross enrolment ratio increased from 65 percent in 2010–11 to 80.1 percent in 2015–16 for secondary, and from 39.3 percent to 56.16 percent in the same period for higher secondary.[408] The last push required is focus on enrolling over six million children who do not go to school and tracking and arresting high rates of absenteeism among those who are enrolled.[409] The Department has started to prepare an index to assess the performance of states and union territories in school education and will be graded on the basis of this index. The index is based on 70 indicators, one of which is average daily attendance of students.

However, while enrolment levels have increased, learning outcomes need to improve. Class V students, for example, were able to correctly answer only 45 percent of reading comprehension items, 46 percent of mathematics items, and 50 percent of environmental studies items in the National Achievement Survey.[410]

Furthermore, student performance, as measured by the National Achievement Survey, is more or less static and not improving over time. For class V, the average scores out of 500 in reading comprehension actually declined marginally from 247 in 2012 to 241 in 2015. Similarly, the average score in math declined from 251 to 241, and in environmental studies from 249 to 244 in the same period.[411]

A comparable trend has played out for higher education. The number of higher education institutions grew from 44,690 in 2010–11 to 51,793 in 2015–16, and enrolment rose from 19.4 percent to 24.5 percent of people between the ages of 18 to 23 years old.[412] However, quality remains a concern even at this level. While islands of excellence are present in the form of prestigious institutions like the Indian Institutes of Technology and Indian Institutes of Management, the average quality of higher education leaves a lot to be desired. Only 17.9 percent of the country's IT graduates are employable in the IT services sector, and 3.7 percent in IT products.[413] Another study found that around 93 percent of MBA graduates of Indian business schools (those ranked in the bottom 80 percent of each class) are unemployable.[414]

Digital content and channels provide a powerful opportunity to bridge the last remaining gaps in access and, equally importantly, to improve learning outcomes significantly. Interactive and gamified digital content that is tailored for individual students can improve retention and learning outcomes by making instruction

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[406] *School education in India 2015–16*, Flash Statistics, Universal District Information System, September 30, 2015; *Annual Report*, University Grants Commission, 2016; All India Survey of Higher Education, Ministry of Human Resource Development, 2015–16.

[407] *School Education in India 2015–16*, Flash Statistics, Universal District Information System, September 30, 2015.

[408] *Statistics of School Education 2010–11*, Ministry of Human Resource Development; *School Education in India 2015–16*, Flash Statistics, Universal District Information System.

[409] Annual Report, Ministry of Human Resource Development, 2015–16.

[410] *What students of class V know and can do*, summary of India's National Achievement Survey, Class V (Cycle 4), National Council of Educational Research and Training, 2015.

[411] *What students of class V know and can do*, summary of India's National Achievement Survey, Class V (Cycle 4), National Council of Educational Research and Training, 2015; National Achievement Survey, Class V (Cycle 3), National Council of Educational Research and Training, 2012.

[412] All India Survey of Higher Education, Ministry of Human Resource Development, 2010–11 and 2015–16.

[413] *National employability report (engineers): Annual report 2016*, Aspiring Minds, 2016.

[414] *B and C category B-schools producing un-employable pass-outs*, The Associated Chambers of Commerce and Industry of India, April 27, 2016.

more effective. Moreover, digital channels can help reach students, especially girls, in areas with poor infrastructure and safety. Operation Digital Board (ODB) has evolved out of the need to provide good quality education by effective use of the Technology and Telecom Services. Department's Operation Digital Board aims to convert every classroom in all senior secondary schools into a digital classroom. This will offer new ways of teaching and learning in schools. A committee has been set up to suggest the parameters and specifications for this.

High-speed broadband internet access will give students in remote areas access to high-definition education content, reducing dependence on physical infrastructure and supplementing live classroom teaching with online courses. It could also benefit rural students who need specialist support, such as reading recovery, or who want to learn subjects that are unavailable at their school.

Accelerated implementation of these themes would result in added economic value of $20 billion to $50 billion by 2025, assuming a 10 to 30 percent improvement in learning outcomes as a result of digitally assisted teaching and learning.[415] Each additional year of schooling lifts wages by over 8 percent.[416] We assume that 40 to 60 percent of the 65 million to 70 million people who are expected to enter India’s labour force between 2017 and 2025 will be taught using digitally assisted means.[417]

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[415] *The EdTech promise: Catalysing quality school education at scale*, Central Square Foundation, July 2015.

[416] Claudio E. Montenegro and Harry Anthony Patrinos, *Comparable estimates of returns to schooling around the world*, policy research working paper number WPS7020, World Bank Group, September 2014.

[417] *The world at work: Jobs, pay and skills for 3.5 billion people*, McKinsey Global Institute, June 2012.

14. Integrated digital education platform for students, with customisable local-language content

Vision and potential impact

Digital content has the potential to make teachers more effective and productive and productive by using digital content using digital content, such as instructional videos or presentations with rich infographics and images, as teaching aids. High-quality, easy-to-understand teaching material would go long way toward reducing the gap in learning outcomes among students due to differences in the quality of teachers. This could help improve engagement with students while enabling instructors to easily reuse and update their teaching materials. More advanced solutions based on gamification and artificial intelligence could allow students to learn even with reduced engagement from teachers.[418]

At the same time, digital content could be used for continuous training of teachers. In Sweden, an online training resource called PIM (for Practical ICT and Media) aims to enhance teaching skills. It is actively used by 35 percent of teachers in the country.[419] In India, the recently announced national platform DIKSHA provides a full stack of services for teachers, including both content and tools. While the initiative is still in its initial stages, it could be a big enabler for improving effectiveness. Adaptive learning solutions could be utilised for teacher training, improving teachers' grasp of course content, and enabling them to learn more effective teaching techniques through gamification and role playing. Moreover, a repository of tools for teachers to create digital content, such as in-class resources, peer-training material, and assessment aids, is envisioned as part of the platform. Furthermore, school administrators could benefit from access to analytics-enabled systems monitoring student performance, scholarship management systems, and other management metrics.

Multiple initiatives under way in the Ministry of Human Resource Development focus on building digital content and solutions (Exhibit R14A). These initiatives are relatively new, started over the last 2–3 years only, and while they are individually useful for different stakeholders, their adoption and usage is currently limited compared to global platforms like Khan Academy, which says it has delivered over one billion lessons and is used by 40 million students and two million teachers every month.[420] Similarly, Denmark's EMU portal pools private and public digital learning resources to make them easily accessible to the entire Danish education community. It includes digital content, conference service for teachers, and databases, and it sees over half a million unique users very month.[421]

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[418] *The Edtech Promise: Catalysing Quality School Education at Scale*, Central Square Foundation, July 2015.

[419] *OECD study on digital learning resources and systemic innovation: Country case study report on Sweden*, Organisation for Economic Co-operation and Development, February 2009.

[420] Khan Academy. Accessed May 2018, khanacademy.org.

[421] EMU.dk – Denmark's Education Portal.

In a similar vein, there is a need to simplify the user experience, especially for students. This could be done by creating a one-stop digital education platform for students at all levels. The vision could be to have a secure, data-protected learning profile for every student, on a platform where students can log in and track learning activities and outcomes. The platform could act as a digital parallel for the school and higher education journeys of students. It could be integrated with data and resources from different agencies such as the National Achievement Survey, the Central Board of Secondary Education, and state boards, to provide a holistic picture of student performance at the individual and aggregate levels. The platform could create seamless links between the student profile and suitable educational content and tools, leveraging existing initiatives like the National Repository of Open Educational Resources, SWAYAM, and ePathshala, and giving students convenient access to content based on their requirements. Moreover, the platform could provide APIs for educational content creators and solution developers. Such an approach would attract entrepreneurs with the potential to create innovative and user-friendly solutions, which is critical for catalysing large-scale adoption and real utility for students. By providing a shared backbone and interoperable content and solutions, this platform could also help bring efficiencies to education-related digital initiatives in different states, while eliminating redundancies in content and solutions that currently exist in silos in different states. Operation Digital Board is looking at various ways and means to ensure this and also other options.

In order to build an effective platform, following important design principles could be considered:

1. **Customisation for regions and individuals:** Education solutions that contextualise content and delivery according to a student's specific circumstances have been shown to deliver significantly superior learning outcomes.[422] Innovative approaches stemming from AI and predictive analytics could be leveraged for building strong feedback loops in the teaching and learning process, for example offering new learning challenges based on how the student or teacher has performed on previous ones.
2. **Solutions robust to digital and language barriers:** Content and tools could be made offline-friendly for areas and users without full-time internet access. Moreover, digital literacy assessment and coaching could be a starting point for all users. Support for local languages could lead to the emergence of a vibrant local-language online world, which could catalyse growth in digital adoption in sectors beyond education.
3. **Assessment of content and student performance:** While there is great potential to crowdsource content creation through an open societal platform, it brings with it a need for a quality framework and process for quality checking the resulting content. This could be done through a mix of a centralised review of content and building in a user-rating system to highlight errors in content by users. Moreover, for leveraging adaptive learning solutions, it is important to create a continuous flow of information from assessments of student learning, through mechanisms such as in-course quizzes and gamified tests.
4. **Services for stakeholders beyond students:** The platform could provide services for different target groups, accessible not just to students, but also to parents, adult learners, and school administrators.

Initiatives already under way

Some initiatives of the Ministry of Human Resources and Development are highlighted in Exhibit R14.

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[422] *How the world's best-performing school systems come out on top*, McKinsey & Company, September 2007.

Exhibit R14

Ministry of Human Resource Development has a number of initiatives to leverage digital application for improved learning outcomes

Organisation	Context	Solution	Impact
DIKSHA	▪ Only ~15% of India's 10 million teachers receive training annually ▪ Training methodologies need to evolve for effective transfer and application of knowledge and continuous access to opportunities ▪ Teachers want to find and create solutions that they can own, use, and deploy ▪ MHRD and NCTE built DIKSHA, the national platform for teachers as shared infrastructure available to all teachers, educators, academics, governments, NGOs, etc. across India	▪ Key components of DIKSHA are – Courses for teachers with content benchmarked to National Curriculum Framework – Resources for use in classroom – Dashboards for progress and assessment – Tools and interfaces to create teaching and learning content – Communities for collaboration and discussion – Tools for announcements, notifications, and circulars ▪ States have the autonomy and choice to represent and extend the national teacher platform to suit their own needs and purposes	▪ Six states and 200,000 teachers have joined the portal ▪ Over 2,500 teaching and learning resources for teachers
ePathshala	▪ ePathshala platform provides educational e-resources including textbooks, audio, video, periodicals, etc. ▪ Available on mobile, tablets, and web, catering to students, teachers, and parents	▪ Students can access digital textbooks, videos, and other content; sign up for events; and take notes digitally ▪ Teachers can access digital textbooks, syllabi, policy documents, teaching instructions, research periodicals, etc. ▪ Parents can access e-textbooks, policy documents, question banks, etc.	▪ 32.9 million visitors ▪ 287,628 app downloads on Google Play Store, Apple App Store, and Windows Apps ▪ 16.5 million total YouTube views
NROER	▪ National Repository of Open Educational Resources (NROER) is an IT platform with open digital content ▪ Resources include educational videos, audio, images, documents, and interactive modules ▪ Content focused on school education	▪ Content can be filtered based on user for teachers, students, or different interest groups ▪ Partners including states, institutions, and individuals can upload content	▪ 13,636 resources available, with about 6,106 videos, 2,581 images, 1,664 audio files, and 2,721 documents ▪ 12,804 users
SWAYAM	▪ IT platform that hosts free online content starting with class 9 ▪ Seeks to share the best teaching and learning resources with all, including the most disadvantaged ▪ Built by the MHRD and AICTE with the help of Microsoft	▪ 4 types of courses: video lectures, downloadable reading material, self-assessment tests, and online discussions ▪ SWAYAM platform is indigenously developed by Ministry of Human Resource Development (MHRD) and All India Council for Technical Education (AICTE) with the help of Microsoft	▪ 1.6 million learners by December 2017 ▪ Hosts 1,031 massive open onilne courses as of April 20, 2018 ▪ Goal is to host up to 2,000 courses and 80,000 hours of learning

Organisation	Context	Solution	Impact
National Centre for School Leadership (NCSL)	▪ Online Programme on School Leadership and Management is being initiated nationwide across all the levels of school education ▪ Goal is to build and enhance the capacity of school heads on a long term and continuous basis	▪ Based on the National Curriculum Framework for School Leadership Development ▪ Programme has been designed and made available to all school heads through the MOODLE[1] platform	▪ Program aids NCSL to reach out to school heads in 36 states & UTs through the use of technology
SWAYAM Prabha	▪ Satellite communication technologies are used for transmission of educational e-content through Swayam Prabha direct-to-home television (DTH-TV)	▪ Everyday a four hour fresh slot is telecast and repeated six times in 24 hours to provide learning opportunities. ▪ DTH channels cover higher education, school education, curriculum-based courses and assist students for competitive exams	▪ Live transmission started from January 1, 2018, with 32 DTH devoted channels and high-quality educational programmes on a 24x7 basis

1 Moodle is a free and open-source learning management system

SOURCE: Central Square Foundation; ePathshala, as on October 1, 2018, National Repository of Open Educational Reosurces, as on October 1, 2018; Swayam; DIKSHA, as of April 24, 2018

Potential actions to ensure accelerated progress

A start can be made by considering the following actions:

- **Integrate and make available education data in an open API framework.** Several initiatives (such as the National Achievement Survey and Central Board of Secondary Education) collect different kinds of education data and share large parts of it, but it is not available in an integrated manner. For example, it is practically impossible to track students across different data sources such as the Unified District Information System for Education (U-DISE) and the National Achievement Survey. There is a need for a single platform for students that integrates all data while encouraging the creation of new ones. This data would help identify gaps in aspects of education — such as lack of availability of teachers for a particular discipline, quality of teachers compared to their peers in a school, and so forth — which will help both public- and private-sector entities generate corrective policy and innovative products to plug gaps. In this regard, Shaala Kosh, the recently announced initiative of the Ministry of Human Resource Development, is a welcome step. ShaalaKosh intends to bring together data not just from U-DISE, Shagun and other EMISs of DSEL as well as of States and UTs but also data collected on schools, students and teachers by other central ministries.

- **Create a dedicated entity or strengthen an existing department to drive the development of a national students' platform.** As stated above, digital education could get a big push from the creation of a one-stop digital education platform for students in school and higher education. Creating an optimal world-class platform for students is a complicated task. The platform must be comprehensive (that is, covering all aspects of learning, from quality instructional material to assessment tests), intelligent (suggesting the most appropriate material depending on students' proficiency levels), open (people and companies are free to use the data and upload their products), and language customisable. Delivering on these criteria necessitates stability in execution coupled with the right skill set. One potential way this could be addressed is by setting up a special-purpose vehicle with the mandate and requisite autonomy to build this open platform.

Creating a special-purpose vehicle would help in recruiting and retaining top technology talent for managing such a complex and ambitious project, while giving the continuity of purpose that is critical for executing such a large IT project. Alternatively, an existing competent department could be given the task with appropriate autonomy and resources.

- **Utilise new sources of capital for funding outcome-focused digital interventions in education** (see Box R2 "New-age pay-for-performance products"). The government could look to start a fund of funds to help pool capital from sources such as corporate social responsibility programmes, impact funds, development finance institutions, and philanthropists. These funds could be used for organising hackathons (similar to Smart India Hackathons) and, more importantly, shepherd promising ideas through the journey from conceptualisation and proof of concept to piloting. While impact funds have started investing in education product and service providers in India, they alone will not be sufficient to bring about transformational change at scale. This is due to the quantum of the resources needed, plus the high risk and relatively lower return on solutions available that are best suited to serve the bottom of the pyramid.

  — Innovation Fund for Secondary Education was announced under Budget 2017–18 for using innovative practices including use of ICT for enhancing access and equity in secondary education in educationally backward blocks of the country. The fund was approved in 2017–18 and approvals of $12 million were given under Rashtriya Madhyamik Shiksha Abhiyan (RMSA) for innovation based on proposals received from the States. As the RMSA scheme has been subsumed under Samagra Shiksha Abhiyan (SmSA) in 2018–19, a provision has been kept under SmSA for funding States and UTs for innovative initiatives for improving access to quality education. The fund of funds initiative could dovetail with this scheme to get going immediately.

Box R2. New-age pay-for-performance products

Leveraging new-age pay-for-performance products could be a catalyst for addressing the challenge of declining learning outcomes and building a focus on outcomes in the entire education ecosystem. Social and development-impact bonds are examples of a structure that could facilitate this, by leveraging risk capital from private investors for upfront payment of social services like education. If the service providers and programmes are able to achieve suitable outcomes on predetermined metrics as measured by a third-party evaluator, the investor is paid back by an outcome funder, which could be philanthropists or the government.

The development-impact bond launched for Educate Girls, a nongovernmental organisation in Rajasthan, is a promising start for this model, which focused on improving learning outcomes and enrolment for 15,000 students over three years starting in 2015. The programme achieved 50 percent of its learning outcomes target and 88 percent of its enrolment target by the end of the second year.

This approach could be scaled up by the private sector coming together to create a large-scale outcomes fund that invests in different outcomes in specific states. Activity on instituting a billion-dollar India Education Outcomes Fund has started, with the Global Steering Group on Impact Investing steering the effort. While still at a nascent stage, going forward, the government could unlock the potential of this idea, not just by participating as an outcomes funder, but also by becoming a large-scale customer for promising digital solutions. The government could set up a team of experts from NCERT and relevant ministries like Ministry of Finance to study these new age pay-for-performance products to ensure that the benefits accrue to the students.

15. Digital content delivery and learning in schools and higher education

> "The basic requirements for digital content delivery models in classrooms are high-speed internet connectivity; devices to be able to access content; rich repository of digital content that is available in local languages and is either hosted on a cloud server or downloaded onto devices; and digitally literate teachers"

Vision and potential impact

Knowledge will be the foundation of India's $1 trillion digital economy, and building this foundation will require improved learning outcomes among students. Research shows that adopting assisted digital delivery models can help to improve the effectiveness of classroom education.[423] The use of digital tools in India's classrooms could be facilitated by teachers who use online lessons, videos, and simulations in local languages to build greater understanding of concepts and their application to students. An important feature would be the use of continuous-assessment tools that help teachers create more personalised learning plans for students based on individuals' achievements and gaps.

A few basic requirements need to be met for digital content delivery models in classrooms. The first is high-speed internet connectivity in classrooms across school and higher education institutions, which could enable streaming and downloading of videos and other content. Second, students and teachers need devices to be able to access content; this could be addressed through a mix of shared computers and individual tablets where possible. Third, teachers and students need a rich repository of digital content that is available in local languages and is either hosted on a cloud server or

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[423] Rachel Jones, Christine Fox, and Douglas Levin, *National educational technology trends: 2011*, State Educational Technology Directors Association, May 2011; Kelly Shapley et al., *Evaluation of the Texas Technology Immersion Pilot*, Texas Center for Educational Research, May 2007.

> “Use of continuous-assessment tools help teachers create more personalised learning plans for students based on individuals’ achievements and gaps”

downloaded onto devices. Finally, India needs digitally literate teachers who not only know how to make use of digital content, but impart that to students as part of the curriculum.

The government has set up a National Knowledge Network to provide high-speed internet connections in higher education institutions and facilitate collaborative research and knowledge sharing. High-speed internet connectivity is already available in 1,688 premier institutions and universities through the National Knowledge Network.[424] However, much remains to be done on the school front. Currently, 27.3 percent of the country’s schools have computers.[425] Bringing high-speed internet connectivity to all schools is part of the BharatNet implementation.

Provision of digital infrastructure for schools is an important foundational element for leveraging the power of digital solutions for education. Recognising this, the government revised the ICT@Schools scheme in 2010. Under the revised scheme, the government assists the states with funds for capital and recurring expenditure to ensure provision of digital infrastructure in schools across the country.[426] The ICT@Schools scheme, subsumed under the Rashtriya Madhyamik Shiksha Abhiyaan in 2013, has resulted in the provision of computers and other infrastructure in over 85,000 schools across the country.[427] Yet assessments of ICT usage in these schools shows wide variation among different states, and even between different regions in the same state. A major factor is the different levels and quality of service provision for device maintenance and teacher training by different state-selected Build-Own-Operate-Transfer vendors for implementation of the ICT@Schools scheme. There is a need to learn from the best practices of various states and modify the programme appropriately to ensure better outcomes. Digital content delivery will require teachers to be trained and certified to use digital teaching aids. School administrators also will need to be coached to enforce effective deployment of the solution.

Creating the right infrastructure and training to enable digitally aided learning in every classroom is an important theme for the country. As previously mentioned, digital content has several advantages over traditional textbooks. Digital platforms can host self-assessment modules for students that they can access and complete as time permits. The scores from these tests can be stored and analysed to understand students’ learning gaps, enabling teachers and administrators to make targeted interventions to correct the student’s learning trajectory. As more students adopt these online materials and the digital content ecosystem grows, devices can also provide personalised content feeds for students based on an analysis of their performance.

Initiatives already under way

Many initiatives and small-scale pilots in digital content delivery are already under way, led by the government and private sector. Some examples are outlined in Exhibit R15.

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[424] Connected institutions, National Knowledge Network website.

[425] *School Education in India: U-DISE 2015–16*, National University of Educational Planning and Administration, September 30, 2015.

[426] Revised ICT@Schools Scheme, Ministry of Human Resource Development, 2010.

[427] *Annual report*, Ministry of Human Resource Development, 2015–16.

Exhibit R15

Ministry of Human Resource Development has a number of initiatives to leverage digital application for improved learning outcomes

Organisation	Context	Solution	Impact
Andhra Pradesh Government along with Microsoft	▪ Andhra Pradesh government collaborated with Microsoft to use machine learning (ML) technology to build a model to predict which students are at the risk of dropping out ▪ Analysis is done on data collected over the past 5 years across 100 para-meters like student performance, school infrastructure, teachers' skills and socio economic aspects as well as data on placements, courses offered by exit options such as ITI, polytechnics etc. ▪ The initial insights on dropouts were observed across 3 categories – Academic performance (higher marks = fewer dropouts) – Medium of language (Kannada medium schools = more dropouts vs. English-medium schools = less dropouts) – Gender (girls = more dropouts)	▪ The understanding of reasons and individual student's profile helped in customised counseling of students at risk ▪ Pilot launched in Tacoma Public School in 2014 in Chittoor district under Badi Pilustondi (back to school) campaign ▪ AP government signed MoU with Microsoft to expand ML to agriculture, rural empowerment, etc.	▪ The model has already produced 600,000 predictions with around 90 percent confidence level ▪ Graduation rate in the district went up from 55% to 78% in 2 years ▪ AP government first expanded the pilot to entire state covering more than 10,000 schools and has now expanded to cover all classes involving more than 5 million students
Shaala Darpan	▪ Shaala Darpan is the MHRD's digital e-governance program to improve the quality, governance, and service delivery of Kendriya Vidyalaya (KV) schools	▪ Offers services such as access to attendance records of wards, class and examination schedules and results, online learning resources, interaction with teachers, and access to online admissions	▪ Approximately 110,000 users of KVs in Delhi can access these services

Organisation	Context	Solution	Impact
Reliance Foundation	Reliance Foundation and the Government of Andhra Pradesh joined hands to solve the below problems: ▪ Limited availability of quality vernacular teaching aids mapped to state board syllabus for delivering quality content in classrooms ▪ Ineffective and irregular training of teachers ▪ Low availability of subject teachers in rural schools	▪ Digital content access: Teaching aids mapped to state board curricu-lum will be developed in Telugu and English and stored locally or delivered from Jio Cloud using Jio 4G LTE ▪ Remote training of teachers: At their schools, teachers attend virtual conferences to learn how to integrate digital content with classroom teaching ▪ Operational support: Every school is mapped to a Jio centre and a Reliance Foundation resource	▪ Deployed in 85 government schools and the State Council of Educational Research and Training in Hyderabad ▪ Present in 11 of 13 districts covering ~19,000 students ▪ Pass rate improved in maths and science (11% and 45%, respectively) ▪ 612 GB of data used over 9 months, an 11% year-on-year increase
Manipal University	Manipal University School of Management faced the following gaps in its education system: ▪ Only traditional classroom learning methods using lectures and notes followed ▪ Uniform content and only one learning pace applied to all students—absence of adaptive learning and need-based delivery ▪ Outcomes measured only through examinations	▪ A private online educator, Manipal Global, partnered with Coursera, a distance-learning company, on a pilot programme to offer a Marketing mix course as part of the university's MBA programme in January 2017 ▪ University faculty members share names of students and Manipal enrols them in the virtual study room ▪ Faculty publishes a course timetable, and students can log in to the Coursera website and learn anytime, anywhere ▪ Quizzes and assessments are accessible online, and Manipal Global records scores per attempt, allowing faculty to track student progress	▪ 116 students enrolled, with access to 3 faculty members ▪ Unique learning methods adopted for a more collaborative classroom ▪ Students more involved in pedagogical process and therefore more engaged ▪ Expert faculty availability seen for student body, with increased ease of access

SOURCE: Reliance Jio; Manipal Global; Ministry of Human Resource Development; Microsoft; Government of India Press Information Bureau; Ministry of Human Resource Development; NIC

> “A dashboard can help in regular monitoring of the status of the installation of computer systems, internet connections, and usage in each school”

Potential actions to ensure accelerated progress

Digital content delivery in schools can scale rapidly with private- and public-sector collaboration, as long as the following three prerequisites are considered:

- **Provide digital infrastructure and monitor its use.** Phase 2 of the BharatNet project aims to extend high-speed broadband connectivity to all gram panchayats by the end of 2018. This network could be used to connect schools and colleges via high-speed Internet throughout the country as a priority but not a binding constraint. Other internet service providers could be encouraged to participate in connecting schools and colleges with broadband. This is the single most important foundational element for achieving the vision of digitally enabled education. The Department of School Education and Litreacy has, under the new integrated scheme for school education viz. SmSA, allowed greater flexibility to the States & UTs, so tablets, computers, and other devices could be procured or upgraded after comprehensive evaluation of current and future requirements in the local context. For example, solar-powered tablets are a better fit than computers for schools in areas with poor electricity service.

