

Socio-Economic Impact of

Digital Transformation

INDIA PERSPECTIVE



April 2019

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KPMG in India foreword

In association with AIMA, KPMG in India is pleased to present the report – ‘Socio Economic Impact of Digital Transformation’. The report traces the evolution and impact of various digital technologies on the social and economic progress of our country. It aims to highlight the impact of significant digital technologies that have redefined numerous industries, and are likely to shape the business and social ecosystem of the country in the future.

‘Digital Transformation’ has been the buzzword in business circles for quite sometime. The amalgamation of digital technologies is creating new avenues for business growth across various sectors. To further the growth of the digital ecosystem, the government has also been making an effort towards creating favourable policy framework, governance systems, and infrastructure. India, on the back of technological advancements and rapid digitisation, is steadily marching towards its vision of becoming a trillion-dollar ‘digital economy’.

Technology is omnipotent. In an environment of mounting competition and rising customer expectations, established businesses are using various technologies to bring speed, scale and efficiency in their entire value chain and attain competitive advantage. The start-ups in India are also utilising technologies to develop innovative solutions to disrupt the market. Mobile telephony networks, broadband and computing have offset the scalability constraint to a large extent, helping the traditional sectors to grow at a much rapid pace. The digital revolution is bound to have significant social impact in the form of employment creation, financial inclusion, and environment change. Emerging technologies and their solutions are likely to solve numerous legacy challenges — including lack of digital education and large scale reskilling of workforce in India. Given this, the government is leveraging technologies to enhance public services delivery and other citizen services.

New age technologies such as robotics, Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), etc. are likely to reshape business models across sectors. These technologies would not only bring greater reliability, efficiency, and flexibility in the organisation, but also pave the path for new collaborations and partnerships, as companies would be looking to acquire niche technologies, which could provide them the required edge over their competitors.

This report is a representation of ideas from a diverse base of stakeholders including service providers, manufacturers, industry associations, policy makers and thought leaders. It is aimed at presenting a consolidated view of various stakeholders to mitigate and alleviate potential disruptions that the industry currently is facing.

We take this opportunity to express our gratitude to various members of the industry and their representative associations as well as government bodies for their input in framing key recommendations. We would also like to thank AIMA for actively contributing to the insights and for facilitating discussions with members of the industry. We hope you find this report interesting and useful in facilitating the industry in attaining the goal of a ‘Digital India’.

Akhil Bansal

Deputy CEO
KPMG in India

AIMA foreword

AIMA has always been at the forefront of building management capability in the country and actively contributes to the management profession through its various programmes, training, education and testing services. Since our inception, we have continuously strived to search for new avenues for management learning and development and to enhance the capability of aspiring and practicing management professionals.

It gives me great pleasure to present this research report on 'Socio-Economic Impact of Digital Transformation in India' brought out in collaboration with KPMG in India. Another significant contribution by AIMA towards the development of management thought in the country.

Digital transformation and adoption of emerging technologies like artificial intelligence, robotics, internet of things and augmented reality is leading to widespread disruption of traditional business models and providing new economic opportunities. Organisations that are adopting digital technologies are witnessing significant enhancement in business operations and customer advocacy. On the social front, digital solutions have also transformed the way citizens interact with their governments, especially in the areas of health and education, while facilitating social inclusion and communication. It is expected that the future economic growth of the nation will be derived from digital products and services driven by digitally enhanced offerings, operations and relationships.

The report presents India's digital transformation journey from a socio-economic point of view and includes inputs and viewpoints from senior industry leaders and experts on the road ahead.

The AIMA and KPMG in India team engaged in carrying out this research deserve special appreciation for their all efforts towards this publication. We hope that this report would prove to be insightful and useful for industry, academia and government alike.

Harshavardhan Neotia

President, AIMA

Chairman, Ambuja Neotia Group

Introduction

Today, India is at the cusp of digital transformation. With nearly 500 million internet users¹ and roughly 340 million smartphone users (2018)², the digital wave is touching the lives of millions of people, shaping them into a digitally empowered society. Businesses, irrespective of scale or industry, are adopting digital technologies to achieve higher operational efficiencies and provide better customer experience. Technology start-ups have further accelerated the trend by disrupting the traditional industries through innovative use of technology across different facets of business. The government is also giving significant impetus on the adoption of digital technologies to improve the scale and speed of public service delivery.

Digital technologies are recasting the relationships between customers, workers, and employers as the digital reach permeates almost everything we do — from buying groceries online to booking cabs on mobile apps. As computing and communications improve dramatically and more and more people across the nation participate in the digital economy, we need to make choices, which will create profound impact on our economy and society

The idea of ‘digital transformation’ is vast enough to re-shape the investment, trade, jobs and skills of any nation. Digital transformation is not a one-time event; instead, it refers to phase-driven digital progress, maturity and diffusion of innovations at various levels of society. The first phase of digitalisation was associated with ‘mature’ technologies, such as management information systems (MIS), internet and its corresponding platforms and telecommunications technologies (voice, broadband).