  Regular monitoring of the status of the installation of computer systems, internet connections, and usage in each school is critical to ensure that planning and expenditure have resulted in infrastructure's being installed and put to use. A dashboard could be created to capture expenses and number of systems bought, linked with schools where it is supposed to be installed. Usage could be tracked by monitoring data from the ISPs with respect to the duration, number of systems, and even content viewed or downloaded.

- **Equip teachers and students with digital literacy.** Internet availability and devices, though critical, are only enablers. Teachers and students need to be trained in ICT in order for digitally enabled teaching and learning to become a reality. Continuous evaluation of ICT@Schools — where schools contract with private parties to create digital infrastructure and provide training to students and teachers — through the newly launched PARAKH app is a good start in this direction. The PARAKH app enables quick surveys of schools with questionnaires for principals, teachers, and students. The ICT@Schools scheme, which has been rolled out in 65,000 schools so far, shows significant variation in the quality of services rendered by contractors in different schools. Sharing best practices among states on ensuring that private parties adhere to the terms of the contract in letter and spirit will go a long way toward improving the level of digital learning in schools across the country. The reach of teacher training programmes could be expanded through MOOCs, or massive open online courses, and the adoption of the DIKSHA platform for teachers by educators all over the country.

  On the student front, state boards' curriculums could be revised to make digital literacy content mandatory for students. The National Council of Educational Research and Training (NCERT) has developed an ICT curriculum for school students, and while some states, like Punjab, have incorporated and adapted it into their curriculum, many others have yet to come on board. NCERT can complement this by laying down clear standards of digital literacy for students by age and class, as well as for teachers. Given how critical digital learning will be in the future, India could launch a national movement toward digital literacy with participation from the central government and the states.

- **Clarify rules and policies to recognise distance learning.** Distance learning is not considered at par with classroom learning, and that is curtailing the full potential of distance learning as a medium of education. For example, the All India Council of Technical Education does not recognise technical degrees earned purely through distance learning. Moreover, all digitally delivered learning is classified as distance learning even if it incorporates live student-teacher interaction via video conferencing.

The Ministry of Human Resource Development is in the advanced stages of drafting a new policy on online learning and virtual universities. This policy would enable students to take advantage of higher education and certification virtually, which would greatly expand access to higher education for the estimated 30 million students entering tertiary education from 2017 to 2025.[428]

- **Special focus on education through digital channels in deprived and troubled areas.** Areas without adequate physical infrastructure or with safety concerns can gain access to education through digital channels. Digital infrastructure required in such locations would include not just internet connectivity and devices, but also supporting infrastructure, like solar-based power supplies. Structured and managed effectively, education programmes in such areas have the potential to improve social outcomes and stability.[429]

  Lessons from initiatives like the Malala Fund and Bridge International Academies, have shown that the government could create a cadre of education fellows from local communities in tribal and other deprived or troubled areas to deliver assisted learning. Such fellows could focus on mobilising and organising students and could facilitate delivery of digital content. It is noteworthy that, while the idea has merit and has been found to be effective in live situations, on-the-ground efficacy depends on how it is implemented at scale. Thus, it is critical for the government to adopt appropriate checks and balances on who can become a facilitator and how they will be evaluated, and to make sure these standards are followed in letter and spirit to get the desired outcome.

  — For example, Odisha has adopted tribal languages as the medium of instruction at the primary level. The Multi Lingual Education programme addresses the challenges faced by the tribal students and it is operational in 21 tribal languages in 17 tribal dominated districts. Textbooks and Supplementary reading materials have also been developed in 21 tribal languages. From the very beginning, the programme has been run by the regular language knowing teachers and community mobilisers where there was no teacher.

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[428] *The world at work: Jobs, pay and skills for 3.5 billion people,* McKinsey Global Institute, June 2012.

[429] Alan Smith, *The influence of education on conflict and peace building*, UNESCO, 2010.

000327.5 KWH
.023 KW
SET TIME

Goal E: Energy for all

Assuring the reliable delivery of affordable power to Indians everywhere

16. Digitally enabled power access

Vision and potential impact

India is the fourth-largest consumer of electricity and the third-largest producer of electricity in the world.[430] Government action, including amending the National Tariff Policy and allowing additional foreign direct investment in the power grid, has provided great impetus to the power sector. India's energy firms have made significant progress in the global energy sector: ten out of 14 Indian energy companies appear in the latest S&P Global Platts Top 250 Global Energy Rankings of the best-performing firms in the industry.[431] Historically, India's power sector has focused on improving access, but a new set of reforms such as the Integrated Power Development Scheme are promoting the use of IT to improve distribution and transmission. These digital reforms would expand the industry's focus beyond access, to consumer-level reliability and quality of the power supply. Digitisation of the distribution network and operations lies at the core of reducing aggregate technical and commercial losses. AT&C losses in India are currently estimated to be around 20 percent, which exceeds average global standards of 8 percent in 2014.[432]

The most fundamental component of digitisation would be the installation of digital meters for all households in the country. Advanced metering Infrastructure, which consists of smart meters connected to the internet, could allow for bidirectional communication between the consumer and the utility. While the cost of these meters is high compared to that of meters enabled with automatic reading, demand aggregation has the potential to lower prices, as demonstrated recently in a bid by government-owned Energy Efficiency Services Limited. To address reliability, the other key component would be a supervisory control and data acquisition (SCADA) system to monitor losses at the 11-kilovolt feeder level. These would have to be supported by adopting operational interventions like improving billing and collections. Metering at the 11 kV feeder level would ensure monitoring of power supplied to consumers. SCADA implementation is in progress in 59 towns in 18 states, with $240 million sanctioned for project implementation under the Integrated Power Distribution Scheme.[433]

State governments also may consider using electronic Direct Benefit Transfer to deliver power subsidies to households below the poverty line and farmers. This could reduce the working capital problems of state distribution companies and ease state governments' subsidy burden through better targeting of subsidies only to customers identified through Aadhaar or other acceptable identification methods. However, improved collection efficiency and identification of users using Aadhaar — especially in the agriculture sector — would be important for successful implementation of DBT.

Accelerated implementation of these measures could reduce AT&C losses from about 20 percent to 8 to 10 percent. This would translate into economic value of $10 billion to $12 billion by 2025. Distribution companies would benefit from increased revenue, leading to reduced debt burden. Consumers would benefit from more reliable power.

Initiatives already under way

The government has launched the Integrated Power Distribution Scheme, with the goal of strengthening sub transmission and distribution in urban areas, and Ujwal Discom Assurance Yojana, with the aim of lowering distribution companies' debt. Digital utility pilots are under way in many cities in India, as outlined in Exhibits R16A and R16B.

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[430] *Power,* India Brand Equity Foundation, February 2018, ibef.org.

[431] S&P Global Platts Top 250 Global Energy Company Ranking, 2017.

[432] Data provided by the Ministry of Power, Government of India, for states participating in the Ujjwal Discom Awas Yojana (UDAY) programme for the financial turnaround of electricity distribution companies; *Electric power transmission and distribution losses (% of output)*, OECD IEA Statistics, 2014.

[433] *Integrated Power Development Scheme (IPDS): Review of SCADA/DMS implementation*, Ministry of Power, February 2017.

EXHIBIT R16A

Key government initiatives under way in the power sector

Initiative	Context	Solution	Impact
Integrated Power Development Scheme	Scheme for strengtheningthe sub-transmission and distribution network in urban areas	Establishment of IT enabled energy accounting / auditing system Improved billed energy and collection efficiency	Operational in 32 states and union territories 97.9% go-live towns Supervisory control and data acquisition completed in 88.8% towns 82% billing efficiency in 2016–17 (through Q3), up from 79% in 2015–16 Customers' pending complaints reduced from 11.4% in March 2017 to 7.5% in March 2018 19% of sanctioned amount disbursed All India Short Code 1912 for complaints on electricity adopted for 58 of 62 distribution companies
Ujwal DISCOM Assurance Yojana	Flagship program to improve distribution network and financial condition of distribution companies (DISCOMs)	Financial and operational improvement by states taking over 75% of DISCOM debt and paying back lenders by selling bonds Reduction of cost of power generation Energy efficiency and conservation through smart metering, upgrading transformers and meters to reduce electricity lost during transmission and distribution (or theft)	Implemented in 32 states and union territories Bonds issued for 86.3% of target amount 100% feeder metering in both urban and rural areas Electricity access to 83% of unconnected households 100% distribution of LEDs under UJALA AT&C losses of discoms in 24 states reduced to 19.1% at the end of FY18 from 20.3% a year ago
Deen Dayal Upadhyaya Gram Jyoti Yojana	Scheme to facilitate 24/7 power supply in rural areas	Separation of agriculture and non-agriculture feeders Strengthening of sub-transmission and distribution networks in the rural areas Rural electrification	Operational in 29 states and union territories 99.9% of villages electrified Intensive electrification completed in 65% of villages 78% below-poverty-line households covered
Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya)	Launched in late 2017 to provide electricity connections to all remaining unelectrified households in rural and urban areas	Universal household electrification by providing last-mile connectivity and electricity connections to all households nationally	Gross budgetary support of $1.9 billion provided Aims to cover 40 million families by December 2018 ~85% of households electrified as of October 2017
Smart Energy Infrastructure and Revenue Administration System (SEITRA), Bihar	Smart Energy Infrastructure and Revenue Administration System (SEITRA) is an integrated framework of web, mobile, and GIS technology to aid electrical infrastructure	Implemented energy billing software and mobile apps for the North Bihar Power Distribution Company, which is spread across 21 districts, and the South Bihar Power Distribution Company, spread across 17 districts ICT based solutions help in project monitoring, handling grievances, spot electricity billing through mobile app, building an appropriate management information system (MIS) for monitoring revenue collection, etc. Helps in greater transparency between the electricity board and its consumers	Timely bill distribution increased revenue by $297 million annually Covers 9.8 million rural consumers across Bihar Monthly revenue has grown from about $53 million in 2014–15 to more than $98 million in 2017–18

SOURCE: Ujwal DISCOM Assurance Yojana, Ministry of Power, as of April 25, 2018; Saubhagya, as on April 25, 2018; Deen Dayal Upadhyay Gram Jyoti Yojana; Power Finance Corporation, as of September 19, 2017.

EXHIBIT R16B

Digital interventions in power distribution have resulted in significant efficiency gains

Organisation	Context	Solution	Impact
Tata Power Delhi Distribution Limited	▪ A joint venture between the Delhi government and Tata Power; to distribute power to 1.4 million customers in North West Delhi ▪ Started operations with multiple challenges: – The system used to lose 53% of its power to network inefficiencies, theft, and other problems – Its meters were not tamper-proof – Customers lodged more than 100,000 billing and metering complaints	▪ Tata Power Delhi Distribution Limited deployed the following digital technologies to the grid ▪ A supervisory control and data acquisition (SCADA) system for real-time automatic monitoring and control of network equipment and operations ▪ GSM-based street-lighting system was used to remotely control street lights and real-time fault detection ▪ Thermal imaging-based heat warning system uses asset-mounted cameras to predict impending asset failures enabling precautionary measures ▪ GIS Asset Mapping for geo-spatial visibility of operations and distribution network; reducing field visits and failure down time	▪ Power losses attributed to network inefficiencies, theft and other so-called aggregated technical and commercial (AT&C) problems fell to 9% from 53% post implementation in December 2015 ▪ Transformer failure rate fell to 1% from 11% ▪ Street light functionality rose to 99% from 40%
Uttar Gujarat Vij Company Limited	▪ Operational since 2005, it is a wholly-owned subsidiary of Gujarat Urja Vikas Nigam Limited, covering over 2.8 million consumers in 9 districts of Gujarat – Formed as part of the disaggregation of the Gujarat Electricity Board – Part of restructuring of Gujarat's electricity industry because of The Electricity Act, 2003, and the Gujarat Electricity Industry (Re-Organisation & Regulation) Act, 2003	UGVCL deployed the following digital technologies to the grid: ▪ Automated meter reading to reduce human time and effort and make the billing process more efficient ▪ Spot billing in 21 subdivisions using Android mobile application (GPRS) ▪ In-house project developed progress-monitoring application and SCADA portal	▪ 237,806 transformer centres in 2015–16, up from 128,117 in 2010–11 ▪ Number of feeders rose from 3,505 in 2010–11 to 4,295 feeders in 2015–16 ▪ Transformer failure rate fell from 9% in 2010–11 to 4.87% in 2015–16 ▪ 15.87% AT&C losses in 2015–16

SOURCE: Tata Power Delhi Distribution Limited; Uttar Gujarat Vij Company Ltd.

> “DISCOMs are in the process of indexing customers to their respective distribution transformers and feeder lines which will help to identify revenue leakages by identifying consumers who are not billed or are billed under an improper category”

Potential actions to ensure accelerated progress

Digitally enabled power access can scale rapidly, as long as the government acts to ensure that the following prerequisites are considered:

- **Different business models for advanced metering infrastructure.** Distribution companies (DISCOMs) could consider having private players use build-own-operate-maintain models for smart metering to reduce the burden on the DISCOM to make a large investment. After a fixed period, these private players could transfer ownership to the DISCOMs. Energy Efficiency Services Limited recently hired Larsen & Toubro to install smart meters in Uttar Pradesh and Bihar over a period of three years and maintain the meters for another five years, based on a fixed-fee model per meter.[434] DISCOMs could also follow other business models such as leasing of meters, in which a financial intermediary would buy the meters and other equipment and lease it to the DISCOM for a monthly payment for ten years. A third-party agency would set prices and tender meters to vendors who meet specific quality standards. This would reduce the load of the initial capital expenditure on the DISCOMs.

  Another model could involve the utilities leveraging a metering services agency that could handle project management and operations management.

- **Digital capability and capacity building.** There is scope to improve DISCOMs’ capabilities to work with digital technologies. To address these gaps, the companies could invest in training, capacity building, and larger transformation programmes for their managers and field workers by identifying the right set of partners. Standard training modules on using digital technologies could also be developed and used across utilities. The modules could cover topics related to operations and maintenance, as well as digital means to improve customer relationships.

- **Prepaid metering.** One of the biggest challenges DISCOMs face is bill collection, which leads to severe problems in maintaining the working capital needed to sustain the companies’ day-to-day operations. Prepaid metering is one possible solution that DISCOMs could consider, especially in areas where collections are low. This could also become a method of transferring direct subsidies.

- **eKYC for using services from DISCOMs.** Getting an electricity connection is a cumbersome process that requires filling out multiple forms and waiting several days. While some initiatives have attempted to streamline the process, eKYC — the secure electronic know-your-customer identification process — can provide a speedy connection to consumers.

- **Adequate indexing of consumers.** In many parts of the country, DISCOMs are in the process of indexing customers to their respective distribution transformers and feeder lines. Completing this process would help to identify revenue leakages by identifying consumers who are not billed or are billed under an improper category.

- **Digital payments.** There is scope for all DISCOMs in the country to shift to digital payments. The Bharat/ BHIM QR code printed on electricity bills could be one way to facilitate and encourage digital payments.

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[434] Nishtha Saluja, “L&T wins Rs 1,000 crore contract to maintain 5 million smart meters”, *Economic Times*, December 28, 2017.

17. Smart grid integrating distributed generation and renewables

Vision and potential impact

Digitising and automating the power grid can aid in bringing down AT&C losses and improve the reliability of electricity service. The increasing use of renewable energy sources and distributed generation also require a smart grid that allows for the bidirectional flow of power. Government programmes like the National Smart Grid Mission are aiming to optimise and automate the grid for efficient power delivery.

The process of automating and optimising the grid has four key digital components — self-healing grids, power-quality management, renewables integration, and demand-side management. Self-healing grids deploy software to detect faults, isolate them, and reroute power around them; the software prevents faults from percolating to other parts of the grid. Power-quality management solutions are a combination of hardware and software that enables distribution and transmission companies to conduct real-time monitoring of voltage, frequency, and other technical parameters, and to rectify any problems through the remote control of grid components.

To equip the grid to handle the power from distributed renewables, transmission companies could upgrade the grid for bidirectional flow of power — that is, to allow electricity to flow from the grid to customers or from customers to the grid if customers have more power than they need from their own solar panels, wind turbines, fossil-fuel-powered dynamos, or even hybrid or electric vehicles. Utility companies across the country and the government could initiate active and passive demand-side management programmes for domestic consumers. They include offering customers financial incentives to use less power and teaching them how to save money by conserving energy, as well as demand-response programmes that use time-based rates or other financial incentives to encourage consumers to reduce electricity usage during peak periods. Such efforts could flatten load curves and manage capacities in a better manner.

A new set of business models have emerged for energy companies that also involves them developing, implementing and financing energy efficiency. Energy saving companies (ESCO) provide energy efficiency-related services and performance contracting is a core part of their business. Energy Service Companies can play a transformative role in implementing demand-side management by providing energy efficient solutions through a risk-sharing model with the consumer.
In Germany the demand-side was driven by the engagement of independent intermediaries since the 1990's.[435] China has also emphasised energy efficiency to its industries and provided sizable incentives to ESCOs to under energy efficiency projects on a large scale.

Accelerated implementation of these ideas could realise $1 billion to $2 billion of savings by 2025 by helping to reduce the losses of transmission networks by 1 percent via real-time monitoring of technical parameters and the remote-control optimisation of grid elements. It also could reduce grid outages to between 250 and 500 minutes per year from the current about 1,300 minutes.[436]

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[435] World ESCo Outlook:Germany, Jan W. Bleyl and Friedrich Seefeldt, December 4 2012.

Initiatives already under way

The government launched the National Smart Grid Mission in 2015 to promote technologies such as advanced metering infrastructure, which is an integrated system of smart meters, communications networks, and data-management systems to enable two-way communication between utilities and their customers. The programme has accelerated smart grid deployment by absorbing newer technologies — smart meters that follow standard IS 16444 published by the Bureau of Indian Standards (BIS), Companion Standard IS 15959 for Smart Meter Data Exchange published by BIS, and model smart grid regulations released by the Forum of Regulators; international collaboration for smart grid knowledge exchange with the International Smart Grid Action Network and bilateral dialogues, and so forth.[437] It also agreed to renovate and modernise substations, deploy real-time monitoring of distribution transformers, and install harmonic filters and other measures to improve the quality of the power being delivered. Twelve smart grid pilot projects are currently under implementation, including one Smart City R&D Platform and one Smart Grid Knowledge Centre.[438] One pilot project at Ajmer Vidyut Vitran Nigam Ltd. has been completed and several other projects have been sanctioned and are under tendering.[439] Details are highlighted in Exhibit R17A.

To illustrate how one country successfully integrated renewables in its power grid, we highlight Germany's case example in Exhibit R17B.

EXHIBIT R17A

Technology can manage power consumption and dampen peak demand

Smart grid pilot project at Ajmer Vidyut Vitran Nigam Limited (AVVNL)

- Smart grid pilot project intended to demonstrate benefits of smart systems and subsequently prepare a base for a larger roll-out of the project
- Helped in demonstrating a viable business case for utilities even on a small scale, and how smart systems can improve operational efficiency of the utilities
- The AVVNL project became the first successful Government of India pilot to demonstrate the benefits of smart grid

- Project reduced AT&C losses by identifying high-loss areas through automatic distribution-transformer wise energy audit, faster collection through auto remote disconnect, and analysis of reconciliation and consumption data
- Metering and billing improved because of automation of meter reading and punching, and quicker bill generation through smart meters
- Reduced equipment and faster fault detection through condition-based asset maintenance (with monitoring of power quality and load parameters)

Estimated impact of pilot:

- Total annual savings of ~$20,000 for ~1,000 consumers
- AT&C losses reduced from 20.0% to 13.5%
- Bill generation cycle to be reduced from 14 days to 5 days
- Reduction in failure rates of meters by 50%
- Reduction in failure rate of transformers by 30%
- Outage time to reduce by 20%
- Reduction in time spent on handling consumer queries by 80%

SOURCE: National Smart Grid Mission, Ministry of Power, as of March 12, 2018.

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[436] Reliability of the cities/towns/villages – Discom wise, Central Electricity Authority.

[437] Inputs from National Smart Grid Mission, Ministry of Power, Government of India, as of March 2018.

[438] Ibid.

[439] Ibid.

EXHIBIT R17B

Germany has taken several initiatives to integrate renewables with the grid

Country	Context	Solution	Impact
Germany	▪ Renewable sources accounted for 38% of the public net power supply in 2017 ▪ In 2017, ~38.4 terawatt hours (TWh) of electricity from photovoltaic arrays was fed into the grid while wind energy produced ~104 TWh ▪ Strong growth in renewable energy sources is aided by robust integration and balancing of grid	Following measures adopted to facilitate renewables integration: ▪ Since 2011, state regulator BNetzA has been required to conduct annual transmission planning analyses that incorporate projections of where renewables will be developed over next ten years ▪ Most German coal power plants have been originally designed or later modified for flexible output—the ability to "ramp" on an hourly basis to much less than full output, and "cycle" on and off on a daily basis. This further helps in offsetting variability of renewables ▪ Wind and solar receive priority dispatch in normal day-ahead wholesale markets—that is, they are sold first. Coal plants sell into the balancing markets as an alternative source of revenue; this creates more robust balancing markets ▪ Transmission system operators (TSOs) have greatly improved their power control and dispatch software and analytical tools to handle much higher system ramp rates ▪ Modest technical improvements such as installation of special tap-changing transformers have been made to local-level distribution systems to cope with two-way ("reverse") flows of power from solar generators	▪ In the first half of 2017, Germany produced 35% of its power from renewables ▪ In 2017, renewable energy accounted for 36.2% of gross electricity consumption ▪ Achieved a reduction of 347 million tonnes CO_2 equivalent, or 27.7% on 1990 emission levels by 2017 ▪ India, Germany have signed a pact to improve sector framework and conditions for grid integration of renewable energies

SOURCE: Eric Martinot, How is Germany integrating and balancing renewable energy today?; MNRE & GIZ Signs Agreement to Improve Framework Conditions for Grid Integration of Renewable Energies, Ministry of New and Renewable Energy, Government of India, August 28, 2017.; Prof. Dr. Bruno Burger, Power generation in Germany – assessment of 2017, Fraunhofer Institute for Solar Energy Systems ISE.

> “Distribution companies could collaborate with original equipment manufacturers, service providers, think tanks, and academia to conduct research and establish proofs of concept for specific smart grid technologies”

Potential actions to ensure accelerated progress

Through the National Smart Grid Mission and state initiatives, India has taken some important early steps toward building a smart grid. Progress could be accelerated through the following interventions.

- **Capability building for smart grid technologies.** There is a need to bridge the capability gap that prevents DISCOMs from using digital technologies in operations and maintenance of the power grid. The government would need to support utility companies to transition to new energy service company business models. To address this gap, distribution companies could collaborate with original equipment manufacturers, service providers, think tanks, and academia to conduct research and establish proofs of concept for specific smart grid technologies. The public or private sector could organise interstate forums of global experts and service providers to discuss lessons learned and best practices. Meanwhile, state distribution companies could explore the use of public-private partnerships for pilot programmes.

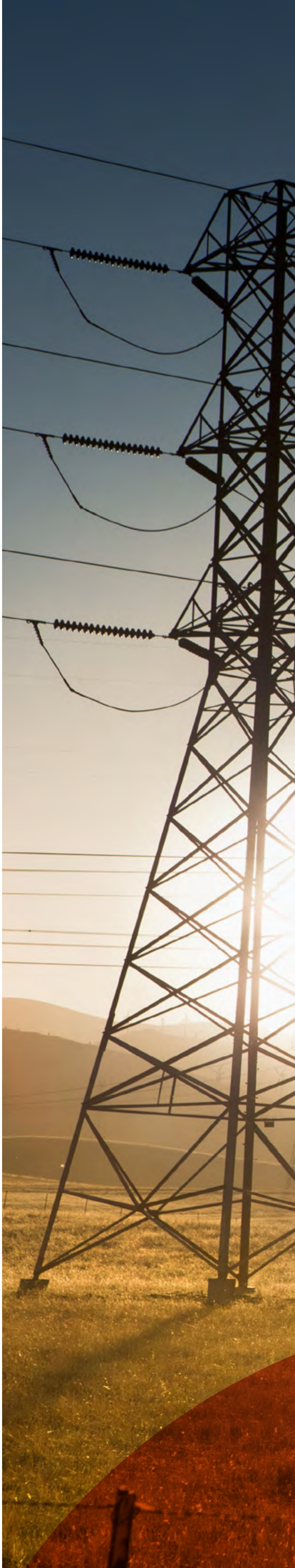
- **Apply information from current projects to ongoing and upcoming ones.** The utilities planning for large-scale smart grid initiatives could apply lessons from three pilots nearing completion, at the Chamundeshwari Electricity Supply Corporation, Himachal Pradesh State Electricity Board, and IIT Kanpur. Utilities could use the information as a checklist while designing and implementing projects, as these insights could help all stakeholders in scaling up smart grid projects. Some of insights include:

  - Meticulous planning from the beginning of the project, prioritising of smart grid objectives and functionalities, and drawing up of a smart grid road map detailing a phased approach.

  - Consumer-engagement strategies focusing on awareness creation, participation, and redressal mechanisms.

  - As utilities graduate from pilot projects to large-scale implementation of smart grid projects, the use of innovative business models such as leases becomes key to minimise upfront capital expenditure by utilities.

  - Data analytics and reporting could provide key insights to utilities for improving operational and financial efficiencies.



Digital Wallet
CREDIT CARD
1234 5678 9000 1234
PAY

Goal F: Next-generation financial services

Bringing finance to all in a less-cash, more-data economy of the future

18. Digital payments solutions and transition to a less-cash economy

Vision and potential impact

India has moved to correct large scale financial exclusion through the massive rollout of bank accounts, reaching over 300 million underserved people in the past few years.[440] The country now aspires to expand the scope of financial inclusion and enable innovative, modern financial solutions for all segments of the country. Two digital themes can help catalyse actions in this area.

Digital payments are rising rapidly in India. From about 876.5 million transactions in November 2016, they rose by more than 27 times to reach about 24.3 billion transactions in December 2018.[441] Nonetheless, India has a long way to go. Measured by value, 26 percent of India's retail payments in 2017 were made electronically.[442] India would reap considerable economic value and consumer benefits from saving the cost incurred in handling cash and increasing transparency by moving to a less-cash economy.

A digital payments ecosystem has three basic requirements. The first is providers of the necessary hardware, software, and network infrastructure for digital payments, including point-of-sale (PoS) terminals, smartphones with payment apps, and mobile or fixed-line internet access. The second is system operators who regulate access and protocols for transactions, ensuring interoperability and accountability. The third is banks and other service providers that process payments.

While digital payment ecosystems have started to emerge in India, until recently they have been difficult to scale because of a lack of internet and digital payments infrastructure, especially in rural areas. Also, customers are not fully aware of the benefits of digital payments and are concerned about the security and reliability of transactions. Similarly, micro, small and medium-size enterprises (MSMEs) have concerns about switching to digital payments because doing so would mean becoming part of the formal financial and tax systems and because they would have to pay digital payment transaction fees. These charges, called the merchant discount rate, or MDR, are 0.3 to 0.9 percent for debit card transactions, depending on the size, whether they are made through PoS machines or using a QR code, and the mode of payment.[443]

Targeted interventions by the government and private sector could help shift about 60 percent of all retail transactions by value — or 30 percent of all retail transactions by number — to digital channels by 2025. This would create $30 billion to $40 billion of economic value by reducing the currency in circulation by 30 to 40 percent, reducing the infrastructure and operations costs of ATMs and bank branches, and cutting printing costs for the Reserve Bank of India. By bringing more of the economy into the banking system, digital payments also would enable many people to earn interest on money that is now stored as cash in homes and small businesses.

Initiatives already under way

India's government has already made significant progress toward mass affordable digital payments by creating strong and affordable infrastructure and solutions through initiatives such as the National Payment

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[440] Pradhan Mantri Jan-Dhan Yojana (beneficiaries as of September 6, 2017), Ministry of Finance, Government of India.

[441] Table 43: Payment system indicators, Reserve Bank of India, February 2017, December 2018.

[442] Euromonitor International Consumer Finance and Retailing 2017 Editions.

[443] Rationalisation of merchant discount rate for debit card transactions, RBI notification, December 6, 2017.

Corporation of India's launch of the Bharat Interface for Money (BHIM) app and Aadhaar-enabled payment app. Private-sector innovation in digital payments has also grown explosively, as evidenced by Paytm, Airtel Payments Bank, and HDFC Bank's DigiThane, which are illustrated in Exhibit R18.

Exhibit R18

Indian payments industry is experiencing significant innovation

Organisation	Context	Solution	Impact
National Payments Corporation of India (NPCI)	▪ Bharat Interface for Money (BHIM) is a mobile payments app, which is based on Unique Payment Interface that integrates customers' mobile devices, Aadhaar number, and bank accounts to create a virtual ID for real-time money transfers around the clock	▪ Users send money using a Virtual Payment Address (VPA), account number, and Indian Financial System Code, Aadhaar number, or QR code and request money by entering VPA or a mobile number ▪ Scan & Pay allows users to pay by scanning the QR code ▪ Currently, BHIM supports linking of one bank account at a time	▪ Value of transactions using BHIM reached $9.9 billion till Sept 2018 ▪ 33.2 million app downloads till August 2018 ▪ 102 banks live on BHIM in Sept 2018 versus 44 banks in March 2017
NPCI, UIDAI and IDFC Bank	▪ IDFC Bank, UIDAI, and NPCI jointly developed an Aadhaar Enabled Payment app Aadhaar Pay ▪ Allows merchants to accept digital payments via Aadhaar-based biometric authentication	▪ Customers need Aadhaar number and a bank account linked with Aadhaar to use the app ▪ Merchants need a smartphone, internet connection, and bank account details to use the app for transactions	▪ 14 banks have enabled this feature, including IDFC, Standard Chartered, Bank of India, RBL, Canara, and UCO
Paytm	▪ App that enables offline retail businesses such as restaurants, pharmacies, and grocery stores to accept digital payments by scanning a QR code that contains the merchant's account details	▪ Merchants use a simple digital process to sign up and receive a Primary Account Number from the issuer, which conducts a biometric Aadhaar electronic know-your-customer anti-money-laundering verification and proprietary risk check	▪ Onboarding process is quick and efficient, and takes less than 3 minutes ▪ Paytm has registered 6 million offline merchants, as of March 2018
DigiThane	▪ HDFC Bank launched an open-loop prepaid card in collaboration with Thane Municipal Corporation (TMC) under Thane Smart City (DigiThane) programme	▪ Card can be used for digital payment for bus rides and other government transport services, utility bills, and municipal payments such as taxes	▪ 1,500 card service centres have been set up to issue cards ▪ The aim is to issue 500,000 cards in the first phase
Airtel Payments	▪ Airtel is the first company licensed to operate a payments bank in India ▪ 100% digital savings bank account opening process is now available at 400,000+ retailers across India	▪ Customers can use multiple payments platforms — virtual debit card powered by MasterCard, Unified Payment Interface (UPI), QR code-based payments, IMPS, and NEFT ▪ Accounts can be opened in less than three minutes with Aadhaar enabled e-KYC and National Securities Depository Limited (NSDL) and e-Mudra enabled e-sign ▪ Cashless village initiative to create a digital ecosystem of customers, banking points, and merchants	▪ Over 10 million accounts opened in the first year of operations (as of October 2017) — over 70% accounts in rural areas driving financial inclusion ▪ Fastest to reach over 2 million virtual cards ▪ Over 2,000 cashless villages in the first six months of operations

SOURCE: National Payments Corporation of India; Paytm; Let's Talk Payments LLC; Forbes; Times of India; HDFC Bank.; MicroEnsure, October 24, 2017; Economic Times.

> “A digital payments ecosystem has three basic requirements – providers of the necessary hardware, software, and network infrastructure for digital payments; system operators who regulate access and protocols for transactions; and lastly, banks and service providers that process payments”

Potential actions to ensure accelerated progress

Digital payments can grow rapidly if businesses and consumers see the benefits of moving transactions to digital channels. The next section discusses one powerful theme — flow-based lending — that can provide real incentive for individuals and SMEs to create a digital trail of their payment patterns. Similarly, the agriculture section of this report outlines ideas for digital farmer financing and insurance payouts, laying out the real incentives for farmers to move to digital payments and create payment data that can be leveraged to access cheaper finance. In addition to these themes, specific steps in the following areas can also accelerate progress and are imperative to be put in place:

- **Incentivise consumers and merchants to adopt digital payments.** At present, relatively few merchant sites have electronic point-of-sale machines — India has only two PoS machines per 1,000 people, far fewer than developed Asian economies such as Korea (53.10) and Singapore (32.60).[444] QR code–based payments via mobile phone can serve as an alternative to credit and debit cards and PoS devices. A Reserve Bank of India initiative would assign each merchant a QR code recognised across participating banks and debit card networks, which include RuPay, Mastercard, and Visa. This will relieve consumers of the need to carry credit or debit cards, or to search for merchants with PoS machines. Merchants in turn will save money by not having to purchase and maintain PoS systems. The government recently moved to pave the way for cashless PoS transactions by launching Bharat/BHIM QR Code, an app that accepts every mode of digital payment, including digital wallets. In addition, the National Payments Corporation of India will integrate Bharat/BHIM QR Code with a BHIM-UPI app based on its Unified Payments Interface, which enables users to transfer funds between bank accounts on a mobile platform. NPCI is enabling interoperability through different mobile wallets on Bharat QR, further facilitating the integration of BHIM-UPI with large partners like WhatsApp, Amazon, and Google. Few examples of avenues where digital payments could be encouraged:

  - All bus, train, and metro tickets could accept Bharat/BHIM QR Code, and utility bills could accept the app as a payment option. Telecom companies could ensure prominent display of their Bharat/BHIM QR code at each recharge point and offer discounts or additional talk time for digital payment.

  - All government departments, public-sector undertakings, autonomous bodies, and societies like Kendriya Bhandar and Mother Dairy must be enabled to receive all manner of digital payments. Government could encourage consumers to use digital payments by absorbing credit card fees when it acts as a merchant — or even by offering a discount on utilities, petrol sales, and other purchases made digitally. These discounts could be rationalised on a net-cost plus basis, limiting fees to a maximum of 200 rupees, or about $3, with the increased volume of transactions helping banks to make up the difference. The government also could allow disincentives for

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[444] ATM and card statistics for February 2018, Reserve Bank of India; population, World Bank; McKinsey Global Payments Map, 2018.

use of cash, such as permitting merchants to levy a cash-handling charge for purchases above certain amount.

— Goods and Services Tax Network (GSTN) rules could be amended to ensure that all registered users with turnover above a certain threshold — say, $7.5 million — initially conduct at least 30 percent of their transactions in digital mode. This could move toward a full digital process in two years.

- **Mandate government agencies to accept digital payments at par with cash.** Digital wallets are currently not accepted for payment because of certain obligations to the government. Moreover, digital payments of all sizes are subject to anti-money-laundering know-your-customer (KYC) regulations. Government agencies must be able to accept online payments using digital wallets, as many merchants do. Transactions too small to require a KYC review if made in cash must be accepted in digital form without KYC. As the government reviews anti-money-laundering regulations for mobile wallets, it could do so in conjunction with the Prevention of Money Laundering Act and Reserve Bank of India reviews.

- **Promote the benefits of digital payments among the socially and financially excluded.** Many consumers are unwilling to shift toward digital payments due to lack of basic digital skills, low awareness of the hidden cost of cash transactions, and doubts about the security and reliability of digital transactions. MeitY could take the lead in educating socially and financially excluded people about the use and benefits of digital payments. This effort could focus on people enrolled in the Mahatma Gandhi National Rural Employment Guarantee Act social security and public works programme, women in self-help groups, and customers at cooperative stores and fair-price shops.

- **Expand the Bharat Bill Payment Scheme.** The scheme is preparing to offer integrated and interoperable bill payment services to customers across India through a network of online and offline agents, allowing multiple payment modes and providing instant confirmation. The National Payments Corporation of India would function as the authorised central unit, setting standards and handling transactions. Scaling up the programme to enable payment of school and university fees, municipal taxes, insurance, mutual fund deposits, and credit card bills would accelerate the adoption of digital payments.

19. Flow-based lending and advanced credit underwriting

Vision and potential impact

Until now, financial institutions have restricted access to credit to individuals and MSMEs because these smaller businesses lack a financial history; increasing the credit available to those groups is a priority as India sets out to build a $1 trillion digital economy by 2025. The country's small businesses are poised to generate a substantial amount of data, such as historical records of revenue, the costs of doing business, and market growth, through online interactions. This data allows advanced credit underwriting and could enable so-called flow-based lending to businesses that until now have been too small for lenders to efficiently assess.

Lending institutions can automate much of the loan underwriting process. To begin with, loan applications can be digitised, allowing individuals to request a loan on web and mobile platforms. As part of the process, banks could ask applicants for their consent to access a set of conventional data sources, including tax returns, bank statements, and credit history. Subject to privacy regulations and user permission, banks may also tap unconventional data sources, such as the Goods and Services Tax Network, mobile phone accounts, utility bills, digital wallet activity, e-commerce history, and social media use.

The practicality of this process is contingent on the development of a secure data framework like DigiLocker to extract data from nontraditional sources, with users' consent. Legal issues must be duly considered before usage of individual transaction data by third parties. In the case of MSMEs, the government can ensure digital data availability. Once a bank has access to data from all of these sources, it can run advanced algorithms to assess the applicant's creditworthiness for the type of loan requested.

Advanced credit underwriting can deliver value to individuals and MSMEs by improving their access to institutional credit despite the absence of a conventional financial history. It may help lower interest rates for these borrowers, who may benefit from data-backed risk pricing and a shift from high-interest informal money lenders.

Financial institutions can grow their lending business by underwriting loans for previously excluded customer segments. At the same time, improved risk assessment could reduce loan defaults. Credit-reporting agencies may also be able to generate more accurate scores for more people based on nontraditional sources of data.

India's MSME sector credit gap is forecast to climb to about $800 billion by 2025, from $300 billion in 2011.[445] Accelerated implementation of advanced credit underwriting by formal channels could address up to 50 percent of this gap. This would create economic value of $90 billion to $120 billion through higher productivity of MSMEs.

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[445] *Sub-group on flow of private sector investments to MSME*, Planning Commission, 2011–12.

Initiatives already under way

Several financial institutions around the world already have developed models for advanced credit underwriting. Exhibit R19 describes examples from China and the United States.

EXHIBIT R19

Private financial services providers offer novel approaches to SME lending

Organisation	Context	Solution	Impact
Ant Financial, Alibaba Group	▪ Alibaba renamed AliPay to Ant Financial in 2014 ▪ Ant Financial uses big data to vet small working capital loans — up to $8 — to merchants on Alibaba's e-commerce platform, Taobao ▪ Taobao is designed for small businesses and entrepreneurs and has 7 million merchants ▪ Partnerships with banks for financing in initial phase ▪ Ant Financial adopted a clean-sheet, customer-centric approach to banking	▪ Ant Financial created its proprietary Zhima Credit Score by processing and assessing data on 5 dimensions of anonymised credit history, behavioural preferences, contractual fulfilment capacity, identity characteristics, and social connections ▪ Data sources include data received from e-commerce transactions on Alibaba, online financial data from Ant Financial, and data from public institutions like Public Security Bureau ▪ Zhima's big data includes anonymised records of credit card payments, online shopping history, fund transfers, utility payments, relocation records, and social relationships ▪ Zhima's scoring service enables Ant Financial to provide rapid credit	▪ Over $107.3 billion lent to 4.1 million small and micro enterprises, as of September 2016 ▪ Value proposition to merchants is Zhima's fast and easy credit approval process: a three-minute application, one-second loan granting, and no manual intervention
Kabbage	▪ Online financial technology company based in Atlanta that provides funding to small businesses through its automated lending platform ▪ Established in 2009 ▪ Provides small loans (average $30,000–$40,000) ▪ Provides fully unsecured rolling six-month loan	▪ 100% digital online underwriting based on both traditional and untraditional data ▪ All operational and fraud checks done using internet usage data and browsing patterns ▪ Underwriting limits set on a daily basis based on data updates ▪ Automated repayment from customer accounts, based on fund availability in accounts ▪ Collections triggers activated automatically, conducted primarily through email and telecalling; lawyers leveraged in extreme cases	▪ Small SME loans can be sanctioned and disbursed in less than 10 minutes ▪ Provided $4 billion dollars in funding to more than 130,000 businesses

SOURCE: Ant Financial; *Social Networks, e-Commerce Platforms, and the Growth of Digital Payment Ecosystems in China: What It Means for other Countries*, The better Than Cash Alliance, April 2017; Kabbage Inc., as on April 25, 2018.

Potential actions to ensure accelerated progress

Banks in India can adopt advanced credit underwriting as a model if the following prerequisites are considered:

- **Mechanisms to extract or aggregate data from multiple sources.** Although ready sources of data are numerous, there are no API-based mechanisms for pulling data from government sources. For example, MCA21, a portal launched by the Ministry of Corporate Affairs, contains data on such information as articles of association, memorandums of association, annual returns, shareholding patterns, and lists of directors; the Goods and Services Tax Network has data on GST, GST identification numbers, and invoices. The government can facilitate the spread of digital lending by moving to aggregate such data, organise it in a standard format, and simplify the process of retrieving data. The Ministry of Finance has constituted a steering committee to drive digital innovation in fintech in India; a subgroup of the committee focuses on enabling flow-based lending to smaller businesses using the GSTN database for creating a repository of trusted invoices. It proposes making these invoices available to lenders through an open API system. Additionally, the Department of Economic Affairs and the Ministry of Micro, Small, and Medium Enterprises could set up a single body to solve data-availability issues for MSMEs by making government data available digitally, designing architecture for data sharing, and building supporting infrastructure like APIs, data security, and consent architecture for accessing information from different sources.

- **Uniformity of data across multiple sources and in a machine-readable form.** The quality of digital data is currently inconsistent across states. For example, electricity bill data is available for only 13 states, and the data that is available is inconsistent. Maharashtra provides billing units, names, consumer numbers, and addresses, while Punjab provides only customer names. Moreover, records at the Ministry of Corporate Affairs include scanned documents, which are not machine readable, so extracting usable data requires time-consuming manual processing. State governments could set targets for increasing data collection while also developing common formats and fields to ensure that data can easily be shared across states. The Ministry of Corporate Affairs could mandate the use of machine-readable formats like XML, or extensible markup language, for data uploaded on government portals.

- **Digitally verifiable identification documents for corporate KYC:** The government's Udyog Aadhaar registration portal has simplified inclusion of MSMEs, creating a national one-page format that permits MSMEs to register based on self-certification and digitally verifiable authentication of each enterprise's owner. Currently, 3.5 million micro, small, and medium-size enterprises have registered on Udyog Aadhaar, out of the more than 51 million MSMEs nationally.[446] Building on this base, the Ministry of Micro, Small and Medium Enterprises and Ministry of Finance could develop a digitally verifiable GSTN-Udyog-Aadhaar identity as a one-stop corporate KYC solution and could educate smaller businesses about the benefits of GSTN to encourage adoption. Scaling up this approach using the model of digitally enabled KYC for individuals could enable significantly easier verification and authorisation for banks in their dealings with MSMEs and reduce the cost to serve them.

- **Guidelines to approve standing instructions digitally.** There is no digital mechanism for standing instructions or e-mandate approval requested by lending institutions, resulting in the need for physical approval of standing instructions thus hampering digitally enabled lending. The Reserve Bank of India could propose a mechanism or guidelines for a digital approval process for standing instructions when lending institutions request them. Banks could develop software to leverage GSTN and other data sources for assessing creditworthiness using advanced analytics–based credit underwriting.

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[446] *Annual report 2016–17*, Ministry of Small and Medium Enterprises; Udyog Aadhaar, Ministry of Micro, Small and Medium Enterprises, Government of India.

Goal G: Doubling farmers' income

Equipping every farmer with access to institutional finance, knowledge to boost crop and animal yields, and the ability to capture maximum value from production.

Agriculture's importance in India is difficult to overemphasise. It accounts for about 13 percent of the country's GDP and employs about 45 percent of its workforce.[447] On average, however, the yield in Indian agriculture is 10 to 50 percent lower than in other Asian countries.[448] Digital applications can play a critical role in improving yields — as well as reducing costs and increasing the market value of crops — by making it easier for farmers to obtain finance, optimise agricultural inputs, and increase direct access to markets. Digital applications promise to play a significant role in government's quest to double farmers' incomes by 2022.[449]

Digital solutions offer promise in three areas in particular: financing, precision agriculture, and online trading. Accessible, affordable credit is important not only because it enables farmers to buy seed and fertiliser, but because it allows them to invest in digital initiatives to improve their productivity. Currently, more than 30 percent of farmers' credit comes from noninstitutional sources, such as village moneylenders.[450] According to the National Sample Survey Office 2012–13 All-India Debt and Investment Survey, interest rates on noninstitutional credit are ten percentage points higher on average than bank rates.[451]

Improved access to institutional finance is a cheaper source of capital for farmers funding both traditional operations and the acquisition of new technologies that can significantly increase productivity.

Some of those technologies focus on field production and are collectively used in precision agriculture. Precision agriculture pilots in India and other developing countries have been found to increase productivity by 10 to 15 percent or more.[452]

Farmers can also raise their incomes by securing improved direct market access, thus getting better prices for their produce. Rather than being limited to selling their crops at the nearest wholesale market, or mandi — and having no choice but to accept the price offered at that one location — farmers can digitally track market prices across the country to find the best offer. In a pilot by the Karnataka government and the National Commodity and Derivatives Exchange spot market, increased online agricultural trading through direct market linkage resulted in a 13 to 15 percent increase in prices realised by farmers.[453]

Digitisation can also improve postharvest management by addressing transportation and storage problems that resulted in a loss of more than $15 billion worth of agricultural produce in 2013.[454] E-negotiable warehousing receipts, for example, can eventually let farmers sell crops to buyers across the country without having to first physically transport the produce. Installing internet-connected sensors in warehouses can warn of conditions that result in spoilage.

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[447] National accounts statistics, Central Statistical Organisation, Ministry of Statistics and Programme Implementation; Report on fifth annual employment-unemployment survey, Ministry of Labour and Employment, 2015–16.

[448] *India's technology opportunity: Transforming work, empowering people*, McKinsey Global Institute, December 2014.

[449] Draft volumes of the *Strategy for Doubling Farmers' Income by 2022*, Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare.

[450] *Household Indebtedness in India*, NSSO, 70th Round, 2012–13.

[451] Ibid.

[452] *Rapid introduction and market development for urea deep placement technology for lowland transplanted rice*, International Fertilizer Development Centre, 2017; IFDC report volume 38 number 2, International Fertilizer Development Centre, 2013; "Precision farming: A pathway to attract youth in agriculture," *Popular Kheti*, volume 2, issue 3, July-September 2014.

[453] Ramesh Chand, *Doubling farmers' income – rationale, strategy, prospective and action plan*, NITI Aayog, March 2017.

[454] *Wastage of agricultural produce*, Ministry of Food Processing Industries press release, August 9, 2016.

Most digital interventions work by either reducing information asymmetry, as in electronic trading or institutional finance, or by enabling the analysis of big data to take better decisions, as in precision agriculture or price forecasting.

The good news is that given the primacy accorded to agriculture, the union and state governments and their agencies collect a vast amount of agricultural data. About 800 national, state and research institutions are dedicated to collecting and sharing information on agriculture and farmers.[455] This existing rich data infrastructure encompasses valuable information for farmers, including seed availability from Seednet India Portal, soil fertility status from Soil Health Cards, weather patterns from meteorological departments, farming practices from the Farmers' Portal, and daily mandi prices in Agmarknet.

Furthermore, governments' push for digital payments, including Direct Benefit Transfers for food and fertiliser, among other subsidies will greatly increase data availability. The data sets across different channels are captured at a fairly detailed level but not in a common, standardised format that can be used for big data analytics and forecasting. For instance, 158.7 million Soil Health Cards have been dispatched, and 42.4 million farmers are registered under the mKisan advisory portal.[456] However, farmer details are not captured in a format compatible with both digitally verifiable records and land details identified by Khasra number. Similarly, different state and central portals have autonomous systems with their own village location codes or broad codes that encompass multiple villages, rather than using more specific identifiers like the Local Government Directory code as a national standard. Standardisation across farmer profiles, crop codes, village location codes, and local languages with real-time updates. Would go a long way facilitate big data analytics and better forecasting models.

Consequently, one of the most important and promising digital initiatives is the creation of an open agriculture data platform integrating information from existing sources in a prescribed, standardised format. This platform is an important foundational enabler for the three themes that follow: digital farmer financing, precision agriculture, and universal agricultural marketplace. The integrated platform could be governed by a body of stakeholders, including core constituents such as the Ministry of Agriculture and Farmers' Welfare, the National Institution for Transforming India (NITI Aayog), the Directorate of Economics and Statistics, state departments, and agencies such as the Indian Council of Agricultural Research and the National Bank for Agriculture and Rural Development. Other nongovernment players, including the private sector and policy research institutes, could be involved in consultations and developing new applications, with many users and contributors. This body would focus on standardising, collecting, collating, disseminating, and analysing data from a multitude of government and private sources with the prime objective of deploying applications that help farmers double their income. While government will be the prime mover in this initiative, its success hinges on widespread adoption by all stakeholders who contribute to a vibrant agricultural economy, such as individual farmers and banks as well as seed, fertiliser, and farm equipment companies. This integrated agricultural platform would spur innovation by making it easier for both large agricultural companies and agritech startups to develop pilot applications in an open regulatory environment, such as the so-called sandboxes used in the finance sector in the United Kingdom and Singapore.

This integrated agricultural data platform could aggregate all sorts of information from farmer financing (digital land records, insurance platform), precision agriculture inputs and outputs (irrigation, soil quality maps, weather data, nutrient needs data), real-time information from IoT sensors and probes in animal husbandry, animal health cards, and live marketplace transactions. It would also consolidate and create a unique profile ID to enable farmers in standard coded villages to access services such as Soil Health Cards, Direct Benefit Transfer payments, agricultural loans, and online trading. The consolidated platform would also be able to provide farmer-centric advisories on subjects from organic farming to high-tech precision agriculture. API-linked real-time updated and structured management of data sets would allow for data analysis and forecasting by multiple stakeholders in the government, farmer cooperatives, banks, agricultural input providers, and research institutions.

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[455] Expert interview.

[456] Soil Health Card website, as of September 27, 2018.; mKisan website, as on September 31, 2018.

Regional- and crop-level microtrends could be assessed, and innovation would be encouraged to solve some of the questions affecting productivity and price realisation. For example, using big data analytics capturing the demand and supply trends of various crops, price forecasting models could be built to guide individual farmers on the optimal crop from a price realisation perspective in both domestic and export markets. This platform would specifically encourage agripreneurs, agriclinics, and agritech businesses to ensure that their extension services are available to individual farmers. Public and private institutions could organise digital hackathons and innovation competitions to use data layers from this platform, which could be further funded from a new fund of funds such as Startup Agri. As is explained above, creating this truly integrated, open data platform would necessitate the cooperation of multiple national, state, research, and nongovernmental bodies.

20. Digital farmer financing and insurance payouts

> “Farmers’ income could also be tracked with payment received for the produce they have sold at a local mandi, at a wholesale market, or through an online agricultural trading platform, and banks could introduce further balances and checks to lower the risk of delinquency”

Vision and potential impact

Access to affordable credit and accurate crop insurance payouts are challenges for farmers in India. Noninstitutional money lenders in villages charge higher interest rates than banks (ten percentage points higher on average), yet farmers turn to them for credit because banks’ loan application processes are time-consuming and small farmers stand a good chance of being rejected because there is insufficient data with which they can establish a credit history.[457] Payouts on crop insurance are currently approximated based on yield forecasting at broad village or district levels based on crop-cutting experiments, which aren’t representative of productivity in individual farmers’ holdings. Farmers can suffer significant losses when they do not receive timely insurance payouts, especially when they experience low yield or crop failure due to local factors.

Aggregation of digitised data in the integrated agriculture platform will help banks to assess individual farmers’ creditworthiness and insurance companies to access precise yield forecasts for individual farm holdings. This data could include digitally verifiable land records; Soil Health Cards; crop-cutting experiments; field-, drone-, and satellite-based images of standing crops; evidence of digital payments to agri-input companies; digital payments received online; agricultural trading platforms; Direct Benefit Transfer payments into farmers’ bank accounts; and digitised cooperative bank data.