The second phase entails the adoption of a range of advanced technologies, such as Big Data/analytics, Internet of Things, robotics, and artificial intelligence, aimed at automating work processes and improving overall human productivity and efficiency. It is crucial to understand the impact of all these technologies and devise policies that will allow us to fully leverage the economic benefits and minimise social anomalies.

Each phase of digital transformation influences the society at numerous levels and has a specific set of social and economic impacts. On the social front, digitalisation strengthens the delivery of public services such as healthcare and education by improving the speed and scale of service delivery to the citizens. In addition, digitalisation contributes to the overall development of society by providing financial inclusion and communication services. On the economic development front, it enables the automation of business processes, leading to operational efficiencies, such as reduction of manufacturing costs and higher productivity. Digital transformation also open door to new business opportunities, thus creating employment. However, digital transformation can trigger societal impacts such as social anomie, jobs displacement, talent shortage and cybersecurity concerns.

As India is ushering into the digital era, there is a strong need to establish robust infrastructure to leverage the growing opportunities and create a digitally empowered society. Policymakers have to take a fresh look at their regulatory approach, which should support the development and implementation of innovative technology solutions. The future will require a technology-agnostic and flexible approach, where the government enables a level-playing field for the private sector and facilitate investment in building secured infrastructure and digital-ready talent pool. The digital growth will also require continued investment and innovation from the private sector to enhance consumer choice and economic growth.

The purpose of this report is to provide understanding and to identify the economic and social impact of digital transformation in the India context. The report also discusses initiatives taken by public and private sectors aimed at maximising benefits and controlling any potential negative outcomes associated with these changes.

1. Internet users in India expected to reach 500 million by June: IAMAI, The Economic Times, 20 February 2018

2. 337 million Indians to use smartphones in 2018: eMarketer report, Hindustan Times, 3 May 2018

India progressing towards digital era

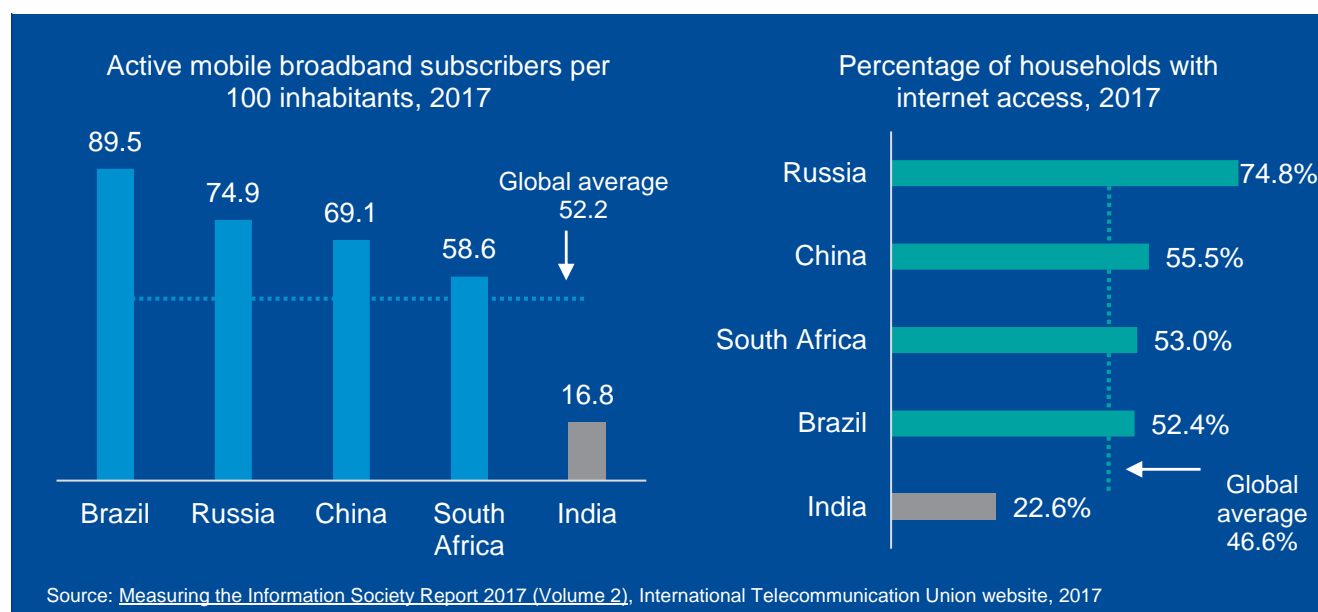
India becoming 'digital colony' — where is India on 'digital maturity'?