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[457] *Household Indebtedness in India*, NSSO, 70th Round, 2012–13.

Such a wealth of data, coupled with electronic bank accounts, could enable swift and accurate algorithmic credit-risk assessment and allow banks to efficiently acquire customers, control financial inflows and outflows, manage credit risk, recover loans, and receive faster insurance payouts. The first element of this model would be a set of mobile and web-based platforms where farmers can apply for financial services. If farmers lack internet access at home, they could apply through a local Common Services Centre or a bank correspondent who has web access. Online applications could include details such as land survey number, farm photos, Soil Health Card profile, and geotagged location.

Applications based on this finance data will enable banks to use eKYC and verify the farmer's land records by accessing the electronic land record registry. Banks will be able to do their due diligence faster, making it easier for them to disburse credit to farmers — where possible, digitally into bank accounts or by using the BHIM app. This digital financial flow information history and farmer credit score could also be used for short-term credit through Kisan credit cards. Farmers' income could also be tracked with payment received for the produce they have sold at a local mandi, at a wholesale market, or through an online agricultural trading platform.

Insurance companies can design more bespoke insurance schemes based on individual farmers' holdings data, including crop-cutting experimental data, weather forecasts, remote sensing data from satellites, drone-based imagery, and photos uploaded by farmers. Big data analysis will allow for better assessment of crop area and productivity in crop zones, which in turn could improve premium assessment and automated claims payments. This aggregation of data from weather and aerial imagery can be used with crop-cutting experiments to improve simulation models and significantly decrease the number of expensive crop-cutting experiments from millions to thousands. A faster and more accurate assessment of crop yields could also speed claim payments from existing programmes such as the Pradhan Mantri Fasal Bima Yojana and state insurance schemes, and may encourage more farmers to adopt them.

> "Big data analysis will allow for better assessment of crop area and productivity in crop zones, which in turn could improve premium assessment and automated claims payments"

Accelerated implementation of these measures could enable banks to serve 40 to 60 percent of the noninstitutional credit market by 2025 (assuming credit for the agricultural sector of $70 billion to $75 billion by 2025, with 30 percent of that being met by non-institutional sources otherwise). This would create $11 billion to $16 billion of economic value, assuming farmers would save 10 percentage points of interest costs by borrowing from banks instead of noninstitutional sources of financing.

Initiatives already under way

The Karnataka government, through the Bhoomi-bank integration scheme, is integrating 20 million Records of Rights, Tenancy, and Crops from 6.7 million farmers with bank computers to simplify the application process for farmers.[458]

The Ministry of Agriculture is also leading a pilot study to build a remote-sensing-based index of crop-yield estimates for index-linked crop insurance.[459] So far, the results of insurance indexing through remote sensing are challenged by the low accuracy of yield estimation through satellite imagery. More work will be needed to find approaches that work, including exploring drone-based images. This is explained in Exhibit R20.

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[458] *Electronic integration of BHOOMI with stakeholders, Karnataka*, National Informatics Centre and Revenue Department, Government of Karnataka.

[459] C.S. Murthy, *Remote sensing based indices for agricultural drought assessment*, National Remote Sensing Centre, February 16, 2017.

EXHIBIT R20

Digital applications are making crop insurance system faster and more accurate

Organisation	Context	Solution	Impact
Ministry of Agriculture	▪ Central government launched a Kisan pilot programme in 2015 to see if satellite and drone-based imaging and other geospatial technology could produce timely and accurate crop-yield data ▪ Study is also being conducted to evaluate a remote sensing-based index for index-based insurance ▪ Pilot jointly conducted by Mahalanobis National Crop Forecast Centre (MNCFC), Indian Space Research Organisation (ISRO), India Meteorological Department (IMD), state agriculture departments, and remote sensing centres ▪ Pilot study carried out in rice and cotton fields in four districts during the kharif season in Karnataka (Shimoga), Maharashtra (Yavatmal), Haryana (Kurkshetra) and Madhya Pradesh (Seoni). It was also conducted during the 2015–16 rabi season in eight districts in the same states to assess crop yields of rice, wheat, and sorghum	▪ In each district, crop-cutting experiment (CCE) sites were generated based on various remote sensing data (optical and microwave) derived parameters such as sowing or transplanting dates, biomass, normalised difference vegetation index, leaf area index, and land surface water index ▪ Approximately 250 CCEs were conducted in each district through state agriculture department/ service provider; these CCEs were supervised by MNCFC along with partner organisation ▪ Envisages use of high-resolution remote sensing images collected from UAV/drone for improvement in yield estimation and better planning of Crop-Cutting Experiments (CCEs)	▪ The government's CCE data were analysed to understand minimum number of CCEs required for getting block-level yield with defined accuracy level
Karnataka	▪ SAMRAKSHANE is an end-to-end e-governance solution to handle crop insurance under Pradhan Mantri Fasal Bima Yojana (PMFBY) programme and the Modified Weather Based Crop Insurance Scheme (MWBCIS)	▪ Connects to the Karnataka State Natural Disaster Monitoring Centre (KSNMDC) for weather data and calculates the compensation based on term sheets under MWBCIS ▪ Transparent and farmer friendly system for enrolment, registering claims, compensation calculation, and payment of compensation to farmers	▪ 1,059,801 enrolments under kharif (2016) and 1,395,933 enrolments under rabi (2016) ▪ 1,425,976 enrolments in kharif (2017) as of August 18, 2016 ▪ 126,928 CSC enrolments with a premium amount of $2.6 million

SOURCE: Mahalanobis National Crop Forecast Centre; National Informatics Centre, Ministry of Electronics and Information Technology.

Potential actions to ensure accelerated progress

Access to farm credit and more precise crop insurance payouts can be unlocked if farmers' credit and financial history data is combined with relevant yield data and shared with banks and insurers, among others. More precise yield forecasting for crop insurance payments is possible by integrating satellite and drone data with crop-cutting experiments for individual farmer holdings. Following are some steps to be considered to expedite the process:

- **Increase the availability of farmers' credit history data and digital payments data for faster access to credit.** Most transactions in the agriculture value chain, from purchasing inputs to selling produce, are conducted using cash, leaving no paper trail for insurers and banks to use in assessing farmers' creditworthiness. Similarly, when farmers borrow from cooperative societies or informal sources, repayment data is not accessible because reporting and compliance by the cooperative banks and nonbanking financial companies are not at par with commercial banks, making it difficult to know the credit history of the borrower and to minimise fraud (such as multiple loans to a single farmer). These issues could be addressed in the following ways:
    - **Develop a credit score for farmers drawn from financial flow–based data.** The National Bank for Agriculture and Rural Development (NABARD) could develop a creditworthiness score for farmers that uses data akin to TransUnion's CIBIL credit score and includes information on relationships with non-banking financial companies.
    - **Ensure banking services are available in every village.** There are approximately 145,800 bank offices in the country, but 640,867 villages.[460] Access to financial services, especially information and application facilities for credit, is difficult in villages with no banking presence. The banking extension could be expanded with the use of bank correspondents, post offices offering banking services, and licensed payment banks. The Department of Financial Services could survey villages with no banking facility and advise banks to extend service into them.
- **Record and share farmers' financial data using a unique identifier.** Farmers' credit and flow data are scattered across multiple channels, making it difficult to secure loans. Collating that information under a standardised farmer identity — an Aadhaar or Khasra number — would make credit more available. For example, credit transaction data from cooperative banks and registered nonbanking financial companies, DBT data, and the Kisan credit card scheme launched by NABARD all capture credit and financial flow information that could be consolidated in a single channel. Additional cash-flow data would come from digital payments in mandis that are linked to the Electronic National Agriculture Market (eNAM) or online buyer-seller platforms.
- **Digitisation of land records and link to banks and insurers.** Different states have achieved different levels of progress on the digitisation of land records. Twenty states and union territories have computerised between 76 and 100 percent of the records of rights in their files, while six states and union territories have computerised 25 percent or less of their records.[461] Most states have yet to start making data available to financial institutions. State governments could accelerate the pace of land record digitisation and allow digital mutation, or transfer, of land record rights. They could invest in creating and regularly updating a database of satellite images and digitised land records. Digital signatures could also be incorporated so that the digitised land record has legal validity.
- **Lessee rights and e-register farm tenants and labourers.** On most farm holdings, lessees (labourers or tenants) rather than landowners do the tilling and harvesting. As these tenants have no official document showing their rental of the land, they face barriers to accessing institutional credit. Tenancy

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[460] *Bank group/population wise number of functioning offices of commercial banks*, Reserve Bank of India, July to September 2017; Population Census of India, 2011.

[461] Digital India Land Records Modernisation Programme, Department of Land Resources, Ministry of Rural Development, Government of India, nlrmp.nic.in.

rights could be more clearly defined to give owners more confidence and tenants the ability to e-register themselves. The legal acknowledgement of their status could allow them to access other financial and agricultural subsidy services. The NITI Aayog is drafting a Model Agricultural Land Leasing Act to help lessee cultivators gain access to credit.[462]

- **Improve yield forecasting for insurance payouts by juxtaposing crop-cutting experiment data with aerial imagery analysis.**
  - **Regularly upload crop-cutting experiment data in a standard format with geotagging.** Insurance payouts in India are based on yield forecasts generated from crop-cutting experiments at the district or block level. These experiments present a rich source of data to help refine understanding of the likely yields of different crops across various regions of the country. However, this is not being utilised at an optimal level because a significant share of crop-cutting experiment data is not available in a digital, easy-to-use format. One way to address this problem and improve the accuracy of forecasts is to equip surveyors with handheld devices to geotag parcels as they are surveyed and store the observations in a standardised format on an open data platform. This would improve yield data quality, enhance data transparency, and capture data in real time.
  - **Create a database of frequently updated, high-resolution multispectral satellite images.** Crop-cutting experiments are not distributed through different agricultural conditions and are limited at the block or village level. They are also limited to forecasting postharvest yields and not preemptive for insurance payouts to the farmer. Other information sources, such as satellite, drone, and weather data, could be combined with crop-cutting experiment results to improve forecast accuracy and rationalise number of crop-cutting experiments. High-resolution imagery is promising for crop-yield forecasting, pest information, and other applications. High-resolution, high-frequency satellite images (along with drone imagery in high-priority areas) can be used in many ways, such as assessing land and crop health; estimating the extent, type, and severity of damage due to drought or floods; issuing warnings; and determining crop insurance payouts. The director general of Civil Aviation has framed a policy for the private use of drones.[463] Once cleared, it will remove a large hurdle to collecting critical data on the agricultural situation in the country on a regular basis.

> “Surveyors can be equipped with handheld devices to geotag parcels as they are surveyed and store the observations in a standardised format on an open data platform”

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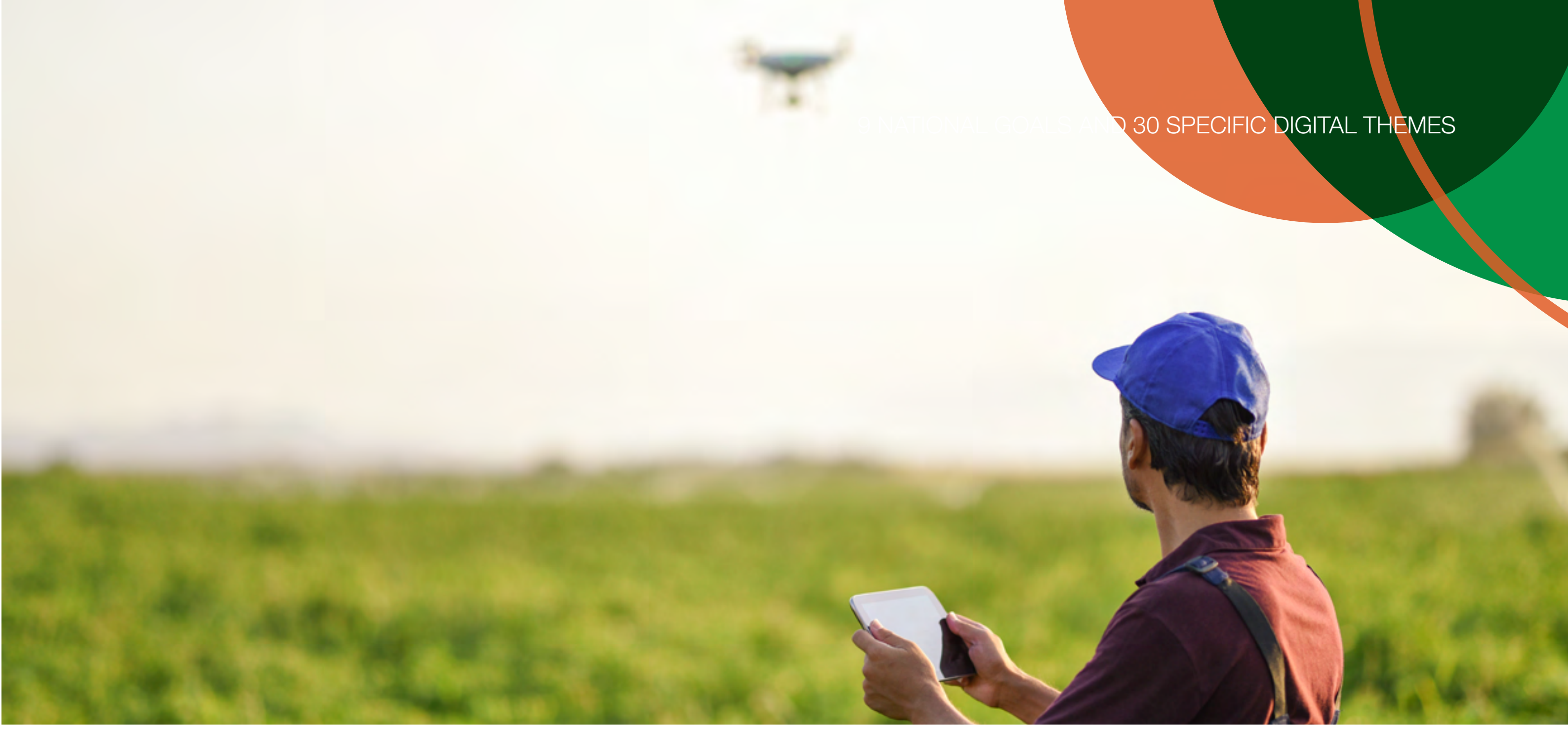
[462] *Report of the expert committee on Land Leasing*, NITI Aayog, March 31, 2016.

[463] Requirements for operation of civil remotely piloted aircraft system (RPAS), Office of the Director General of Civil Aviation.



21. Precision agriculture know-how for every farmer

Vision and potential impact

Technically, all practices that help farmers increase productivity and output through more precise and customised advice could be considered precision agriculture. It is not a specific way of doing things, but rather a spectrum of better or more scientific practices that farmers can adopt in order to increase productivity. There are three core sources of precision agriculture intelligence: a) soil information, b) weather information, and c) crop information. Any application that helps farmers make better decisions as a result of more or more detailed information on these dimensions is part of precision agriculture.

Precision agriculture is the practice of using detailed, real-time data from a variety of sources to minimise inputs and maximise outputs. Public or private agencies advise farmers on crop mix, fertiliser use, and other inputs — a "package of practices" — after analysing soil nutrient condition, aerial images, weather forecasts, and other factors over a four- to six-month crop cycle.

Farmers face a challenge in gaining access to timely and accurate information in one centralised portal on crucial agricultural inputs such as which crop to sow, rainfall and other weather conditions, when to irrigate, the availability and cost of farm equipment, how to monitor animal health, crop health and pesticide use, and adopting good agricultural practices in order to make informed decisions. Moreover, the average Indian landholding is approximately 1.3 hectares, compared with the global average of 3.7 hectares.[464] This makes it difficult to economically implement standard precision agriculture programmes developed for large farm holdings.

A significant number of digital platforms already exist. The Ministry of Agriculture alone operates approximately 80 portals, and state departments and universities combined run roughly 800 portals covering almost all aspects of the agriculture value chain, with a reasonable level of geographic granularity.[465] These multiple data or knowledge portals could be aggregated in a single integrated platform to provide bespoke advice to farmers through mobile apps or through secure USSD text-messaging services, which currently have a wider reach. To realise precision agriculture, multiple players have to be brought together to consolidate data. These players include government ministries for agriculture, IT companies, and water resources; weather forecasting organisations; and seed, fertiliser, and farm-equipment companies.

Big data analysis of the integrated data platform can derive actionable insights for farmers, such as information on pests and how to control them, animal disease forecasting, individualised nutrition management plans, and when crops should be harvested. Currently, ministries and research institutes such as the Indian Council of Agricultural Research draw some insights with limited data access. Several more players can offer value-added services on the basis of this information: insurance providers, for example, could provide direct payouts based on live ground data without the need for claims; ag-tech companies can conduct data analytics and last-mile extension; seed and fertiliser companies can modify their supply chains based on local conditions; and the government can estimate the number of hectares planted in different crops.

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[464] *Highlights of agricultural census*, Press Information Bureau, Ministry of Agriculture and Farmers' Welfare, December 9, 2015.

[465] Expert interview.

Accelerated implementation of this theme would imply productivity improvement of 10 percent by 2025. At this scale, the improved yield outcomes imply $20 billion to $25 billion of added economic value in 2025. Beyond the economic value of better yields, farmers in rural India can also benefit from access to formal credit through data-backed credit-risk assessment.

This open data platform could be used by all stakeholders — government, research institutes, and the private sector — to maximise their respective interests.

Initiatives already under way

Government and nongovernment organisations have launched many initiatives and small-scale pilot programmes in precision agriculture, all of which are designed to put more information and insights into farmers' hands. The Ministry of Agriculture and Farmers' Welfare has made Soil Health Cards with landholding, nutrient, and crop details for over 158.7 million dispatches, and provided fertiliser advisory reports in 22 local languages.[466] Kisan call centres are currently active in 14 locations, with the most popular enquiry on near-term weather and rainfall forecasts.[467] The Department of Animal Husbandry, Dairy, and Fishery has also started the National Animal Disease Reporting System with the objective of monitoring 143 animal diseases in 7,000 locations at the subdistrict level.[468] Some examples are outlined in Exhibit R21.

EXHIBIT R21

Real-time agricultural data can help to increase yields and decrease costs

Initiative	Context	Solution	Impact
Soil Health Card	- Ministry of Agriculture launched soil health card in 2015 - Scheme tests soil samples to encourage judicious use of inputs such as fertiliser	- Soil samples from 10 hectare plots in rainfed areas and 2.5 hectare plots in irrigated areas are tested in a lab, which issues a card with test results in local languages - Card to contain information on soil nutrients and suggestions on how to adapt farming practices to particular soil types	- 158.7 million Soil Health Cards dispatched to farmers, as of Sept 27, 2018 - Early indicators show 10–25% increase in yield for paddy and cereals
mKisan	- Ministry of Agriculture launched mKisan in 2013 to increase the information available to farmers on crucial aspects of farming such as weather & soil health	- Customised information, services, and advisories are given to farmers by SMS, accounting for preferences in language, agricultural practices, and location - A small fee is charged for the service	- Covered 42.4 million farmers, as of September 27, 2018 - Over 22.2 billion texts have been sent since inception, as of September 27, 2018

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[466] Soil Health Card website, as on September 27, 2018; mKisan website, as on September 27, 2018.

[467] mKisan website.

[468] Training manual for veterinary consultants under IDSP, Integrated Disease Surveillance Programme (IDSP), November 2015.

Initiative	Context	Solution	Impact
mKRISHI	▪ mKRISHI is a technology platform for Indian farmers ▪ Tata Consultancy Services designed it to enable farmers in remote areas to access real-time agricultural information, best practices, and market and weather information ▪ The service, started in 2013, plans to reach 2.5 million farmers and generate ~$150 million in revenue by 2023	▪ The mKRISHI platform includes a variety of solutions such as – Disease management system enables farmers to upload photos of their crops and get real-time information on pest type and pest control – Smart devices such as IoT-enabled soil sensors and 'smart shirts' capture crop and soil data for use in forecasting production and monitoring pests	▪ Significant revenue, yield and profit improvements, such as 15% improvement in yield, 88% increase in profits, and 19% decrease in cost for farmers in Tamil Nadu ▪ More than 5,000 farmers in Tamil Nadu, Uttar Pradesh, and Maharashtra currently use the service
MyAgriGuru (Mahindra)	▪ Mahindra launched a web/mobile-based digital platform called MyAgriGuru in February 2017 to create an integrated agri-community ▪ The app connects experts and farmers and enables exchange of ideas and information to create an empowering agriculture ecosystem in the country	▪ The platform has 4 broad sections — Crop, Agri-Buzz, Market Prices, and Weather ▪ Section Crop: Contains information about crops including market price trends, agronomic activity calendar, new technologies, and innovative practices related to crop ▪ Section Agri-Buzz: A unique platform connecting farmers to come and initiate a conversation, inviting opinions and advice from others ▪ Section Market Price: Lists prices of agricultural commodities in all Agricultural Produce Market Committee mandis across India ▪ Section Weather: Provides regional short- and long-term weather forecasts ▪ Provides latest news/updates related to agriculture including schemes and subsidies	▪ Exhaustive information available on 10 crops including cotton, wheat, and potato ▪ Agri-Buzz has seen an average of 120 interactions per day and in total 11,500 interactions ▪ In 7 months after launch, the app was downloaded by more than 200,000 people
Microsoft	▪ Microsoft started a pilot with Hyderabad-based International Crop Research Institute for Semi-Arid Tropics (a UN agency) in 2016 to build a sowing solution to help farmers to predict the right time for sowing crops ▪ Microsoft developed a sowing app to conveniently provide sowing information to farmers	▪ App tells famers which week is perfect for sowing seeds, and provides information on soil health, recommended fertilisers, etc. ▪ App uses rainfall data collected from farms in 13 districts in Andhra Pradesh over 45 years to give farmers a sense of when to start planting ▪ Farmers are asked to register a mobile number with the state government, choose a language — currently limited to the regional Telugu and English — and enter details of the village, district, or subdistrict ▪ App provides crop- and region-specific information and advisory	▪ Official results showed a 30% increase in yield for the initial pilot with 175 groundnut farmers ▪ Sowing app delivered SMS advice in the native language of Telugu and Kannada to farmers in Andhra Pradesh and Karnataka to sow their groundnut crops ▪ In 2017, the program was expanded to touch more than 3,000 farmers in Andhra Pradesh and Karnataka during the Kharif crop cycle (rainy season) for a host of crops including groundnut, ragi, maize, rice, and cotton

SOURCE: Press Information Bureau of India; Ministry of Agriculture and Farmers Welfare; Evolution of mKRISHI: A technology platform for Indian farmers, *Business Innovation Facility*, December 2013.

Potential actions to ensure accelerated progress

Application of precision agriculture improves intelligence-based productivity for farmers. There are a variety of initiatives that can be considered, from the short to the long run:

- **Push usage of existing know-how by raising awareness and giving financial incentives.** The Ministry of Agriculture and Farmers' Welfare has taken a big leap in terms of issuing more than 158.7 million Soil Health Cards, capturing details of each individual farmer's soil type, along with advice on the amount and mix of fertiliser that must be used for maximising his farm's yield.[469] Still, on-the-ground experience suggests that farmers are not yet making optimal use of this intelligence — partly because of ignorance (the Soil Health Cards system is supply driven) and partly because of the risk involved in trying a new crop, fertiliser mix, or other change. To tackle this, the government needs to ensure that Soil Health Cards are used for their intended purpose. Specific actions to unlock the implementation and value of these existing digital initiatives could be:

  - Demonstration programmes in every village to showcase the increased yield accruing as a result of following the Soil Health Card advisory. The Ministry of Agriculture is already planning to run demonstration in all 640,000 villages in the country to showcase the benefits of following the Soil Health Card advisory.[470] Starting in 2018–19, the ministry is planning to pick one farm sample from each village, which will be cultivated per the Soil Health Card recommendations.[471] The idea is for farmers to recognise the importance of leveraging Soil Health Cards by observing the yield and productivity of these demonstrations in their own villages. Given the scale of the operation, it would be advisable for the ministry to invite the private sector and NGO community to conduct these demonstrations in every corner of the country over the next one to two years.

    - Going forward, once card usage becomes pervasive and farmers start seeing benefits, they may want to have their soil tested more frequently than the current rhythm of once every two to three years. Consequently, it's critical to create the right infrastructure and business model so that soil testing could be done on demand for a fee charged to the farmer.

    - Invest in grand challenges for the development of simplified, farmer-friendly devices for soil testing.

  - Incentivise farmers and vendors to follow the Soil Health Card advisory. Altering the crop and fertiliser mix is akin to entering unknown terrain, impacting the farmers' propensity to adopt the advisories. Giving financial incentives (like fertiliser or seed) to farmers, vendors, or both for compliance with Soil Health Card advisories could go a long way toward mitigating the inertia due to risk (perception). Currently, states offer subsidies of over 80 percent of the cost of microirrigation systems; this has improved deployment and consequently yield.[472] In the near future, linking Soil Health Cards and the Fertiliser Monitoring System could enable government to offer discounts or cash back to vendors when they provide customised chemical or organic fertilisers to individual farmers. These incentives could include discounts, cash back, or subsidies.

  - Support the use of text message services to deliver advisories to farmers through SMS (push and pull) or USSD. This already exists for the Farmers Portal, and it could be encouraged for other initiatives, such as soil nutrient and irrigation management through the call centres.

- **Aggregate a large pool of data in a simple, usable format and make it available on an integrated platform.** Currently, agriculture-related data collected by various government departments — such as pest incidence by the Indian Council of Agricultural Research, call-centre data on pest attacks from the Ministry of Agriculture, weather patterns by the Meteorological Department, harvest data by the Department of Agriculture, market price and arrival data on the Agricultural Marketing Information

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[469] Soil Health Card website as of September 27, 2018.

[470] Ministry of Agriculture & Farmers' Welfare.

[471] Ibid.

[472] "Make use of state govt's drip irrigation scheme, farmers told", *Times of India*, February 11, 2018.

Network (Agmarknet), and cost-of-cultivation data from the National Centre of Geo-Informatics — is fragmented across multiple sources and seldom available in a format that is easy to access and use. Furthermore, due to the high number of information sources, most of the data updating happens with a lag. The Ministry of Electronics and Information Technology, along with the Ministry of Agriculture, state departments, and research institutes, among others, could develop an integrated agricultural platform to aggregate information and make it available in an easy-to-use format for everyone. Existing platforms such as the Farmers' Portal could be expanded to incorporate the following features:

- Update data on a regular basis. APIs could be made live again so that data can routinely and automatically be updated to reflect latest picture. Farmer profiling data could be extended for higher coverage across the different platforms.
- Build additional functionalities comparable to the digital transactions on mKisan and other platforms to enable farmers to purchase seeds, fertilisers, and pesticide through linked input-supply-management systems.
- Supplement existing sources of data with new and upcoming channels. A data explosion is happening in all sectors and walks of life, including agriculture. For example, the data from drones, satellites, and digital payments could be included as part of this integrated platform for it to be a truly one-stop solution for all information on Indian agriculture.

This open data platform could be used by all stakeholders — government, research institutes, and the private sector — to maximise their respective interests. In fact, the hallmark for success of the platform has to be its widespread adoption. Such an open data platform will spur private-sector innovation in precision agriculture, which has been traditionally low but is now growing thanks to the emerging agritech startup ecosystem. Startups that are already active in predictive analysis for yield improvement and quality control include Farmguide, Intello Labs, Agricx, Skymet Weather, and Progressive Environmental and Agricultural Technologies (PEAT). Established organisations such as Microsoft and the International Crops Research Institute for the Semi-Arid Tropics have developed a sowing solution that analyses weather, soil conditions, and other indicators to advise farmers on when to plant crops and how to maximise yields. Equipment manufacturers such as Mahindra can develop sensor-equipped tractors and other implements adapted to precision farming as well as insights about how to use them. Agricultural seed and chemical players, such as Monsanto and UPL, can leverage field-level data for targeted inputs to farmers. Foreign non-profit organisations such as the Gates Foundation are also partnering with data intelligence companies like SocialCops to make data-driven investments of about $8 million to develop an India Stack for agriculture.[473]

- **Encourage sharing platforms to make affordable farm equipment more available.** Farmers with smaller landholdings struggle to afford and get returns from equipment because of the high initial investment required. Installing a digitally enabled drip irrigation system can cost hundreds of dollars (between $457 and $1,900) per hectare. Also, the average Indian landholding size is approximately 1.3 hectares, compared with the global average of 3.7 hectares, and this reduces the return on investment for farmers.[474]
  - The Ministry of Agriculture and state governments, in collaboration with agriculture equipment manufacturers, food processors, and others in the private sector, could encourage a custom-hiring model to give farmers access to precision agriculture equipment. An example would be online/offline service centres where farmers can rent equipment from different providers based on their individual needs. New-age companies such as EM3 agri have set up pay-as-you-use services to allow farmers to use expensive agricultural equipment and technologies.

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[473] Social Corps website as of April 24, 2018.

[474] *Highlights of Agriculture Census*, Press Information Bureau, Ministry of Agriculture and Farmers' Welfare, December 9, 2015.

22. Universal online agricultural marketplaces to connect farmers to the market

Vision and potential impact

Farmers in India face the challenge of limited access to agricultural markets. Most farmers can sell produce only in the closest mandi, or wholesale market, and thus have very little bargaining power, resulting in poor income realisation. An online trading platform based on scaling up the eNAM and Buyer Seller platform could address this problem by providing both farmers and traders with direct, electronically enabled channels delivering timely information about local prices, supply, counterparty records, and transaction fulfilment. When accompanied by an e-warehousing and logistics interface to assure timely produce delivery, such a digital venue would open farmers' market options from trading within a single mandi to intermandi trading within a state, and ultimately to interstate trading.

Much is at stake. Over $4.8 billion worth of produce already has been traded on eNAM by 96,118 buyers and 5.08 million sellers in 13 states.[475] By eliminating intermediaries and preventing distress sales due to lack of access to nearby markets, prices for agricultural commodities traded electronically have averaged approximately 15 percent higher than those traded locally.[476] To deliver fully on its promise, the online trading platform needs to be a market manager, accessible by farmers and by traders in local mandis seamlessly with appropriate mobile computing devices and broadband access.

In addition to enabling farmers to see live prices from individual buyers, online trading ultimately could enable better postharvest management and processing of crops; inadequate storage and logistics resulted in a loss of more than $15 billion worth of agricultural produce in 2013.[477] More information about where and why losses occur can encourage investment in better short-term warehousing and logistics facilities. With such facilities, farmers could store their produce in a short-term warehouse, triggering an e-receipt. At the warehouse they could get a quality grade certificate. This warehousing e-receipt and grading certification could be visible in the online marketplace, where a buyer from a different state can participate in the market. The intermandi buyer-seller delivery could be handled by a logistics player chosen on this platform. Payment for the produce could happen electronically and be tracked to help the farmer build a credit history that could give him access to bank financing.

Accelerated implementation of the agricultural marketplace in all states would, by 2025, enable between 40 and 60 percent of agricultural product trades to occur on unified markets, boosting prices received by farmers by at least 15 percent.[478] Simultaneously, consumers would benefit from lower food prices due to a reduction in intermediaries. This could imply $20 billion to $30 billion of economic value creation in terms of consumer and producer surplus in 2025.

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[475] eNAM dashboard, as of April 26, 2018.

[476] Ramesh Chand, *Doubling farmers' income – rationale, strategy, prospective and action plan*, NITI Aayog, March 2017.

[477] *Wastage of agricultural produce*, Ministry of Food Processing Industries press release, August 9, 2016.

Initiatives already under way

In addition to eNAM, at least two private companies have established electronic commodities markets to more directly link farmers to the markets. These examples are outlined in Exhibit R22.

EXHIBIT R22

Technology is bringing transparency to India's agricultural markets

Initiative	Context	Solution	Impact
Karnataka Government and NCDEX Spot Exchange	▪ The Karnataka state government and the National Commodity and Derivatives Exchange (NCDEX) started Rashtriya e-Market Services to encourage competition in agricultural markets and help farmers receive better prices for their crops	▪ An electronic auction system links more than 300 Agricultural Produce Market Committee (APMC) mandis ▪ Incoming commodities are recorded online at the gate of each mandi and assayed at dedicated facilities ▪ Traders across the state can see the lots and bid via computer or mobile phone ▪ Once a farmer accepts the price, payment is made electronically directly to the farmer's bank account	▪ Average price for yield increased by 38% in nominal terms and 13% in real terms between 2013–14 and 2015–16 ▪ 4.2 million farmers trade with 34,000 registered traders on the platform, as of July 2017
eNAM	▪ Ministry of Agriculture in 2015 launched eNam, the electronic National Agriculture Market, to connect the 7,000 APMC mandis across India to promote transparency in agricultural markets	▪ eNAM is an online portal to connect each mandi to a national platform ▪ Traders across the country can see all the produce traded in connected APMC mandis and make bids ▪ Through eNAM, farmers are assured transparency in pricing and a wider market beyond the mandi closest to their farms	▪ 585 agricultural markets in 16 states and 2 union territories have joined the platform, as of March 2018
Buyer Seller Platform	▪ Ministry of Agriculture launched Buyer Seller platform / mKisan for farmers to receive local buyer prices over SMS ▪ Connect farmers with buyers (farmer producer organisations, exporters, traders, and processors)	▪ Buyer registers on this platform and chooses the area from where he wants to buy the product ▪ Farmers in selected location get SMS of buyer price on their mobile phone ▪ SMS contains name of buyer, mobile number, and offer price	▪ Since 2013, 19.6 billion SMS have been sent to farmers, as of April 20, 2018

SOURCE: NCDEX; NITI Aayog; India Today, July 22, 2017.

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[478] Ramesh Chand, *Doubling farmers' income – rationale, strategy, prospective and action plan*, NITI Aayog, March 2017.

Potential actions to ensure accelerated progress

Widespread and effective implementation of direct buying and selling of agricultural goods can increase farmers' incomes significantly. Taking Karnataka NCDEX as an example, direct buying and selling could increase income by 10 to 15 percent by cutting out middlemen and bringing transparency to the market.[479]

Nonetheless, given the number of people involved, legislative legacy, and vastness of geography, moving from the traditional physical mandi-dominated trade to direct buying and selling is going to take serious commitment to reform the sector. Also, given the size of the problem, a multi-pronged strategy may work as opposed to a one size fits all solution. Potential solutions could include creating incentives and institutions to enable electronic trading in states where eNAMs are allowed while also ensuring that the remaining states amend the Agricultural Produce Market Committee Act to allow direct buying and selling of agricultural produce. A few key enablers are listed, beginning with how to kick-start electronic trading in states that already have amended the APMC Act and then moving to states that are yet to be onboarded.

- **Place agricultural marketing on the concurrent list.** States have different levels of eNAM sign-up and digitisation of mandi transactions. Coordination and compliance among the various state and non-state stakeholders could be managed more efficiently. The one-India market concept opens farmer produce marketing with no boundaries to meet both intrastate and interstate demand.

- **Create a policy for institutional market facilitators to execute electronic trades and resolve disputes.** Given the inherent remoteness of buyers and sellers on an electronic platform, the need for a market facilitator becomes paramount, to build trust in digital trading and ensure consummation of agreed-upon trades. Currently, this market facilitator institution is missing, resulting in tepid adoption of electronic trading of agricultural goods. This market facilitator could work as an e-market platform for agricultural goods, also guaranteeing delivery of goods and payments. This institutional mechanism could be led by Agricultural Market Boards or through a special-purpose vehicle with non-governmental bodies.

> "The need for a market facilitator is paramount to build trust in digital trading and ensure consummation of agreed-upon trades which could be led by Agricultural Market Boards or through a special-purpose vehicle with non-governmental bodies"

- **Push for intramandi and intermandi trade within states using the electronic platform.** In an ideal world, all agricultural markets would be linked throughout the country, so that farmers get the best possible price for their produce, maximising their incomes. We first need to ensure that price discovery and transaction closure within each mandi happens electronically. This needs to be followed with incentivising intermandi buying and selling of produce within a state. This could begin with 585 prioritised mandis have been connected with eNAMs as of March 2018.[480] Agricultural Produce Market Committees in each mandi need to ensure that the transactions within these mandis are settled electronically.

- **Convenient access to the universal agricultural marketplace for farmers.** On average, there is approximately one mandi for every 450 square kilometres in India.[481] Farmers find it inconvenient to travel to mandis run by local Agricultural Produce

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[479] Ramesh Chand, *Doubling farmers' income – rationale, strategy, prospective and action plan*, NITI Aayog, March 2017.

[480] eNAM website, as of April 24, 2018.

[481] *Report of the working group on agricultural marketing infrastructure, secondary agriculture and policy required for internal and external trade, Agricultural Division*, Planning Commission, Government of India, 2011.

Market Committees (APMCs), and as a result, growers sell a significant proportion of produce — 83 percent of coconut crops, for example, and 56 percent of paddy, or unmilled rice — to local middlemen who aggregate the produce of several small farmers and then sell it at mandis.[482]

The central government has launched the GRAM (Gramin Retail Agricultural Markets) programme with the goal of establishing 22,000 gramin haats, or local farmers' markets, that will have digital infrastructure to link them with eNAM to increase the number of accessible marketplaces.[483]

- **Expand e-market portals to include animal husbandry products.** Diversifed revenue streams for farmers protect them from individual product market risks. Additionally, animal husbandry products provide a good cost premium with growing domestic and export market demand. The category includes products such as milk, bovine serum, and premium seafood like shrimp and prawns.

- **Create clear, simple mechanisms to verify quality using assaying and grading standards.** Established grading standards for agricultural produce are lacking, as are grading and assaying facilities in mandis, which makes it difficult for traders to verify produce quality without physical checks, which hampers electronic models of trading agricultural goods.

  - The government could link financial grants for setting up eNAM in mandis to whether the Directorate of Marketing and Inspection has published grading standards for commodities, whether a state has solicited bids to build grading and assaying facilities, and how far it has progressed in building those facilities.

  - Further research could concentrate on developing faster assaying tests rather than physical checks that can be subjective and difficult to standardise. Handheld devices that can conduct rapid chemical or sensory tests will accelerate assaying and grading in mandis. Competitions like grand challenges organised by the Ministry of Agriculture encourage innovation through new ideas or pilot projects to develop handheld or chemical testing solutions.

- **Encourage widespread adoption of e-negotiable warehouse receipts linked with logistics.** The government introduced e-negotiable warehouse receipts in September 2017.[484] An e-warehousing receipt allows farmers to store their produce for short periods in the mandis and get an electronic receipt documenting the quality and quantity of the stored produce. Potential buyers and creditors can use this receipt to assess the creditworthiness of the farmer and be used in trading goods. Once a transaction is triggered, the intermandi delivery to the buyer could be handled by a logistics company chosen on the platform. Payment for the produce could be managed electronically.

- **Promote amending the APMC Act to allow eNAM to operate in all states.** Three changes to the APMC Act are necessary for eNAMs to operate.

> "Three changes to the APMC Act necessary for eNAMs to operate are a specific provision allowing e-trading, issuing of licences to anyone in India who wants to trade in a mandi through eNAM, and the third is a consolidated licence fee"

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482 *Some aspects of farming in India*, National Sample Survey Office, 2016.

483 *Doubling farmers' income: Government keeps MSP of all hitherto unannounced Kharif crops at least at one and half times of production cost*, Ministry of Finance press release, February 1, 2018.

484 *Shri Ram Vilas Paswan launches "Electronic Negotiable Warehouse Receipt (e-NWR) System".* Ministry of Consumer Affairs, Food and Public Distribution, September 26, 2017.

One is a specific provision allowing e-trading. Another is the issuing of licences to anyone in India who wants to trade in a mandi through eNAM, and the third is a consolidated licence fee. Seventeen states and union territories have not made all the requisite amendments.[485] The central government could push states to amend the APMC Act with the requisite changes by regularly expressing its concerns in frequent consultations with state agriculture departments.

- State agricultural departments could improve market-point access by allowing farmers to establish private market yards and link them to eNAMs. Investment in setting up yards could be encouraged through public-private partnerships, with government providing viability gap funding and designating private market yards as infrastructure projects in order to attract foreign direct investment. Trade in private market yards could be encouraged by waiving market fees or linking market fees to the availability of facilities. States can frame supporting regulations. One example is the new Agricultural Produce and Livestock Marketing Act in Punjab, which allows private players to set up private market yards close to farmers.

- **Utilise Buyer Seller platform in areas where eNAM is not yet operational.** The Ministry of Agriculture's mKisan portal has more than 42.4 million subscribers and the functionality to enable subscribers to send custom SMS texts to other subscribers in any local area of their choice.[486] This platform could be used for direct trading of goods between farmers and buyers, especially in areas where eNAMs are not operational, by giving details of the quality, quantity, and quoted price of the produce. Direct buying and selling also would require an agency that works as market facilitator as well as standardised assaying and grading codes and facilities. Clarity would be needed on the legal status of using this tool for bulk and wholesale transactions, as opposed to restricting it to retail sales.

- **Introduce ways to validate organic produce and other premium agricultural products.** Organic products and traditional local specialty products carry a price premium based on their production and place of origin. However, it can be hard to validate these agricultural inputs and realise their high market value without direct market access.

  - The added value created by premium agricultural products can justify the high initial cost of IoT sensors, geotagging, blockchain technology, and other new tools capable of validating the origin and quality of such products. Certification processes such as the Decentralised Organic Farming Certification System can be used with precision monitoring through data sets such as Soil Health Cards, to qualify more farmers using appropriate standards for organic farming and deliver the accompanying premium.

    - Contract farming by large corporations for special products in specific regions could fund the use of new technologies to boost yield and productivity and improve individual farmers' income. The draft Contract Farming Act released in 2018 by the Ministry of Agriculture could make advance price agreements between farmers and private players legally possible and help induce investment by farmers.[487]

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[485] *Centre to modify model APMC law to address States' concerns*, The Hindu BusinessLine, October 21, 2016.

[486] mKisan website.

[487] *Model Contract Farming Act*, Ministry of Agriculture and Farmers' Welfare, December 23, 2017.

4.0

Goal H: Make in digital India, make for India, make for the world

Making manufacturing, trade, transportation, and services globally competitive through business automation, digital platforms, and advanced analytics.

23. End-to-end supply chain, e-enabled trade, and e-commerce

Vision and potential impact

With the advent of Industry 4.0 — the name given to the digitisation and automation of factory production processes — the supply chain is experiencing a transformation. Supply chains are leveraging the power of big data analytics to become more flexible, granular, and accurate. Flexibility is achieved through ad hoc and continuous planning that is able to react dynamically to the changing environment. Microsegmentation and mass customisation are enabling granularity, and accuracy is maintained through real-time end-to-end transparency. The tremendous growth of e-commerce in India has led customers to expect shorter delivery times and increased service levels, highlighting an urgent need for the private sector to adopt newer supply chain technologies to become more competitive.

The fundamental requirement for a digital supply chain is an integrated data platform that can capture data on inventory and goods flow from vendors to manufacturers, then to wholesalers, and finally to retailers and consumers. Private companies dealing in FMCG — fast-moving consumer goods, which are products like soft drinks and packaged foods that sell quickly for a low price — can have their own integrated data platform that captures goods information on a real-time basis with the help of point-of-sale technologies such as bar-code scanners.

The implementation of the Goods and Services Tax and the advent of the Goods and Services Tax Network to track economic activity and collect taxes have spurred small and medium-size enterprises to store data about what they buy and sell. Application service providers are offering to help small-business owners to manage this data and use it to optimise the businesses' supply chains. This data could be aggregated to create a "supply chain cloud".

In addition, lenders can use GSTN data to determine how much credit they can safely extend to businesses by analysing their flows of goods and cash.

With the help of big data analytics, a lot of value can be created. Computers can use machine learning to analyse data and teach themselves to more accurately forecast demand. This information opens many opportunities for businesses, including better managing by removing dated and unneeded inventory without compromising service levels. Microsegmentation of the market can better match demand and supply. This helps in stocking the right number of the right items at wholesale and retail points, thereby minimising inventory and reducing waste. Further, data analytics can be used for predictive shipping of goods. Situational offerings such as discounts on specific shipments can be scheduled. Improved inventory algorithms can be used to reduce uncertainty regarding stock.

E-commerce, a part of the overall digital supply chain theme, has the potential to grow significantly by 2025. In other emerging countries, the share of e-commerce in retail trade has grown in line with national internet penetration. Based on such a trajectory, e-commerce in India could add $15 billion to $20 billion in 2025, with e-tailing gross merchandise value accounting for around 10 to 15 percent of total trade in the country in that year, close to the level that it accounts for in China today.[488] China's experience suggests that e-commerce provides strong impetus for consumption growth in smaller towns that do not have access to modern offline retail infrastructure, and provides growth and productivity-boosting opportunities to small manufacturers and logistics players.[489] Similar benefits could be expected in India.

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[488] Central Statistics Office.

Accelerated implementation of this level of digitisation could help reduce inventory costs from 5 percent of overall costs to 3 percent by 2025, which translates into creation of $12 billion to $15 billion of economic value. Manufacturers can also reduce their production costs through accurate planning. Vendors and retailers can benefit from better service levels and easier access to credit. Customers could enjoy higher service levels and faster delivery.

Initiatives already under way

Private-sector companies in India have started to implement end-to-end digital supply chains. Hindustan Unilever Limited and Amazon are examples highlighted in Exhibit R23.

EXHIBIT R23

Big data is helping corporations to better manage complex supply chains

Organisation	Context	Solution	Impact
Hindustan Unilever	▪ Hindustan Unilever uses real-time point-of-sale data to improve sales and operations planning processes	▪ Captures data using hand-held-terminal platform called Unify along with bar codes on products ▪ Uses advanced statistical tools and models to get a robust baseline number ▪ Cloud-based data collaboration tool to make data easily available to planners ▪ Shorten planning cycle significantly, replenish inventory based on real-time market signals ▪ Already being implemented in Mumbai, Delhi, Bangalore, and Chennai	▪ 14% reduction in inventory ▪ Service improvement by 200 basis points during the pilot
	▪ Adopts a micro-segmentation approach at the customer level to manage demand and supply	▪ Enables market-based customised offerings at optimal supply chain cost ▪ Sustains higher service levels with higher complexity ▪ Accelerates speed to market with faster response times ▪ Leaner tail means less waste and non-value-adding complexity	▪ Improved service by 300 basis points over two years ▪ Reduced inventory by 16% across supply chain ▪ Reduced volume of slow and obsolete inventory by 20%
Amazon	▪ Amazon has established 62 fulfilment centres across 13 states, serving micro, small, and medium-sized retailers, wholesalers, and manufacturers	▪ Amazon Seller Services platform offers participating sellers the option to manage inventory online ▪ Platform uses big data analytics to forecast demand	▪ Over 300,000 sellers manage their inventory online directly, making it cost effective ▪ Higher customer satisfaction through faster delivery and reliable transit times

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[489] *China's e-tail revolution*, McKinsey Global Institute, March 2013.

Organisation	Context	Solution	Impact
Andhra Pradesh	▪ Aadhaar-enabled public distribution system (AePDS) ▪ Entirely digitised PDS system in Andhra Pradesh with supply chain management; fair-shop transactions automated with Aadhaar-based biometric ID enables PoS devices	▪ Ration card data is digitised and Aadhaar seeded ▪ Monitors the movement of PDS stocks from the FCI godown to fair price shop until it reaches the consumers	▪ 13 million monthly Aadhaar beneficiaries (ration card holders) ▪ Resulted in $165 million in savings ▪ 28,132 total shops with 12.2 million availed cards and 12.4 million monthly transactions

SOURCE: Ministry of Human Resource Development; Government of India Press Information Bureau; Economic Times, February 18, 2018; Amazon, March 19, 2018.

> "Tremendous growth of e-commerce in India has led customers to expect shorter delivery times and increased service levels, highlighting an urgent need for the private sector to adopt newer supply chain technologies to become more competitive"

Potential actions to ensure accelerated progress

Digital supply chains can scale rapidly, as long as the government and private players act to ensure that the following prerequisites are considered:

- **Tangible economic benefits for adopting GSTN and supply chain software.** MSMEs — particularly retailers — have been reluctant to adopt the Goods and Services Tax Network because they are concerned that it may expose them to higher tax liability. At the same time, available supply chain software is expensive and complicated to use for MSME retailers.

  The development of flow-based lending for working capital may encourage MSMEs to join the GSTN. Application service providers can develop software to handle supply chain analytics for smaller businesses at prices they can afford.

- **Tangible economic benefits for adopting point-of-sale terminals:** Large private companies focused on fast-moving consumer goods can benefit by encouraging small retailers and even wholesalers to install digital PoS terminals to track tertiary sales. This would help FMCG companies get a fuller picture of how their products are selling, which could help them improve inventory management. Persuading small retailers to use PoS terminals would provide data at a very micro level and help in making planning more efficient and waste-free. Cloud-based mobile applications coupled with bar-code scanning can serve as simple solutions for PoS transaction tracking.

24. Efficient transportation enabled by shared platforms

Vision and potential impact

India's transport sector is entrusted with the unenviable task of ensuring swift and safe movement for its 1.3 billion people. The country has developed extensive infrastructure to make it happen. India has almost 4.7 million kilometres of roads, one of the largest systems in the world, and 115,000 kilometres of railway track.[490] The government, realising the importance of infrastructure, has made road and highway construction one of its key priorities in recent years, reaching an all-time high of 8,231 kilometres of new highway construction in 2016–17, compared with 4,410 kilometres in 2014–15.[491]

Despite these achievements, there is still immense and increasing pressure on the road infrastructure. Almost 210 million vehicles are registered, with more than 50,000 new vehicles — including buses, trucks, cars, and two-wheelers — registered every day throughout the country.[492] Consequently, average peak speed on city streets is low and declining. For example, the average speed in Delhi is 26 kilometres per hour, which is 35 to 48 percent below the posted speed limit.[493] In Mumbai, the average speed is only 20.7 kilometres per hour.[494]

An IIT Madras study estimated the annual congestion cost in New Delhi at $9 billion in 2013, 12.5 percent higher than Delhi's total annual budget for the year 2017–18.[495]

Traffic congestion in Indian cities causes people to spend more time in traffic, reducing productivity, and causes vehicles to spend more time idling, wasting fuel and releasing more pollutants into the air. The effects of this are perceptible: in 2016, the World Health Organisation concluded that ten of the 20 most polluted cities in the world were in India.[496]

Even as the government pushes to improve and expand roads and highways, there is a need for new solutions that allow optimal utilisation of finite resources. One such solution that has gained prominence and offers promise is shared mobility, which offers on-demand rides in a vehicle or mode of the traveler's choice. A ride aggregator not only helps reduce travel costs by splitting expenses but also aids in reducing road congestion and pollution. Shared mobility has the potential to benefit countries globally. A NITI Aayog report estimates that India could reduce carbon emissions 37 percent by 2030 by pursuing a shared, electric, and connected mobility future.[497] For example, Ola Cabs, a local cab aggregator in India, reported having saved four million litres of fuel and reducing 6.5 million kilograms of carbon dioxide emissions through ride sharing in seven Indian cities in 2016.[498]

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[490] *Demand for grants 2018–19 analyses*, PRS Legislative Research, February 28, 2018; *Safety in Indian railways*, The PRS Blog, August 24, 2017.

[491] *2017: A year of ambitious roll-outs and engineering marvels*, Ministry of Road Transport and Highways, January 1, 2018.

[492] Motor Vehicles, Statistical Year Book India, MOSPI, 2016.

[493] *Congestion on Delhi roads has worsened says new analysis by CSE of latest Google map data*, Centre for Science and Environment press release, July 10, 2017.

[494] *How India commutes*, Ola, January 6, 2017.

[495] Neema Davis et al., *Congestion costs incurred on Indian roads: A case study for New Delhi*, Indian Institute of Technology Madras, 2017.

[496] Jayashree Nandi, "10 of world's 20 most polluted cities in India: List inside", *Times of India*, May 15, 2017.

Initiatives already under way

The public and private sectors in India have started to implement several initiatives. Key examples are highlighted in Exhibit R24.