India, since its independence, has come a long way from largely being an agro-based economy to a globalised and service-driven economy. The economic reforms in the 1990s, coupled with technological interventions, have established India as one of the fastest-growing economies in the world. The country has made notable progress on a number of global digital metrics — such as mobile subscriptions, internet penetration, and digital transactions — in the last few decades. However, the growth is primarily driven by young and urban population. As a result, India scores lower in global digital rankings. India ranked 48 (among 63 countries) in the World Digital Competitiveness Rankings 2018³, and 91 among 139 countries on the WEF's Network Readiness Index 2016^{4,5}.

As per the IMD World Digital Competitiveness Report 2018, Digital India initiatives has strengthened its position in technology category, however, a lack of development of highly-skilled workforce has led to fall in knowledge and future readiness categories.

– World Digital Competitiveness Report 2018

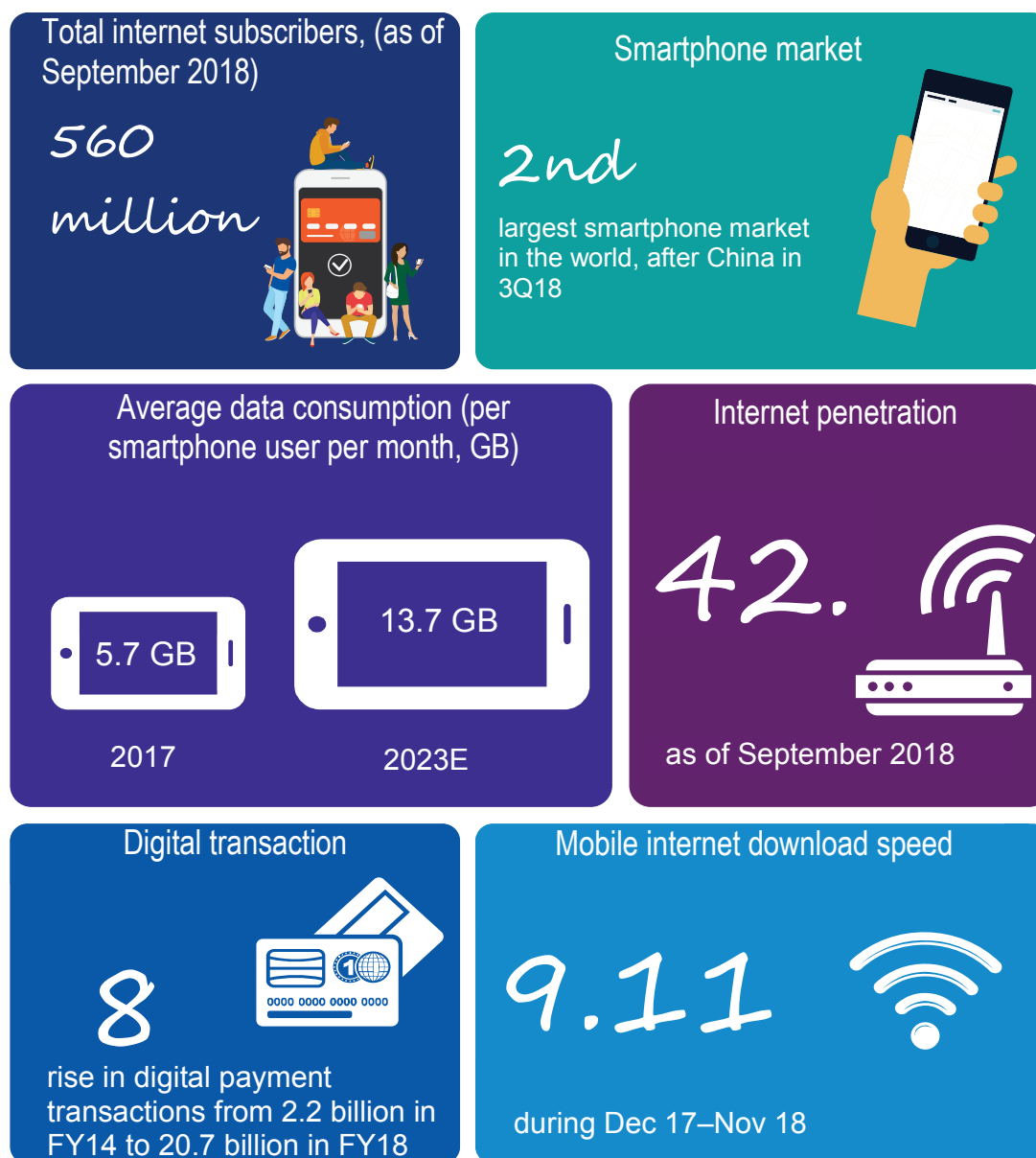
Internet penetration rate: India lags behind other emerging economies in access to internet