EXHIBIT R24

Untangling traffic congestion and easing transport by unleashing data-driven technologies

Organisation	Context	Solution	Impact
Ola and Uber	▪ Ola and Uber are India's top online transportation network companies and cab aggregators ▪ Connect drivers and passengers for intra- and inter-city travel ▪ Before their entry, only three or four cities had well-established mass rapid transit systems	▪ Platforms work by connecting drivers to passengers via a mobile application (accessed by both drivers and passengers) ▪ Types of vehicles include 2 wheelers, 3 wheelers (auto rickshaws), 4 wheelers and 6 wheelers (shuttle buses) ▪ Verifying drivers adds a level of security ▪ Customers choose their pick-up and drop points; request is transmitted to nearby drivers, who can accept and connect with customers ▪ Real-time ride tracking and SOS features are available ▪ Passengers and drivers can rate their experience after the ride	▪ Ola and Uber rides rose to 500 million in 2016 from 130 million in 2015 Ola ▪ Present in 102 Indian towns and cities with a fleet of about 450,000 vehicles ▪ By June 2017, Ola Share, reduced 12 million kg of CO_2 emissions, saved over 7 million litres of fuel, and cut the distance travelled by cabs by 84 million km Uber ▪ Present in 29 cities with a fleet size of about 400,000 vehicles ▪ By June 2017, uberPOOL helped save 940,000 litres of fuel and 20 million km travelled, thereby curbing 2.2 million kg of CO_2 emissions in Delhi
BlaBlaCar	▪ BlaBlaCar is the world's largest long-distance ride-sharing community ▪ Founded in 2006, BlaBlaCar connects drivers and passengers willing to travel together between cities and share the cost	▪ Platform works by providing a list of people travelling on a particular route on a given date ▪ Verified member profiles lets users know who exactly is travelling ▪ Government ID verification adds another level of security to members' profiles ▪ Passengers and drivers rate their experience after the ride ▪ Pricing is based on cost sharing and not on profit making	▪ Platform available in over 22 countries including India ▪ 60 million members worldwide and over 18 million travellers quarterly ▪ Rides are priced at $4.50 between Mumbai and Pune, $7.50 between Delhi and Chandigarh ▪ Has offered more than 3 million seats, as of June 2016

SOURCE: Bla Bla Car, as of May 10, 2018; Ola, as of May 10, 2018; Uber, as of May 10, 2018; Business Standard, June 5, 2017; livemint, February 2017.

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[497] Shikha Juyal et al., *India leaps ahead: Transformative mobility solutions for all*, NITI Aayog and Rocky Mountain Institute, May 2017; *The future of mobility in India: Challenges and opportunities for the auto component industry*, McKinsey & Company, September 2017.

[498] *How India commuted in 2016 — our insights*, Ola Blog, January 6, 2017.

Potential actions to ensure accelerated progress

Efficient transportation enabled by digital technology can scale rapidly as long as the public and private sectors act to ensure that the following prerequisites are considered:

- **Relax licensing requirements for taxi and auto drivers.** The Ministry of Road Transport and Highways recently relaxed a requirement that taxi and auto drivers hold commercial driving licences.[499] The move would help India address its current shortage of about 2.2 million drivers as ride-sharing platforms gain prominence.[500]

- **Allow aggregation of private vehicles.** Currently, private vehicles are not allowed to be registered on ride-sharing platforms and offer rides for a fee. Only commercially registered vehicles are allowed to do so. The government is looking at the prospect of liberalising taxi permits so that private cars can easily be employed as taxis by service aggregators.

- **Adopt clear guidelines for cab aggregators and ride-sharing platforms.** Cab aggregators are inherently different from traditional taxi companies in that they use the power of digital platforms' real-time matching of demand and supply to provide mobility solutions. Because of this, they can be regulated by two laws, the Motor Vehicle Act and the IT Act. The Parliament recently amended the Motor Vehicle Act to recognise aggregators as a business entity distinct from taxi operators.[501] The amendment would redefine aggregators as intermediaries that connect passengers with drivers for transportation purposes. The amendment, once passed, would require state governments to issue licences to taxi aggregators under central government guidelines, introducing standardisation across various states.

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[499] Dipak K Dash, "Commercial driving licence not needed for taxis, autos", *Times of India*, April 19, 2018.

[500] *Report of the Select Committee on The Motor Vehicles (Amendment) Bill*, Parliament of India, December 2017.

[501] Ibid.

25. Integrated logistics platform

Vision and potential impact

India currently spends 13 to 14 percent of its GDP on logistics, compared to 9 percent for the US and 8 percent for Europe.[502] This accounts for direct costs involved in moving goods from one place to another, including transportation and warehousing, and for indirect costs such as holding inventory and absorbing damages and theft. Estimates suggest that while most of the discussion of high logistics costs has focused on direct costs, indirect costs make up as much as 40 percent of overall logistics cost.[503] The two are inextricably linked — firms need greater inventory in India due to longer times involved in moving goods from one place to another as well as higher uncertainty with respect to the actual time it will take. For example, estimates suggest that the average time of transporting goods 1,400 kilometres via road in India is about 20 percent more than it is in China; in certain instances, delays caused by India's inadequate infrastructure — lower speeds, congestion and inefficiencies at ports, and lack of automation — can increase the difference to as much as 40 percent longer than in China.

In 2018, India ranked 44th out of 160 countries on the World Bank's Logistics Performance Index, with a score of 3.18 out of 5.[504] India's low ranking can be attributed largely to its lagging performance on timeliness (of shipments reaching their destination within the scheduled or expected delivery time) and efficiency of clearance processes, including customs. The difference from China is the greatest on infrastructure, on which India ranks at 52 against China's 20.[505] The 2018 ranking is a drop from the country's 2016 ranking, 35th, and score, 3.42.[506]

Having robust, reliable, and efficient logistics in India is critical to increasing productivity and thus making Indian goods competitive in global markets. This assumes even greater importance in the context of the government's Make in India programme, which seeks to raise manufacturing's share of GDP from approximately 16 percent currently to 25 percent by 2022.[507] Realising this, the Government of India in January 2018 set out to create a national logistics platform, an integrated portal that will serve as a transactional e-marketplace to connect logistics buyers and service providers with all government agencies, such as customs, as well as port community systems, sea and airport terminals, shipping lines, and railways. The key objective is to reduce logistics costs to 10 percent or less of GDP from the current

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[502] *Building India: Transforming the nation's logistics infrastructure*, McKinsey & Company, July 2010.
[503] Debunking India's logistics myths, Neelesh Mundra, Abhinav Singh, Raghavendra Uthpala, *Live Mint,* 2018.
[504] *Country Score Card: India 2018,* Logistics Performance Index, World Bank.
[505] Ibid.
[506] Ibid.
[507] *Manufacturing sector in India*, India Brand Equity Foundation, March 2018.

13 to 14 percent of GDP, to level the playing field for Indian producers and manufacturers.[508]

Government has already launched efforts on multiple dimensions to kickstart the process of putting together this integrated logistics portal, right from developing a logistics masterplan to estimating the main levers of logistics cost to thinking through the creation of Centres of Excellence in logistics research and development.

- **Development of a logistics masterplan.** As described above, the idea of an integrated logistics portal is to have an electronic platform that links shippers, carriers and customers to facilitate trade and collaboration between the parties involved through the use of intelligent systems. The platform is envisioned to be a single window clearance from finding the optimal mix of transporting goods from one place to another, to finding the right warehousing and packaging facility (including cold chain) to also initiating and completing the associated documentation process. Creating this portal requires intelligence on multiple core aspects, like baseline cost, identification and prioritisation of right set of interventions, and implementation and monitoring. The government is moving at a fast pace to make considerable progress on all the key levers.
- **Baselining logistics cost and identification of cost reduction measures.** Logistics cost can be broken down into two types of costs. Direct cost, comprising of components like transportation cost, cargo handing cost, warehousing cost; and Indirect cost, comprising of things like packaging cost, administration cost. Any effort to optimise and reduce India's logistics cost first has to start with a robust baselining of various costs as they stand today. The government is at an advanced stage to launch a detailed baselining study to estimate the various components of the overall logistics cost, which will help prioritise the most impactful levers.
- **Establishing the Centres of Excellence in the logistics research and development facility.** Globally, Centres of Excellence have played a critical role in reducing the logistics cost by helping industries adopt best practices. Japan Institute of Logistics Systems and National Logistics Information Centre (NLIC), South Korea are two examples that have not only produced a highly skilled workforce for the logistics sector but also successfully disseminated best practices throughout the country. The government is looking to create five–six such Centres throughout the country, with participation from academics and industry. IIM Bangalore has been tasked with preparing an administrative structure of the proposed Institutes.

A national logistics platform could help manufacturers reduce turnaround time in warehouse activities and better administer the end-to-end movement of goods in supply chains. Retailers and sellers could benefit from faster deliveries, lower inventory requirements, and smoother order processing. Consumers could have better service levels, less congestion, and easier payment at tolls. Accelerated implementation of this theme has the potential to reduce fleet turnaround time by as much as 30 percent, increasing productivity and reducing costs. This could imply $21 billion to $26 billion of added economic value in 2025.

Initiatives already under way

While the logistics sector remains highly unorganised and unregulated, the public and private sectors have launched initiatives to improve its efficiency and functioning. For example, Rivigo, a trucking startup, has adopted a suite of technologies — IoT sensors to improve maintenance of its fleet, dynamic routing, and driver relay models — that have allowed the firm to reduce delivery times for clients by 50 to 70 percent.[509] Other examples include Blackbuck's truck aggregation platform, which links shippers with truckers, and the National Highways Authority of India's electronic toll-collection system, FASTag (Exhibit R25).

In addition to these encouraging developments at home, India can also learn from countries that have already put together integrated multimodal logistics platforms. Dubai Logistics City, for example, links markets globally in a 25-kilometre-wide free zone, offering benefits such as logistics solutions and value-added services, shared warehousing, and an office park.[510] The logistics authorities of China, Japan, and South Korea operate the

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[508] RFP for engaging a consultant for working out integrated logistics plan for the country, Ministry of Commerce, Government of India, January 2018.

[509] Who we are, Rivigo website.

[510] Dubai World Central.

Northeast Asia Logistics Information Service Network, which connects the countries' logistics information systems.[511] It started as a pilot for a dynamic container-vessel schedule interface and later added services such as a container information service that helps shippers, forwarders, and other stakeholders receive timely information on seaborne containers. The UN Economic and Social Commission for Asia and the Pacific has proposed developing the network into an information service that serves all logistical modes, provides logistics industry chain management, and functions as an interconnected logistics information exchange with harmonised technical standards for seamless cargo transfer from South Korea to China.[512]

EXHIBIT R25

Untangling traffic congestion by unleashing data-driven technologies

Organisation	Context	Solution	Impact
Rivigo	▪ A disruptive logistics company that provides express surface delivery across India ▪ Serves major companies in auto, pharma, cold chain, e-commerce, and textile industries	▪ IoT-enabled devices installed across all trucks for 24/7 alert-based vitals and real-time visibility of trucks ▪ Advanced analytics for network optimisation ▪ Unique driver relay model: drivers change every 300 km	▪ Creates 50–70% reduction in turnaround time on long-haul routes for clients through driver-relay method ▪ Fleet of over 2,000 trucks, as of April 2018
Blackbuck	▪ Truck aggregation platform focused on B2B intercity trucking which enables shippers to see which trucks are available, choose one, and track it on its journey	▪ Platform integrates with customers' enterprise-resource-planning systems ▪ Features include track and trace, trip mapping, verifications, account management, and checking the health and condition of the truck	▪ Over 120,000 trucks enrolled on the platform, as of December 2017 ▪ Charges a commission of 10–15% on every transaction
NHAI	▪ National Highways Authority of India (NHAI) FASTag electronic toll collection system enables smart tolling	▪ Tag account is linked to a prepaid account from which toll amount is deducted ▪ Tag account can be recharged online and purchased from any of the PoS locations at toll plazas or issuer agency ▪ Employs RFID technology to pay toll directly from linked account	▪ Currently operational at more than 350 toll plazas (over 75%) on national highways ▪ Near-nonstop movement of vehicles, thereby lowering fuel consumption ▪ Convenience in recharging and paying digitally

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[511] *Northeast Asia Logistics Information Service Network kicks off*, Japan International Freight Forwarders Association, December 9, 2011; *Northeast Asia Logistics Information Service Network (NEAL-NET) technical architecture and standard*, NEAL-NET Secretariat, 2012; *An Introduction of NEAL-NET*, Northeast Asia Logistics Information Service Network, 2012; *NEAL-NET launches container information service*, Japan International Freight Forwarders Association, August 29, 2014.

[512] *The establishment of the integrated logistics system in the region connecting to the Korean peninsula*, UN Economic and Social Commission for Asia and the Pacific, 2017.

Organisation	Context	Solution	Impact
Dubai World Central	■ Dubai Logistics City is an integrated multi-modal logistics platform covering over 25 km of free zone ■ A network of service providers, forwarders, integrators, and airlines provides logistical solutions for players in high-tech, electronics, healthcare, consumer goods, etc.	■ Provides end-to-end logistics and value-added services to companies across industries and links global markets through sea and air transport ■ Also provides customised value-added services such as packaging and labelling ■ Offers an office park for local companies and a shared warehouse for air cargo	■ Capacity to handle 12 million tons of air cargo annually ■ UAE ranked 13th in 2016, jumping from 24th in 2010, on World Bank's Logistics Performance Index
Neal-net	■ Logistics-information sharing platform for South Korea, Japan, and China to facilitate real-time and efficient logistics among the three countries ■ Defines public logistics nodes such as airports, highway freight stations, etc. and establishes information-sharing standards for each ■ Proposed to turn into an integrated multimodal information exchange platform	■ Clear information-sharing mechanism creates transparency between consigner and consignee through key steps such as road and marine transport, customs, distribution, etc. ■ Shares information on vessel entry/departure and movement of containers	■ Enhances logistics efficiency by saving time and logistics costs through real-time information exchange ■ Expected to cut total cost of logistics by at least 0.1% annually

SOURCE: Rivigo; Blackbuck; Economic Times, December 12, 2017; ICICI Bank; National Highways Authority of India; Dubai World Central; NEAL-NET.

Potential actions to ensure accelerated progress

Learning from global best practices coupled with India's own context and starting point, the following key steps would go a long way toward creating an integrated logistics portal to make India's logistics ecosystem efficient:

- **Minimise the transportation of physical goods by sharing information.** Stakeholders could achieve significant savings by getting better at sharing information to minimise the need to actually transport physical goods. For example, the state-run oil companies transport large quantities of oil, depending on demand and supply. It is conceivable that while one company may be transporting oil from the north to the south, another could be doing so from the south to the north. Both could gain if there was a mechanism to share information.

- **Modernise the port community system to systemise port-related activity.** The existing port-community system is old and does not seamlessly integrate all port-related activities. As a result, most stakeholders operate on different software platforms. This can be addressed by off-the-shelf solutions that will need minimal customisation for use in Indian ports. Given this, the government could immediately implement a modern port community system that will not only help to standardise and streamline data, but will also reduce the redundancy inherent in requiring the same information on multiple documents.

- **Universalise the acceptability of the RFID tags and create the requisite arrangements.** As Exhibit R25 makes clear, government has pushed the adoption of RFID tags to encourage e-toll collection. Making RFID tags universally acceptable throughout the country, including state highways, coupled with equipping an adequate number of highway lanes with the capability to read RFID, will go a long way in ensuring that its adoption increases significantly among truck fleet owners.

- **Put in place a robust administrative structure.** As is clear from the above discussion, creating an integrated platform in this loosely knit, predominantly unorganised sector will require a concerted multistep strategy. A structure could be created in the immediate future to engineer and monitor quick wins while at the same time preparing an organisational setup that can best address the creation and maintenance of the national logistics platform going forward.

    - Government could start by creating a war room to maximise the efficiency of existing infrastructure. As discussed above, inefficiencies in the system (like the improvement potential from standardising the port community system), offer significant opportunity for improving efficiency and could be tackled relatively easily within the current administrative structure. All that is required is a dedicated team that relentlessly tracks progress of the identified projects and clears roadblocks.

    - **Create a governing structure for the evolving nature of the logistics sector.** Interconnectedness of different modes — rail, road, ship, and air — is a salient feature of countries that have evolved logistics sectors. Traditional mode-specific regulating, planning, and executing agencies may be suboptimal, as they tend to work in siloes, creating inefficiencies. Consequently, a truly integrated multimodal logistics sector warrants an apex body that provides the right level of coordination and control over the various modes. Existing options include establishing a centralised ministry of logistics that oversees and controls all different modes as well as setting up a body to convene multiple independent regulatory authorities that manage specific transport modes.

- **Enact laws to fully integrate data on a single platform.** Only a central law mandating data aggregation from private players can improve the sector by enabling the national logistics platform to consolidate information about the routes, availability, cost, and timing of different modes of transport. This is needed to enable the platform to find optimal routes, from origin to destination, using all available modes of transportation. The necessary level of data sharing would be possible only when it is mandated by law. Apart from data sourcing, other aspects of the digital trade and single-window systems can be regulated through this law.

- **Encourage efficient warehouses to go with efficient transportation.** Warehouses are an important component in goods movement, and improving warehouse productivity can reduce transit time. Warehouses could, for example, use autonomous guided vehicles to increase their rate of picking, or selecting the correct item in a warehouse. “Smart shelving” technology can be used to track real-time inventory using IoT devices. Amazon’s fulfilment centres in India are equipped with highly automated “pick, pack, and ship” procedures to facilitate safe and timely processing of orders. Amazon’s Kiva robots in particular bring high efficiency to picking. Augmented reality can be used to enhance worker productivity by replacing paper lists with digital lists projected into their field of vision, along with directions to the location of each item.

- **Improve railways, inland waterways, and coastal shipping.** The modal share of railways is gradually falling, resulting in increasing logistics costs. The government could invest in strengthening railways — along with inland waterways and coastal shipping — to decrease these costs.

- **Train the workforce in the logistics sector.** Given the unorganised nature of the logistics industry, most of its workforce is at best low skilled. Going forward, with the advent of technology throughout the sector — from smart warehouses to electronic tolls — the workforce needs to be adequately trained to keep up with changing times and remain relevant. Sector Skill Councils could ensure that the right kind of training is made available to the workforce.

26. Manufacturing automation and IOT-based advanced analytics

> “Automation and IoT-based advanced analytics have the potential to unlock huge productivity gains for the economy through performance benefits, including greater throughput, higher quality, improved safety, reduced variability, less waste, and higher customer satisfaction”

Vision and potential impact

Automation and IoT-based advanced analytics are fundamental technologies that will become increasingly pervasive across businesses and sectors in the coming decades. These technologies have the potential to unlock huge productivity gains for the economy through performance benefits, including greater throughput, higher quality, improved safety, reduced variability, less waste, and higher customer satisfaction. Manufacturing processes that use these next-generation technologies are referred to as Industry 4.0.

Manufacturing automation — the reorganisation of human work amid advances such as robotics, artificial intelligence, and machine learning — will be an unavoidable and irreversible trend in coming years. This implies that there will be significant changes in the way businesses conduct work and in the daily activities of all types of workers, from miners, welders, and security guards to accountants, lawyers, and software coders. India’s automation potential — the share of work that can be automated — for the year 2025 has been pegged at 60 percent. Taking into account wage rates and the cost of automation, and the technology adoption curve, only 10 percent of the total hours spent could actually be automated by 2025, under the early adoption scenario.

Manufacturing is one of the biggest users of the Internet of Things, a global system of sensors, actuators, machines, and other devices connected via the web. Manufacturers were active buyers of IoT technology in 2016 and 2017, spending $148 billion and $169 billion respectively, but there are potential use cases in many sectors of the economy.[513] India, which accounted for a small percentage of global spending on IoT devices in the manufacturing sector, needs to recognise the importance of this technology and start promoting investment in this field.

The basic approach for manufacturers is to install IoT devices to generate real-time information at different locations in a plant and build an integrated platform to collect data and present it in usable forms. Managers using advanced data analytics can then distil insights, make decisions, and send real-time instructions to employees in the operations and maintenance departments.

Coupling the IoT with advanced analytics can help to maximise the yield and throughput of plants while minimising energy consumption. Sensors along the production line can measure the input parameters of raw materials, such as humidity, pressure, and concentration, and enable human operators to monitor real-time data on the production process itself, including the concentration of raw materials, chemical dosing, and machine settings. With the help of advanced analytics, it is possible to optimise input and process parameters to maximise a plant's yield and throughput while also ensuring efficient energy consumption. Input and process parameters can also be tuned to improve product quality.

IoT can also help in managing assets, such as monitoring the condition of critical equipment. This involves checking parameters such as temperature and vibration levels in real time, allowing plant managers to be alerted to the need for preventive maintenance before machines fail, which eventually leads to higher plant throughput.

> "A committee of national experts could be created to develop and adopt globally established and interoperable IoT standards"

If manufacturers accelerate implementation of this technology, 40 to 60 percent of India's manufacturing sector output could be IoT enabled by 2025, which could in turn improve overall productivity by 7 to 11 percent. This could translate into added economic value of $113 billion to $127 billion by 2025. Automation could generate an additional $28 billion in potential economic value for India.

Initiatives already under way

Private-sector companies around the world have started to implement IoT-based manufacturing techniques to make factories more flexible, improve quality, and produce parts that cannot be made with traditional manufacturing processes. Exhibit R26A highlights a few notable examples.

Use of automation — especially robotics, including "cobots", which are robots that collaborate with human workers on the shop floor — is rising in Indian industries. Exhibit R26B highlights some examples of how manufacturers are employing robots from several suppliers, including Bajaj and Lumax.

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[513] *IDC Worldwide Semi-annual Internet of Things Spending Guide*, International Data Corporation, November 2017.

Exhibit R26A

Manufacturers use advanced analytics to boost productivity in factories

Organisation	Context	Solution	Impact
Harley-Davidson	- Harley-Davidson moved to reduce costs and increase efficiency in order to simplify its complex manufacturing operations - Installed software and sensors to measure, record, and manage the performance of different equipment and processes	- Invested in IoT-enabled production facilities – Real-time performance management system for tracking and monitoring – Paint booth is monitored for heat and humidity, and software automatically adjusts the speed of fans when measurements deviate from acceptable ranges	- Reduced costs by 7% - Increased productivity by 2.4% - Boosted net margin by 19%
Stanley Black & Decker	- Stanley Black & Decker is a leading global provider of hand tools, power tools, and related accessories - Reducing manufacturing complexity and increasing visibility and productivity gains at its Reynosa, Mexico, plant were its key objectives behind implementation of IoT	- Stanley Black & Decker deployed IoT technology to build out a fully connected production line with Real-Time Location System (RTLS) - The RTLS includes small and easily deployed Wi-Fi active RFID tags that attach to virtually any material and provide real-time location and status to assembly workers and plant managers - Through this technology, floor managers are constantly aware of each line's output, whether production needs to speed up or slow down to meet daily targets, and how quickly employees are completing stages of production	- Labour utilisation improved by 12% - Throughput increased by ~10% - Reduced material inventory carrying costs by 10%
Daimler Trucks North America	Daimler Trucks North America set the following goals for itself: - Deliver customised vehicles for consumers - Control costs by boosting manufacturing efficiency - Improve agility and scalability to support innovation and future production needs	- Pervasive wireless connectivity is used to connect employees and machines across the factory - Shared network helps keep managers informed so they can predict and respond to production or supply chain issues faster - Robust, standards-based security helps meet compliance needs	- Improved visibility to help increase agility and minimise production issues - Enhanced asset tracking, making operations more efficient

SOURCE: 5 Areas Where the IoT Is Having the Most Business Impact, Forbes, December 18, 2017.

EXHIBIT R26B

Process automation is used by different players in India

Organisation	Context	Solution	Impact
Bajaj	▪ First Indian company to implement use of collaborative robots in automotive assembly lines in 2010 ▪ Bajaj Auto, today has more than 150 cobots ▪ Key benefits of Universal Robots' products are their compactness, low pay-back period, flexibility, light weight, cost-effectiveness, accuracy, and safety	▪ Deployed Universal Robots primarily as they: – Diminished the challenge of space constraint in a manufacturing facility by the use of ceiling-mounted cobots – Reduce redundancy of work by completing repetitive movements that require precision standardisation – Catered to multi-modelling adaptability	▪ Productivity at Bajaj Auto has grown from 507 to 804 vehicles per person per year, 58.5% increase year-on-year ▪ The cobots brought down costs by around 30% to 40%
Lumax	▪ Introduction of robots was seen by Lumax not just as an improvement to the process but as an essential requirement; main aims were to: – Save costs – Increase productivity – Reduce level of parts rejection	▪ Principal robotic application within Lumax involves the gluing together of headlamp parts with hot-melt adhesives ▪ Helped manufacturers improve productivity, product quality, and worker safety	▪ 345 finished two-wheeler headlamps produced per hour versus 300 units with manual labour ▪ Lumax estimates robots save one hour of labour on every eight-hour shift
Ford Motor	Ford Motor's main aims were to ensure: ▪ Complex manufacturing as cars become more sophisticated ▪ Control costs by boosting manufacturing efficiency ▪ Stringent quality and safety standards	▪ By deploying automation, only the right amount of material gets used ▪ Involves integration of various systems from Tier 1 suppliers along with reduced installation time and effort — that is, getting as much plug-and-play as possible	▪ Robots help reduce wastage and save costs ▪ Reduction in material consumption when human labour is replaced by automation
Tata Motors	▪ Set up one of the most automated production lines for its small car line, Indica, at the Pimpri, Pune, plant with a total capacity of 565,000 units per year ▪ Tata Motors moved to reduce costs and increase efficiency	▪ Installed around 300 robots on a single line compared to its older 70-robot line ▪ Employs a large number of KR 210 robots, which are used for typical material handling applications, and the KR 16 for arc welding	▪ New line is capable of producing 1,000 cars per day

SOURCE: Tata Motors, as of April 26, 2018; The Hindu, November 12, 2017; Automation World, February 20, 2014; ABB, March 2009.

Potential actions to ensure accelerated progress

IoT-based advanced analytics in manufacturing can scale rapidly, as long as the government and private sector act to ensure that key prerequisites are considered:

- **Affordable IoT infrastructure and the capability to use it.** IoT technology currently requires relatively high initial infrastructure investment because of limited local ecosystems for producing IoT devices and the cost of connecting software and infrastructure. This deters small manufacturers from investing due to lower initial return on investment. Compared to the capital investment, labour costs in India remain low. Also, graduates with the skills to operate IoT-enabled equipment and advanced analytic tools are in short supply.

  The Ministry of Electronics and Information Technology, in partnership with industry associations, could promote venture funds specifically to support companies in IoT-related domains such as memory, processors, sensors, and low-power devices. It could also set up public-private partnership incubation centres to support IoT and AI. An example is the Centre of Excellence for small and medium-size enterprises set up in a public-private partnership with the IT industry association NASSCOM.[514] The Ministry of Finance could help finance this initiative with duty benefits on imports and reimbursements of GST for capital goods and raw materials required for manufacturing IoT. MeitY could also fund resource centres and test beds in academic institutions to help the community experiment with IoT devices and applications.

- **Clear, interoperable IoT standards.** IoT devices currently lack interoperability, and concerns about cybersecurity are high. Companies need to invest in expensive system-integration software to capture data from multiple systems that don't necessarily speak to one another. In addition, MeitY, in partnership with industry associations, could facilitate global and national participation of industry and research bodies with relevant service-setting organisations, such as the International Organisation for Standardisation, to promote standards for IoT technologies developed in India. A committee of national experts could be created to develop and adopt globally established and interoperable IoT standards. MeitY can appoint representatives to the Institute of Electrical and Electronics Engineers world forum on IoT or similar forums to take part in the formation of standards.

- **Adequate data security and privacy.** Businesses have concerns about sharing often proprietary information in cyberspace through cloud-based technologies. Data leaks and privacy are significant issues for businesses. In the discussion of Theme 2, state-of-the-art cybersecurity and data protection, we discussed steps government can take to ensure that adequate data security and privacy policies are implemented.

> "The Ministry of Electronics and Information Technology, in partnership with industry associations, could promote venture funds specifically to support companies in IoT-related domains"

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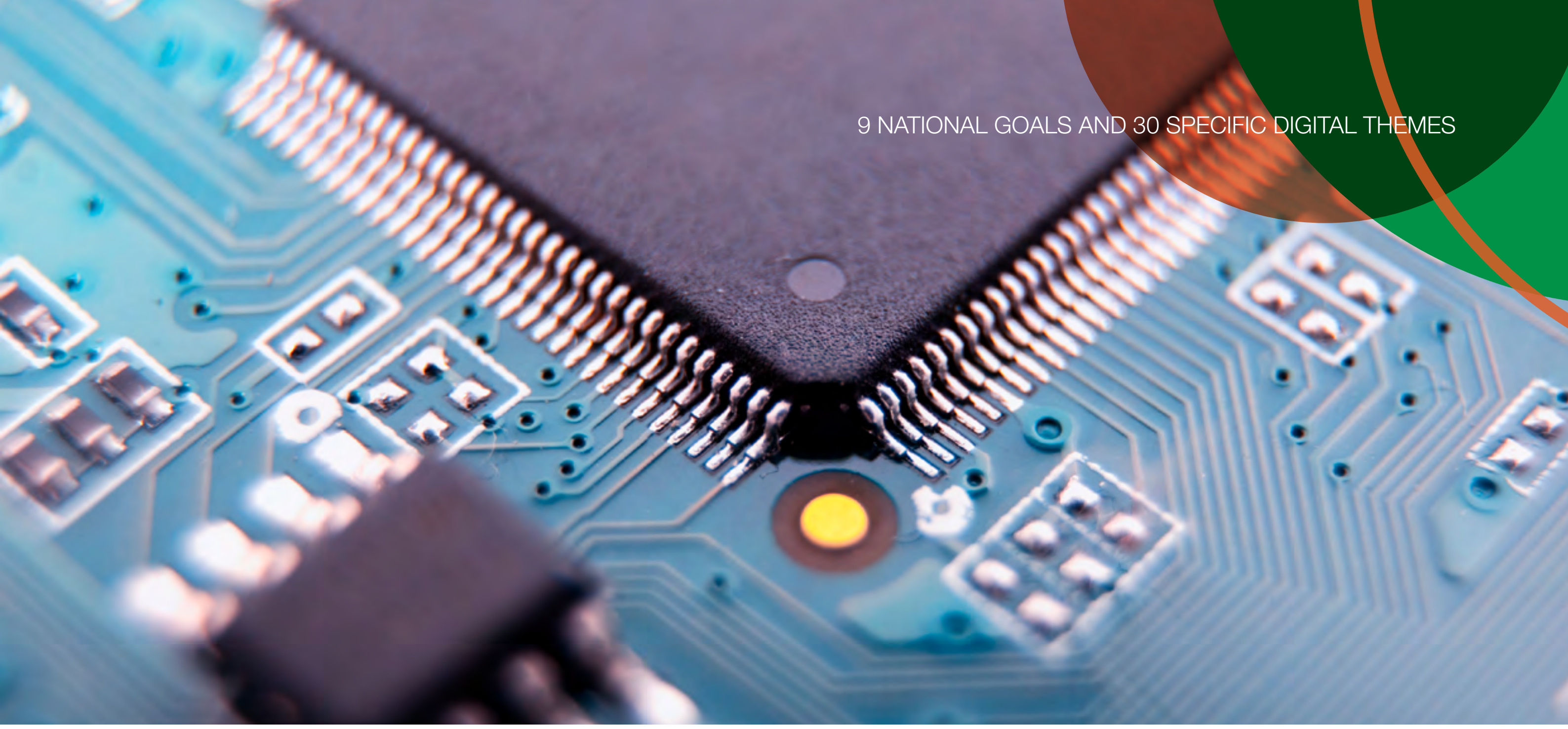
[514] *Overview of CoE for IoT*, Centre of Excellence for Internet of Things, Ministry of Electronics and Information Technology website, November 2017.



27. Vibrant electronic-device manufacturing ecosystems

Vision and potential impact

The demand for electronics in India in 2017–18 stood at $106.1 billion, of which domestic electronics manufacturing fulfilled $59.6 billion.[515] Growth in India's mobile handset manufacturing is particularly encouraging, with the importation of mobile handsets declining by 37 percent from 2015–16 to 2016–17.[516] Significant growth potential exists in a number of other sectors, where domestic demand is high and increasing. China leveraged its cheap labour to build an electronics manufacturing industry that generates $519.5 billion in gross value added, or 4.6 percent of its GDP in 2016.[517] By comparison, the Indian electronics manufacturing industry's value added accounts for only 0.6 percent of GDP.[518]

It is important to realise India's growth potential in this field, and to promote the domestic electronics manufacturing sector. Doing so can both increase employment and provide affordable electronics to the country, which is critical for leveraging the benefits of digital applications. Affordable mobile handsets in particular have an important role to play in improving the quality of life for rural and urban families, including those below the poverty line, by providing them with increased connectivity, access to e-banking services (especially Direct Benefit Transfer payments), farming advice, access to job platforms, educational content, and e-governance services.

To promote the domestic electronics manufacturing sector, the government introduced the National Electronics Policy (NPE) in 2012.[519] Several schemes were notified under the support of the NPE 2012 including

> "Affordable mobile handsets have an important role to play in improving the quality of life for rural and urban families by providing them with increased connectivity, access to e-banking services, farming advice, and job platforms, among others"

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[515] Ministry of Electronics and Information Technology, Government of India, May 2018.

[516] Ibid.

[517] IHS Markit, August 2017 forecast; GDP figures from World Bank, as on June 1, 2018.

[518] Ibid.

[519] Ministry of Electronics & Information Technology website.

Modified Special Incentive Package Scheme (M-SIPS), Electronics Manufacturing Clusters (EMC) Scheme, and Compulsory Registration Order for mandating Indian safety standards. These are besides tariff interventions for promotion of electronics manufacturing, policy for providing preference to domestically manufactured electronic products, skill development programmes, and innovation, research & development initiatives for the sector. The M-SIPS offers capital subsidy of as much as 25 percent on the invested amount to spur domestic investment.[520] Separately, the EMC scheme provides financial assistance to build manufacturing infrastructure.[521] Also, the Government has set up National Centres of Excellence at Indian Institute of Technology (IIT) Bombay for technology solutions in internal national security and at IIT Kanpur for flexible electronics.[522] The Government has also set up a centre of Excellence in Bangalore in collaboration with the National Association of Software and Services Companies (NASSCOM) Internet of Things (IoT).[523]

Big boost to domestic production of mobile handsets came from the Government's Phased Manufacturing Programme (PMP), under which import duty is being imposed on the notified sub-assemblies used in manufacturing of cellular mobile handsets, in a phased manner.

As a result of implementation of the PMP, starting in 2016–17, wherein 14 sub-assemblies of the cellular mobile handsets are being indigenised in a phased manner, India rapidly started attracting investments into this sector and as many as 118 units manufacturing mobile handsets and their parts/components have been set up in the country during the last three years, resulting in employment for about 450,000 persons directly and indirectly.[524] The production of mobile handsets has gone up from 60 million units valued at $2.9 billion in 2014–15 to 225 million units valued at $20.3 billion in 2017–18.[525] Government initiatives have encouraged manufacturing in other areas, too. The production of LCD/LED TVs has increased from 8.7 million units in 2014–15 to 16 million in 2017–18.[526] The value of LED products made in India has risen from $334 million in 2014–15 to $1.5 billion in 2017–18.[527] While PMP has resulted in increased domestic value addition and growth of manufacturing of mobile handsets and their parts and components in India, the next big step is to roll out the PMP for other electronics goods with the objective of increasing domestic value addition to strengthen the manufacturing base in long run and speedily move ahead with effective measures aimed at promoting exports from India in the medium to long term. It has now become imperative for India to have an all-round, multi-pronged approach to raise the scale and competitiveness of the electronics ecosystem in the country.

The industry faces key challenges such as inadequate infrastructure, bottlenecks in supply chain and logistics, high cost of finance, availability of reliable and quality power at competitive rates, limited focus on R&D, among others. The sector needs a conducive policy environment and targeted incentives to thrive and prosper in an increasingly competitive global environment. The Government could ensure quality infrastructure to manufacturing players by using existing and upcoming industrial corridors and promoting new clusters. It could encourage startups in this space through technical assistance and financial incentives such as tax holidays and import duty exemptions on capital requirement. Setting up incubation centres while encouraging startups in emerging technologies such as 5G, IoT/sensors, artificial intelligence (AI), machine learning, augmented reality (AR) and virtual reality (VR), gaming and entertainment and support for generation of intellectual property and patents would also give the sector the required push. R&D support for concept-to-market innovation can add immense value in all sub-sectors of electronics along with simplified clearance procedures for import of goods required for R&D. These interventions could encourage the gross value added of India's domestic electronics manufacturing industry to grow from $100 billion to $130 billion by 2025.[528]

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[520] Ministry of Electronics & Information Technology website.

[521] Ibid.

[522] National Centre of Excellence in Technology for Internal Security (NCETIS) at Indian Institute of Technology Bombay website , FlexE, National Centre for Flexible Electronics website.

[523] The Centre of Excellence for IoT India, at Bangalore website.

[524] Ministry of Electronics & Information Technology, March 2018.

[525] Ibid.

[526] Ibid.

[527] Ibid.

[528] Ministry of Electronics and Information Technology.

Initiatives already under way

To illustrate the growth of the mobile industry in India, Exhibit R27 offers two examples of cheap handsets targeted at rural and below-the-poverty-line households.

EXHIBIT R27

Process automation is used by different players in India

Organisation	Context	Solution	Impact
Jio phone	▪ Reliance launched its mobile services in September 2016 and as of December 2017 had 160.1 million subscribers ▪ To attract more customers, especially in rural areas, the firm is manufacturing its own 4G enabled Jio phone	▪ Jio phone requires a $23 security deposit, which is refundable after three years ▪ Has features such as HTML5 apps to simulate a basic smartphone, 24 language support, Dual SIM slots, FM radio, and GPS ▪ Near-field communication (NFC) support for tap-and-go payments ▪ 42 GB data availability for $2.40	▪ 6 million phones booked within a day of announcement ▪ To be sold through Jio's e-commerce platform and 10,000 Jio offices across India
Bharat 1	▪ Micromax, an Indian mobile manufacturer, has started rolling out basic smartphones with 4G capabilities under Bharat series to capture early first-time 4G adapters	▪ Bharat 1 was launched in October 2017, priced at $33.80, and includes features such as VoLTE support, dual SIM slot, FM radio, GPS	▪ Bharat 1 rivals the Jio phone and other feature phones ▪ Available through retail stores and e-commerce platforms

SOURCE: Jio, as of April 25, 2018; Gadgets360.com, September 2, 2017; *Economic Times*, July 21, 2017; Business Standard, October 17, 2017.

> "Domestic electronics manufacturing can scale rapidly with a two-pronged strategy – first, alleviating structural bottlenecks and second, making targeted policy interventions and providing fiscal incentives"

Potential actions to ensure accelerated progress

As indicated above, domestic electronics manufacturing can scale rapidly if the government and industry take steps to remove structural barriers for the industry and facilitate a favourable environment for it to thrive. This requires a two-pronged strategy – a) Alleviate structural bottlenecks that affect the industry in general, like infrastructural deficiencies, high cost of finance, etc., and b) Make targeted policy interventions and provide fiscal incentives in identified areas where investment is needed such as electronic components and semiconductors. The following are the key policy actions expected for achieving the aspiration of making India being self-sufficient in terms of meeting its domestic demand for electronics goods by 2025.

- **Expand the Phased Manufacturing Programme to cover other electronic devices.** Given the Phased Manufacturing Programme's success in promoting the domestic manufacture of mobile handsets, the Ministry of Electronics and Information Technology (MeitY) could use the same approach to spur the production of other devices. The time is ripe to focus on medical electronics and consumer electronics such as LCD/LED televisions, LED lighting products and set-top boxes, along with automotive electronics. With an increased focus on energy-efficient lighting and the largest national street-lighting programme globally[529], India has an opportunity to be a leader in the large and growing market for LED lighting. Additionally, growing disposable incomes has increased domestic demand for affordable healthcare services, opening a large potential market for medical electronics devices.

  - **Build infrastructure for a medical electronics devices industry.** Lack of proper regulatory structure has inhibited the growth of a medical electronics devices industry in India. To promote the sector, the government could embrace a public-private partnership model to support R&D. It could also work to commercialise technologies developed by academic laboratories or private-sector R&D institutions. To help the medical electronics device industry thrive, the government could facilitate the establishment of industrial parks with appropriate infrastructure for carrying out testing, evaluation, accreditation and compliance, and provide subsidised access to these facilities by MSMEs. It could also develop Centres of Excellence to support product development and validation. To encourage startups in this industry, government also may want to consider providing common manufacturing facilities, tinkering labs, and other facilities.

  - **Create policies and financial incentives to encourage fabless chip design.** With semiconductors present in all electronic devices, fabless chip design offers considerable potential. The government could enable a policy environment that encourages the industry to flourish — for example, by offering income tax benefits on R&D spending. It could also classify startups' semiconductor products as domestically manufactured goods to enable their inclusion in the notification of electronic products under Public Procurement (Preference to Make in India) Order 2017 (PPO 2017). Further, the government could provide fabless chip design companies with financial assistance for filing international patents or facilitate collaboration with international organisations, such as IMEC, the advanced microelectronics research laboratory in Belgium, or the Industrial Technology Research Institute in Taiwan. The government could provide tool and fab support to early-stage startups to help them address the high cost of fabless chip design. It could also set up a National Fabless Semiconductor Centre.

- Create a conducive export environment through suitable export incentives and trade agreements, such as:

  - Increasing export incentives available under the Merchandise Export from India Scheme (MEIS) or evolving an alternate scheme to MEIS incentive

  - Income tax holiday on export profits for 10 years in a block of 15 years

  - Entering into free trade agreements (FTAs) primarily with consumption economies such as EU, Africa, South America, etc., which may benefit the indigenous electronics industry

  - Providing support for Brand-building through a dedicated fund or a separate allocation under the existing schemes such Market Development Assistance (MDA) and India Brand Equity Fund (IBEF) of the Department of Commerce for promoting investment in electronics manufacturing and export of electronic goods

  - Evolving suitable policy interventions to promote R&D, such as reinstating Income Tax deduction to 200 percent of expenditure incurred on R&D and including the "business of electronics system design, including semiconductor design" as well as outsourced R&D to commercial/non-commercial R&D entities for ESDM Industry with IP residing in India, with no requirement for in-house manufacturing

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[529] *Shri Piyush Goyal dedicates World's Largest LED Street Lighting Programme to the Nation*, Press Information Bureau, January 9, 2017.

  - Relaxation/procedural simplification of certain ageing restrictions, such as:
    - Re-import of electronic goods within three years from the date of exportation, for repair or reconditioning
    - Import of second hand manufacturing plant and machinery without any restriction for re-exporting these goods within stipulated time period or subject to certain conditions like the end of life of such manufacturing plant and machinery must not be less than five years or so
  - New electronics manufacturing clusters/up-gradation of existing clusters to primarily attract investment from anchor units and ancillary units thereof
  - Expanding the list of capital goods not manufactured in India for Basic Customs Duty (BCD) exemption

- **Adopt a forward-looking, stable tax regime.** The government could provide a boost to domestic electronics manufacturers by enacting a forward-looking tax regime that offers such features as an income tax holiday for 10 years in a block of 15 years, including an exemption from Minimum Alternative Tax.

- **Offer incentives to address financial disabilities.** To address the heavy upfront capital expenditure faced by electronics manufacturers, the government could offer interest subsidies and credit default programmes, and appropriately increase duty on goods not covered by the Information Technology Agreement (ITA-1). Moreover, the government could help manufacturers minimise capital spending by exempting them from import duty on all capital equipment needed to set up new units or expand existing units in the Domestic Tariff Area (DTA).

- **Promote electronics in strategic and core infrastructure sectors.** India imports about $20 billion worth of defence equipment every year; a significant portion of this comprises electronic goods, an important area for India to promote domestically.[530] The government could encourage capacities for sourcing defence equipment as well as other core infrastructure sectors such as nuclear power, space, railways, and telecommunications. To do this, it could create long-term partnerships in the electronics and design industries and buy electronic goods domestically.

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[530] Ministry of Electronics and Information Technology.

ARCHITECTURE
PROTOCOL
VIRTUAL
COMMUNICATION
WIRELESS
DATA

Goal I: Jobs and skills for all

Better skill planning aligned with future industry demands to increase the employability of trained candidates in India

To make full use of the demographic dividend of its growing workforce and create sufficient employment opportunities, India needs to ensure continuous improvement in workforce participation rates, the number and type of jobs, and earnings potential for workers. Three digital themes that can help address overall labour market challenges in the context of rising digital adoption are discussed below.

28. Skill building for the future

Vision and potential impact

For India to build the skilled workforce necessary to compete in the rapidly digitising world, it needs to address the unique dynamics of its labour market. To start, India's working-age population grows by some 16 million every year, even as the workforces in most advanced economies and China are stagnant or shrinking.[531] Also, India's labour force participation rate for women is only 31 percent, with women contributing a mere 17 percent to the country's GDP, among the lowest ratios in the world.[532] At the same time, India's labour markets are undergoing a dramatic structural shift; automation replaced 26 million agriculture workers from 2014 to 2017.[533] All of these forces have the potential to deliver a beneficial demographic dividend for India, but only if the country succeeds in providing the workforce with access to useful skills.

India needs a demand-driven training ecosystem, especially in light of rapidly changing industry demands, such as the increasing use of digital technology across different sectors. The job scenario in IT-BPM industry is undergoing a transformation through the emergence of new technologies. The government, IT industry and academia need to join together to re-skilling of employees of the IT industry to retain the edge of the IT sector through the young and dynamic workforce. IT services companies need to rapidly retrain their employees in disruptive technologies like virtual reality, IoT, and 3-D printing. Analysts must be trained in big data, machine learning, and other topics related to artificial intelligence. Supervisors and managers need the digital skills to interpret and act on the data presented on digital dashboards. NASSCOM is working with industry, academia and government stakeholders to re-skill a total of 2 million employees in the sector through its Future Skills platform launched in February 2018.[534] Healthcare workers must be trained in how to access and use electronic health records. Similarly, the agriculture sector needs trained correspondents who can understand and disseminate farming advice from mobile applications. Every organisation needs digital marketing experts as well as software and app developers to scale up their businesses and expand their reach.

In order to create a future-ready workforce, India could follow a demand-driven approach for forecasting skill requirements. In Australia, the Department of Employment produces five-year projections by industry, region, skill level, and occupation in order to provide a guide to the direction of the labour market and future skill requirements.[535]

Moreover, India's current education and training ecosystem is not reflective of changing industry needs, which risks creating a large number of educated but unemployable job seekers. A study conducted by Aspiring Minds, a New Delhi–based employability evaluation and certification company, suggested that only 7 percent of engineering graduates are employable.[536] Another study found that around 93 percent of MBA graduates of Indian business schools (in the bottom 80 percent of each class) are unemployable.[537] There is a need to align both courses offered by universities and instruction offered by training institutes with evolving industry needs to create a workforce equipped with job-generating digital tools and capabilities.

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[531] *India's Labour Market: A new emphasis on gainful employment*, McKinsey Global Institute, June 2017.

[532] *The Power of Parity: Advancing women's equality in India*, McKinsey Global Institute, November 2015.

[533] *India's Labour Market: A new emphasis on gainful employment*, McKinsey Global Institute, June 2017.

[534] *Future Skills NASSCOM website*, as of May 15 2018.

[535] Labour Market Information Portal website, Department of Jobs and Small Businesses, Australian Government.

This can be achieved if educational institutions, as well as training providers, government training agencies, and industrial bodies like the National Association of Software and Services Companies and Sector Skill Councils, collaborate to design, develop, and deliver the proper content to current and potential job seekers. Universities and industrial bodies could partner with employers to understand their needs and update curriculums accordingly. Recently, IBM partnered with the Telecom Sector Skill Council to have its technology experts develop innovative curriculums for courses on topics such as software development and big-data analytics.[538] Students will also have access to relevant IBM software and platforms, including the IBM Cloud, IBM Watson IoT platform, and Big Data Solutions, as well as mobile application development tools.[539] Google is collaborating with the National Institute of Electronics and Information Technology, part of MeitY, to train two million software developers in India under its Android Skill programme.[540]

A large part of the required digitally skilled workforce will come from retraining current employees. To accomplish this, employers could partner with Sector Skill Councils or training institutes. To ensure continuous training in new courses, government could provide skill insurance to certified individuals through its training schemes. The government of Singapore, for instance, provides all citizens aged above 25 with a $500 SkillsFuture Credit to cover part of the cost of work-related skill development, including online courses.[541]

Training partners associated with the government training schemes like Pradhan Mantri Kaushal Vikas Yojana and Deen Dayal Upadhyaya Grameen Kaushalya Yojana and private training institutes such as IL&FS Skills and IndiaSkills could expand the list of courses they offer to include new digital courses and do away with or reduce their capacity for traditional courses that are gradually losing importance. In February, the government announced the Skill Strengthening for Industrial Value Enhancement (STRIVE) scheme with budget of $320 million to improve the relevance and efficiency of vocational training provided through Industrial Training Institutes and apprenticeship programmes; the goal is to create a globally competitive and employable workforce.[542] Training institutes could also upgrade their infrastructure to facilitate new digital skills. Projectors in classrooms, computers in laboratories, decent power supplies, and high-speed internet connectivity are some of the basic requirements for training work seekers in digital skills such as data analytics and machine operation.

Digital technology can be leveraged to improve the quality of skill training. Educators of all types can use digital technology to train more students and job seekers. They could make massive open online courses (MOOCs) available to everyone and explore the use of augmented reality and virtual reality tools to train skill seekers in how to use high-end machines at work. Training providers and universities can collaborate to conduct webinars and live, faculty-assisted video lectures that can not only train a large number of students at one time but also help to address the problem of a shortage of good trainers. The for-profit education company NIIT launched NIIT.tv, an online platform to provide learners with digital content from its classrooms with over 740,510 registered users, and Training.com, an interactive virtual-training platform that offers courses taught by industry experts through live online classes.[543]

While classroom and lab training is the first step, on-the-job apprenticeship is another essential step in obtaining gainful skills. The digital infrastructure could also be leveraged for continued structured learning during the apprenticeship phase, and even after students are employed. This could ensure continued progress and the acquisition of additional skills.

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[536] *National employability report (engineers): Annual report 2016*, Aspiring Minds, 2016.

[537] B and C category B-schools producing un-employable pass-outs, The Associated Chambers of Commerce and Industry of India (ASSOCHAM), April 27, 2016.

[538] *Telecom Sector Skill Council (TSSC) and IBM Collaborate to Spur Emerging Technology Skills Within Indian Telecom Industry*, IBM press release, August 8, 2017.

[539] Ibid.

[540] *MeitY, Google join hands*, The Hindu, March 23, 2017.

[541] SkillsFuture website, Singapore Government.

[542] *Union budget*, Ministry of Finance, 2017–18.

[543] NIIT.tv website.

Moreover, digital technology presents a unique opportunity to expand access to basic skills. Social norms in many parts of the country make women responsible for household maintenance and child rearing, restricting their mobility. Lack of mobility is an impediment not just in gaining employment, but also in obtaining skill training. Through mobile and web-based training applications, women can gain at-home and self-paced skills, which could enable socioeconomic advancement. This would in turn lead to productivity growth for the country.

Accelerated implementation of digital-based initiatives would generate better-educated and -trained job seekers with improved employment prospects. In addition, job seekers' productivity can improve significantly because they will face much less risk of losing their current jobs.

Initiatives already under way

Many skill-building initiatives and programmes are already under way, led by government as well as the private sector. Some examples appear in Exhibits R28A and R28B.

EXHIBIT R28A

Skills programs train a generation of workers for the jobs of the future

Organisation	Context	Solution	Impact
Ministry of Electronics and IT, (NDLM)	▪ Government launched National Digital Literacy Mission (NDLM) to provide digital literacy to every Indian ▪ Training partners are appointed through PPP model to open training centres ▪ Training centres conduct surveys, select beneficiaries, offer training, and monitor student performance	▪ As per the National Policy on IT, 2012, the goal is to make at least one person in every family digitally literate ▪ Scheme is intended to train 5.25 million people, including Anganwadi child-care workers, Accredited Social Health Activists, and authorised ration dealers ▪ Government has committed to investing $275 million in the program	▪ ~12 million people trained and over 6 million certified under NDLM since its inception in 2014 ▪ 614 training partners
NIIT	▪ NIIT, a private vocational education company, has developed a suite of courses and remote training platforms to train the next generation of technology leaders	▪ NIIT's Digital Transformation Program consists of four key offerings: – DigiNXT: courses on transformation technologies such as cloud computing, IoT, and virtual reality – StackRoute: boot camps focused on full-stack programming with the MEAN (MongoDB, Express, Angular, Node.js) and MERN (MongoDB, Express, React, Node.js) technology stacks – NIIT.tv: online platform brings NIIT classes to digitally connected individuals around the world for free – Training.com: interactive virtual platform offering training programs through online live classes, collaboration between faculty and students through chat forums, and coding practice in online labs	▪ DigiNXT courses added 1,628 enrolments in 2017 ▪ Over 1,500 learners and 23 advanced courses on Training.com ▪ NIIT plans to scale up to 10 million learners in the next 5 years ▪ Virtual training programs allow participants to save significant amount of time otherwise spent on traveling to classrooms

SOURCE: National Institute of Electronics and Information Technology; PMDISHA, as of April 26, 2018; *Hindustan Times*; NIIT, February 2018; Manipal Global, as of April 26, 2018.

Exhibit R28B

Skills programs train a generation of workers for the jobs of the future

Organisation	Context	Solution	Impact
Manipal Global	▪ Manipal ProLearn, part of Manipal Global Education Services offers a variety of professional certification courses across technology, digital marketing, data sciences, project management, and finance for upskilling students/ employees without interrupting jobs/full time courses	▪ Manipal ProLearn's learning management system (LMS) runs on any device (laptop, mobile, etc.) ▪ EduNxt unites learning, assessment, live classes, and solving queries along with a dashboard to keep track of self-progress ▪ Course material is available online, and regular live and interactive webinars are conducted to connect learners with industry experts ▪ Learning model is very flexible, delivering courses in three modes: online (self-based), online (instructor-led) and classroom	▪ Over 50,000 professionals have been trained and certified in over 100 professionally certified courses ▪ Over 15 global knowledge partners such as Google and EY provide high-quality new content ▪ More than 20 corporate partners offering job opportunities to certified candidates
Ministry of Education (MOE), Singapore	▪ SkillsFuture is a national movement started by the government to serve different needs of jobseekers, employers, and training providers based on industry demands ▪ The main objective was to promote a culture and holistic system of lifelong learning ▪ Several initiatives have been taken for students, job seekers, employers, and training providers	▪ MySkillsFuture: One-stop education, training, and career guidance online portal that enables citizens to chart a good career path throughout life ▪ Skills Future Credit: All Singaporeans aged 25 and above receive an opening credit of $365 from January 2016 which they can use to pay for work-skills-related courses supported by public agencies ▪ SkillsFuture Credit can be used for a wide range of courses including courses available online ▪ Earn and Learn Program: Fresh ITE (Institute of Technical Education) and polytechnic graduates get placed with employers for on-the-job training. Employers can receive up to $15,000 to offset the training cost	▪ More than 285,000 Singaporeans have used the SkillsFuture Credit to upskill or reskill, as of December 2017 ▪ 160,000 additional Singaporeans began using the SkillsFuture Credit in 2017 ▪ Over 4,600 working adults have attended SkillsFutureAdvice workshops since its launch

SOURCE: Singapore Ministry of Education, as of April 26, 2018; The Straits Times, February 1, 2018.

> "A biometric-based enrolment system could also be instituted over time to track candidates truly availing the training programme"

Potential actions to ensure accelerated progress

The theme can scale rapidly with private and public collaboration, as long as the government acts to ensure that the following prerequisites are considered:

- **Outcome-based training schemes and programmes.** Training schemes and programmes currently offer training partners a flat fee based on the number of students enrolled and exam clearance. As training institutes are paid based on such metrics, they have little incentive to invest in the infrastructure needed to offer cutting-edge digital courses.

As an alternative, government ministries or agencies running training schemes can allocate funds based on the duration of training and the type of job and salary ultimately offered to the trainee after he or she completes the course. A biometric-based enrolment system could also be instituted over time to track candidates truly availing the training programme.

- **Create a single point of contact to approve online training platforms.** Skill-development platforms created by private companies need approvals from several government bodies — including departments within the Ministry of Skill Development and Entrepreneurship, Ministry of Human Resource Development, and Ministry of Labour and Employment — in order to operate. The process of obtaining those approvals is lengthy and complex.

  To address this, the Ministry of Skill Development and Entrepreneurship could create a body or committee that could serve as a single point of contact for private companies seeking approval for training platforms.

- **New approach to encourage and regulate remoted training schemes.** The Ministry of Human Resource Development is drafting regulations for online learning and revising the Open Distance Learning policy. These changes could be extended to skills, by scaling up innovative operating models like Virtual Labs, an initiative of IIT Delhi to enable remote laboratory training. This virtual-learning channel could be blended with practical aspects for certain vocational skills. Content for digital-only skills could be hosted on the SWAYAM platform as MOOCs. These could be helpful in facilitating at-home and self-paced training of women who are now unable to access skill training programmes due to restricted mobility.

  The Ministry of Skill Development and Entrepreneurship's has initiated the process of building a regulator for skills, one of whose responsibilities will be to build a National Information Utility in partnership with the private and non-government sector.[544] The NIU could have in its mandate the responsibility to create an interoperable platform for skill training, which would allow open access to trainers and trainees. The quality of content on the platform could be controlled by a separate assessment bodies that test candidates for job readiness.

- **Implement programmes to re-skill the industry workforce through Government-Industry platforms.** The Ministry of Electronics and Information Technology and the National Association of Software and Services Companies are working together to create a retraining framework that will include a skills-training platform, along with corresponding assessment standards and mechanism.[545] This platform is targeted at over a million IT professionals in the country and aims to provide future-ready training in technologies like internet of things, artificial intelligence, deep learning, machine learning, robotics, cloud computing, social media, and cyber security. Done properly, it could enable IT sector companies and professionals to unlock the next wave of IT-based growth in India. Course curriculum needs to be updated on regular intervals based on industry need. Industry job demand driven skill development courses needs to be given priority or taken up by various skilling agencies/training centres. Each skill based training course need to include training of Soft Skills. Faculty upgradation programmes should be taken up on new/emerging areas/technologies in the respective domain.

  Such collaborative platforms for retraining could be replicated by other industries, to keep pace with digital and other disruptions.

- **Raise clarity on responsibilities of Sector Skill Councils.** The roles and responsibilities of Sector Skill Councils are currently unclear, which often leads to inadequate contributions from them in bridging skill gaps in industry.

  The National Skill Development Corporation could help by clearly defining the roles and responsibilities of skill councils. It could also set up a committee or a body to regularly monitor their performance. The councils could collaborate with private firms to identify sector-specific skill demands for the future as well as technology that can be used to deliver training. They can also set up a robust certification and accreditation process that matches international standards for industry-related courses.

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[544] Ministry of Skill Development and Entrepreneurship.

[545] Ministry of Electronics and Information Technology website.

29. Online talent marketplaces to connect employers with work seekers

Vision and potential impact

India has always relied on informal networks for job matching. Entrepreneurs hire from their families and local communities, and most informal-sector job matching is through word of mouth. In today's fast-evolving economy, with increased urban mobility and disruption of traditional business enterprise models, it is becoming increasingly difficult to rely on informal networks. Leveraging the power of digital technology could provide all working-age citizens with access to information and opportunities for jobs, based on their skills and interest.

> "The first step is to aggregate information about trained candidates and job availability by sector and geography across the country, including remote and rural areas"

The first step toward accomplishing this is to aggregate information about trained candidates and job availability by sector and geography across the country, including remote and rural areas. A number of private online job marketplaces, like Naukri.com and BabaJob, currently collect information on job seekers and employers who use their platforms, but this does not present a complete picture of the labour market. Google launched a jobs portal in April 2018 that aggregates employment openings from IBM Talent Management Solutions, LinkedIn, TimesJobs, and others, to provide a more comprehensive view of the Indian job market.[546]

Equally important is the need to track the informal labour market, which is not being captured by any private players. Similarly, data on government jobs, while more accessible than information about the informal sector, is often dispersed on different channels, and it could benefit from consolidation. There is an opportunity to create a comprehensive central government platform of labour market information.

The Ministry of Skill Development and Entrepreneurship is setting up a regulator for skills, one of whose responsibilities will be creating a national information utility to scale up the existing Labour Market Information

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[546] "Google launches job search in India", *Economic Times*, April 24, 2018.

> "Profiles of trained candidates could be digitally verified to avoid duplication in the system"

System (LMIS). It could evolve to become a central repository for comprehensive, detailed, and dynamic information on the supply side of the labour market. A significant part of the required information could be gathered by combing through the catalogues of public and private training centres or directly from trained candidates. Profiles of trained candidates could be digitally verified to avoid duplication in the system, with an option to add skills as candidates acquire more certificates. The platform could provide valuable information to job-matching services. Moreover, it could house useful data on labour demand, especially at the sector and regional levels.

On the demand side, platforms would need to cater to different kinds of employers. Agencies such as Naukri and Saral Rozgar are already serving the private sector. The National Career Service initiative of the Ministry of Labour and Employment could become a consolidated platform for government employment. This would help citizens gain transparent access to information on jobs, while at the same time eliminating inefficiencies in the hiring process for government agencies. Similarly, job-matching platforms do not cover the informal jobs sector, a gap that government and private-sector platforms could fill jointly.

However, it is not enough to provide platforms. Real productivity gains will be achieved only with the wide-scale adoption of these digital services. The network of Common Services Centres, over 292,748 functional as of April 2018 and e Mitra kiosks (45,835 in Rajasthan alone)[547] could serve as decentralised local employment exchanges.[548] They could further help in feeding local data into the Labour Market Information System. To attract work seekers and employers, CSCs, e Mitra, and e-Seva centres could use local champions such as the sarpanch, or elected leader, of a gram panchayat; well-known school principals; or colony presidents. Local campaigns using newspapers, radio, loudspeakers, and door-to-door marketing could be useful in encouraging trained candidates to register their online profiles on the government systems like LMIS and the National Career Service (NCS), as well as private job portals though Common Services Centres. This could, in turn, pull local employers to CSCs to find candidates who match their requirements. Representatives at CSCs and e-Mitra centres could also counsel rural job seekers about such tasks as creating CVs and completing application forms.

Accelerated implementation of online talent market-places would imply having new and better job matches for 20 million to 28 million job seekers. In addition, there would be significant improvement in the productivity of job seekers driven primarily by reducing job search time, which would fall by 7 to 22 percent. At this scale, improved job matches imply $63 billion to $71 billion of economic value in 2025. This will also help to make job markets more efficient due to lower attrition rates and targeted skill investment driven by the availability of better information.

Initiatives already under way

Many online talent marketplace initiatives and investments are showing encouraging progress, led by government as well as the private sector. Some examples are outlined in Exhibit R29.

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[547] e-mitra MIS PORTAL, Department of Information Technology & Communication, as of April 25, 2018.

[548] e-Mitra MIS portal, Department of Information Technology and Communication; Rakesh Dubbudu, *Number of operational CSCs in India reaches 2 lakh*, Factly.in, August 25, 2016; Government of Rajasthan Department of Information Technology and Communication.

EXHIBIT R29

Portals build digital bridges between employers and job-seekers

Organisation	Context	Solution	Impact
National Skill Development Agency (NSDA)	▪ NSDA under Ministry of Skill Development and Entrepreneurship (MSDE), launched the Labour Market Information System (LMIS) to connect potential employers with more than 10 million workers trained annually	▪ MSDE collaborates with government ministries and schemes at both national and state levels to publish certified candidates' data on the portal ▪ Data of 16 states will be shared on a single portal, which covers schemes of 16 ministries ▪ Portal also contains a catalogue of training courses and institutes	▪ A robust LMIS can lead to the development of several use cases such as training aligned with industry demand, effective recruitment by employers, effective policy decisions and budget allocation by the government to spur job creation in economic slumps
QuikrJobs	▪ Mobile/web-based job marketplace for connecting semiskilled workers with employers; primarily for blue-collar and entry-level white-collar jobs such as sales, delivery executive, drivers, etc.	▪ An employer can contact workers listed by job role (such as beauticians or bouncers), job type (part time or full time), industry and geography via SMS or email ▪ Candidates' profiles are sorted by job role and job type	▪ Connects recruiters to candidates in over 1,200 cities and towns ▪ Portal receives over 7 million applications each month ▪ More than 1.3 million new profiles are added on QuikrJobs each month ▪ Portal's missed call service generated 1 million registrations in a year, as of June 2016
Tech Mahindra	▪ Tech Mahindra launched Saral Rozgar in August 2014 ▪ Unique web/call based job marketplace that connects blue-collar and entry-level job seekers with mainstream employers across India via mobile in their own language	▪ Job seekers can buy a Saral Rozgar Card for less than $1 and register their online profile with a voice call ▪ Job vacancies are listed by job role and geography ▪ Single helpline number to resolve all queries	▪ Database of more than 6 million blue-collar and entry-level job seekers ▪ Portal lists 150,000 job opportunities and 15,000 job providers
Naukri.com	▪ Naukri.com is a web/mobile-based job portal for connecting job seekers with employers from different sectors and regions	▪ Portal also provides services like resume writing, career counselling, training and certifications in areas like project management and software development	▪ More than 58.8 million registered jobseekers ▪ 500,000 new CVs added every month ▪ 14,600 average resumes added daily ▪ 6 million to 9 million job seekers contacted by recruiters daily

SOURCE: National Skill Development Agency; QuikrJobs, as of July 27, 2018; Saral Rozgar, as of April 26, 201; Info Edge, February 2018; Economic Times, May 26, 2017; Naukri.com as of June 21, 2018.

Potential actions to ensure accelerated progress

Online talent marketplaces can scale rapidly with private and public collaboration. Government and business need to cooperate in collecting and integrating data on workers' education, skills, and experience and on industries' needs and preferences. The combination of supply-side labour skills data from government and private company training channels will provide a more comprehensive picture for individual candidates. Further sources of data such as employment rates, the Periodic Labour Force Survey, GDP growth by sector, investment in local areas, and regional policy announcements will provide additional information on local and sector-driven demand. This aggregated data will allow for advanced modelling techniques to provide district-wide demand of jobs and provision of skilled individuals. The following prerequisites could be considered before advanced analytics and forecasting on jobs and labour supply by geography is possible:

- **Put in place a clear mechanism to aggregate an up-to-date supply view.** The National Skill Development Agency is currently aggregating data on registered job candidates from about 20 government ministries and numerous skill-development schemes. The absence of a mandate from a central body to share data is an impediment to the data-collection process. Moreover, there is no mechanism to capture independent trained candidates' data on a portal or to refresh candidates' data once they have completed a vocational training course.

  Government agencies running training schemes can mandate that all training partners share regularly updated information on candidates. The Labour Market Information System could accommodate independent work seekers who want to register their profiles directly on that portal. The NCS could host the results of all exams conducted by the government, which could provide pools of verified profiles of job seekers to private employers looking to hire people with specific skills.

  Moreover, information on candidates could include not just work experience and skill training, but also educational qualifications. Scaling up the Labour Market Information System through the proposed National Information Utility could include a link with education records, with mechanisms to automatically onboard students as they reach a certain age, making it a one-stop solution for skill data on citizens. Moreover, this data could be updated more dynamically than it is now, with the possibility of eventually providing real-time updates.

  Such information would be of great value to job-matching platforms like National Career Service, Naukri, and others, which could use it to actively target suitable candidates and bring them into the workforce. This makes interoperability and open APIs an important element in the system architecture.

- **Integrate NCS and LMIS as the one-stop solution for public and private employers.** The National Career Service could strategically pursue employment matching in government and the micro, small, and medium-size enterprise sector. This would allow it to build a niche value proposition for candidates and employers, which would fill a large gap in the market. A proposal is under consideration in the Ministry of Skill Development and Entrepreneurship and Ministry of Labour and Employment to link the National Career Service with the Labour Market Information System; connecting the two has great potential to increase job seekers' access to opportunities.[549]

> "The National Skill Development Agency could mandate that Sector Skill Councils aggregate and update industry-wide job-related data on a portal, in collaboration with private job marketplaces"

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[549] Frequently asked questions, NSDA website.

It could also provide its network of counsellors to other job-matching platforms, which could address the need for mentorship and guidance for candidates. In the same vein, it could expand and share its counselling services with educational institutions, training agencies, and their partnering employers, ensuring that candidates get support at critical junctures before and after gaining employment.

- **Develop mechanisms to aggregate real-time information on job vacancies and work opportunities:** No mechanism currently aggregates real-time information on job vacancies across locations, sectors, and occupations. Disaggregated and partial views of job availability are available on private job marketplaces, but there is no incentive to share that data with a central information system.

  To address this, the National Skill Development Agency could mandate that Sector Skill Councils aggregate and update industry-wide job-related data on a portal, in collaboration with private job marketplaces. Policy makers could also create incentives to encourage private job aggregators to share information on job vacancies and filters pool of candidates relevant to their needs.

- **Standardise assessment tests to differentiate the quality of electricians, carpenters, and mechanics registered on online platforms.** Employers have a difficult time screening job candidates because there currently is no standard certification for online remote workers. There also are no standard certifications or assessment tests to measure the knowledge and quality of people working in plumbing, electronics repair, or other trades. This makes it difficult for employers and customers using online platforms to categorise workers based on their skill level.

  Certification bodies, along with the National Skills Qualification Framework, can develop online certifications for remote job seekers and assessment tests for individual service providers across different and unconventional trades such as beauty services and event planning. The Ministry of Skills Development and Entrepreneurship is working with IIT Delhi to develop a framework and camps for certifying candidates with vocational experience through the ministry’s Recognition of Prior Learning programme.

30. Digitally enabled jobs

Vision and potential impact

India's workforce, currently 460 million people, grows by eight million to ten million every year. Ensuring jobs for all job seekers is a pressing national priority.[550] Digital technology is often associated with job losses, but it can be leveraged to create new and improved income opportunities for job seekers in different parts of country. If the right ecosystem is created, these new opportunities can more than offset job losses. Moreover, new technology has the potential to create good jobs in rural villages as well as cities, which will motivate Indians to pursue education and skills. Digitally enabled jobs are those that do not require employees to be at the point of delivery, allowing them to work from any location.

Digital technology can be a facilitator in creating new job opportunities for trained people outside cities. This is especially true for women, who, in much of the country, face restrictions on mobility due to household chores and child-rearing responsibilities. India's labour force participation rate for women is 23.7 percent.[551] If India were to reach regional benchmarks for women's labour force participation, it could add $700 billion to GDP by 2025.[552] Increasing participation also could lead to significant social empowerment for women. Digital technology presents an opportunity to create home-based and community centre–based working models. Digitally enabled enterprises such as BPO centres and the 292,748 functional Common Services Centres can be the source for these jobs.[553] Several private-sector–led pilot programmes such as RuralShores and DesiCrew are opening BPO centres in non-metro cities and towns in India that provide relatively well-paying jobs. Half of the workers in RuralShores' centres are women, many of whom were not employed earlier but can now conveniently work where they live and contribute to the economy.[554]

Digital technology has opened avenues for the new job category of technology-enabled services. On-the-ground workers in various fields such as agriculture, fisheries, animal husbandry, healthcare, and education can use tech-enabled delivery models to provide services to local users and communities. For example, agricultural correspondents can provide advisories to farmers on the right time to sow a crop and at what price it should be sold in a wholesale market. This is similar to the way banking correspondents operate in the financial-services industry.

A new category of on-demand project-based work is emerging, offering part-time employment opportunities to trained individuals. Currently, around 15 million freelancers are registered in India.[555] Online platforms enable these so-called gig workers to find work throughout the country. Independent trained professionals who are not willing to travel to find work because of family or health concerns can participate in the workforce by remotely doing short-term assignments such as website creation, content development, or remote consulting. Online platforms such as Flexing It, PeoplePerHour, and Freelancer help independent workers to connect with potential employers.

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[550] Report on Fifth Annual Employment and Unemployment Survey (2015–16), Labour Bureau, Ministry of Labour and Employment; UN Population Estimate.

[551] Unemployment Employment Survey 2015–16. Labour Bureau.

[552] *The power of parity: Advancing women's equality in India*, McKinsey Global Institute, November 2015.

[553] Rakesh Dubbudu, *Number of Operational CSCs in India reaches 2 Lakh*, Factly.in website.

[554] Rural shores website.

Accelerated implementation of these ideas would imply the creation of 20 million new job opportunities for the trained workforce in India.[556] Beyond the economic value to the nation as a whole, the use of digital platforms in the employment field also will enable job seekers to experience significant benefits by getting access to wide variety of job opportunities, by improving their income prospects, and by decreasing the difficulty and cost of migration in search of employment.

Initiatives already under way

Many initiatives and programmes are already under way, led by private-sector digital job marketplaces. Some examples are outlined in Exhibit R30.

EXHIBIT R30

Portals build digital bridges between employers and job-seekers

Organisation	Context	Solution	Impact
RuralShores	▪ Educated rural youth migrate to cities for better job prospects, contributing to the exclusion of rural India from economic and social progress ▪ RuralShores establishes business-process outsourcing (BPO) centres in rural areas to generate rural employment	▪ BPO centres educate youth recruited from catchment area and trained in soft skills and other skills specific to assigned processes ▪ Services offered include digitisation of forms, and local language help-desk ▪ Take stringent information security measures such as biometric access	▪ In the last nine years, RuralShores has set up 17 centres in ten states including Rajasthan, Uttar Pradesh, Andhra Pradesh, and Karnataka, employing over 2,500 employees ▪ Delivered more than 45 processes to over 30 blue-chip clients
Flexig It	▪ Online platform that helps generate part-time paid jobs for independent professionals by connecting them with employers all over the world	▪ Every job seeker's profile is vetted before being added to the portal to ensure quality ▪ Uses Flexscore, a proprietary matching algorithm so companies can find relevant professionals	▪ More than 64,073 skilled professionals are registered ▪ Portal lists 2,467 clients, including big corporations, consulting firms, and startups, with over 3,500 projects
Swiggy	▪ A mobile/web-based portal for food ordering and delivery that connects neighbourhood restaurants with potential customers in selected areas	▪ Delivery people are notified of service requests on their Swiggy accounts	▪ Has generated jobs for more than 20,000 delivery people ▪ 25,000 listed restaurants in 15 cities receive over 4 million orders per month
UrbanClap	▪ A web/mobile-based marketplace for the exchange of local services such as plumbing and cosmetology	▪ Customers request a service on portal and professionals reply if they are interested ▪ Feedback system to rate professionals on quality of service provided, with low-rated professionals removed from platform	▪ Platform offers 107 different services to customers ▪ More than 100,000 service professionals and 3 million customers are registered on the platform

SOURCE: RuralShores, as of April 2018; Flexing It Services, as of April 2018; Swiggy; UrbanClap, as of February 2018 Technologies;*Economic Times*, April 2017.

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[555] Sruthin Lal, "Thanks to internet, India has most freelance professionals after US", *Hindustan Times*, December 8, 2015.

[556] *A labour market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

Potential actions to ensure accelerated progress

A digitised jobs market can scale rapidly with private and public collaboration, as long as the government acts to ensure that the following prerequisites are considered:

- **A reliable flow of customers for digitally enabled businesses in urban, semi-urban, and rural areas.** The client-development cycle is long for BPOs in semi-urban and rural areas because of a lack of standard quality certifications and private-sector concerns about data privacy. This leads to erratic workloads and high variance in capacity utilisation. They currently operate at borderline margins leading to serious concerns about their long-term viability.

  The union government could encourage data confidentiality and quality standards. Industry certification bodies such as Sector Skill Councils could collaborate to develop a checklist that would help to ensure quality work from semi-urban and rural service delivery points. State governments also can help, by outsourcing the digitisation of documents and other data-intensive work to semi-urban and rural BPOs for at least 12 months after they are established. This will help to increase their credibility, which will in turn motivate the private sector to contract out more work to these centres.

- **Unlock economic activity of women by facilitating creation of home-based work models.** The Ministry of Electronics and Information Technology could partner with IT industry and startups to incubate business models like home-based work for BPOs, which could unlock significant economic activity from women.

  Hackathons and B-Plan competitions could be organised for top engineering and management institutes to foster innovation of businesses, ideas from which could be supported through funding and mentorship for scale up.

- **Enable independent skilled professionals to engage in project-based employment.** Freelancers are often considered outside the purview of employers to provide social benefits like medical insurance and interest-free loans. In addition, they have limited access to financial and insurance services due to concerns over their creditworthiness. The absence of an online freelancing community makes it difficult for them to stay up to date with new technology in their areas of interest and to obtain counselling on personal finance and other matters. Currently, there is no mandate for employers to share written contracts with freelancers before employing them. This sometimes results in freelancers being defrauded or working for unrecognised employers who may not provide them with employment certificates and salaries.

  To address this need, the Ministry of Labour and Employment could recognise freelancers as an important job category. This will help address the concerns of banks and insurance companies about their creditworthiness and would enable them to gain access to convenient loans and insurance schemes. Private freelancing portals such as Flexing It and Truelancer can collaborate to create an online community to facilitate the simple exchange of information among independent workers. Freelancing portals could perform background checks of employers and gig workers seeking to sign on in order to avoid any fraudulent registrations. They could also require all employers to share written contracts and job certificates with the freelancers they engage.

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- Greenko Group
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- Hero MotoCorp Ltd.
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- Hindustan Unilever Ltd.
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- IBM India Pvt. Ltd.
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- Paytm
- Piramal Foundation
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- Quick Heal Technologies Ltd.
- Reliance Industries Ltd.
- ReNew Power Ltd.
- Rivigo Services Pvt. Ltd.
- RuralShores Business Services Pvt. Ltd.
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सत्यमेव जयते

Ministry of Electronics and Information Technology (MeitY)
(Government of India)

Electronics Niketan, 6, CGO Complex, Lodhi Road, New Delhi – 110003, India
Tel.: +91-11-24361733
Website: http://meity.gov.in