The growth in mobile subscriber base, smartphone penetration, data affordability along with favourable government policies have played a key role in driving digitalisation in the Indian economy. As of March 2018, India accounted for 15 per cent of the global mobile subscriber base of 7.9 billion. Today, India is consuming

3. India climbs three spots in IMD's 2018 World Digital Competitiveness Rankings, Forbes India website, 20 June 2018
4. Networked Readiness Index, World Economic Forum website, accessed on 7 January 2019
5. The Indian Telecom Services Performance Indicator July - September, 2018, TRAI, 8 January 2019

more mobile data than the U.S. and China combined⁶. Tapping the opportunity, some of the leading Indian companies have started exploring new-age technologies such as AI and Internet of Things (IoT) to bring quantum changes across various business segments.



Sources: India overtakes US to become 2nd largest smartphone market in Q3: Canals report, Hindustan Times, 9 November 2018; The Indian Telecom Services Performance Indicator July - September, 2018, TRAI, 8 January 2019; Mobile Data Traffic in India to Grow 5 Times by 2023: Ericsson Mobility, NDTV, 12 June 2018; Big boost to Modi's 'Digital India'; e-payments surge over 8-fold in 5 years to 2,070 crore, Financial Express, 9 August 2018; Ookla Says Amongst Largest Countries, India's Fixed Broadband Speeds Improved the Most in 2018, NDTV, 19 December 2018

The digital revolution has now triggered transformative changes in areas such as e-payments, digital literacy, e-health, financial inclusion, rural development, social benefits programmes, language localisation, and much more. The government of India is playing a key role of a facilitator-cum-provider in steering the country towards a digitally empowered society. The Indian government, through its flagship programmes such as 'Digital India', 'Make in India', 'Startup India', and 'Smart Cities Mission', has brought together a range of initiatives, which are bound to create an impact at social and economic fronts through **digital infrastructure, digital business, digital citizen and digital skilling**.

6. "Indians consuming more mobile data than US and China combined": Rajan Anandan, Google, Campaign India, 21 September 2018

Digital infrastructure



BharatNet: Launched in 2011, the programme aims to provide high-speed broadband to 250,000 gram panchayats via optical fibre cable. By January 2019, nearly 50 per cent of the target was met.

National Digital Communications Policy 2018: It aims to provide the necessary policy framework to provide digital sovereignty, ensure nationwide connectivity, safeguard privacy and autonomy.

DigiLocker: This is a public Cloud storage platform for issuance and verification of documents and certificates in a digital format, enabling paperless governance. As of January 2019, the app had over 17 million registered users and provided access to nearly 3.5 billion documents.

Digital skilling



National Skill Development Corporation: It provides funding to build scalable and profitable vocational training initiatives in collaboration with private sector partners for effective and swift implementation.

Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA): This initiative, launched to improve the digital quotient of people, has made notable progress in the last couple of years. During FY18, a total of **5.7 million** rural population was made digitally literate under PMGDISHA.



Digital business

GSTN: The Goods and Services Tax Network (GSTN) is not for profit organisation owned by government and private players jointly, to centralise the income tax databases of all the states.

Over 10 million
businesses
registered on
GST portal*

~INR900 billion
average GST
collection per
month in FY18

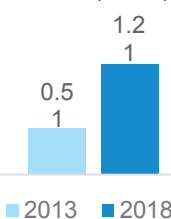
*As of March 2017



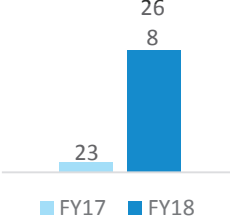
Digital citizens

Aadhaar: The Government of India launched Aadhaar, the world's largest biometric database, to provide national identity to all Indian citizens.

Aadhaar cards
issued (billion)



Aadhaar-enabled
transactions (billion)



44 mission mode projects such as **e-Gov AppStore, MyGov platform** and **eBhasha** that are focused on providing government services via electronic mode have been launched.

Sources: BharatNet Status, BBNL website, 3 February 2019; DigiLocker National Statistics, DigiLocker website, accessed on 21 January 2019; Aiming to cover 3 crore people, digital literacy scheme covers 57 lakh, The Indian Express, 8 June 2018; Over 1.03 crore businesses registered under GST: Government, The Economic Times, 9 March 2018; GST added Rs 90,000 crore a month to govt kitty in FY18, The Economic Times, 28 April 2018; 164 Aadhaar-Related Frauds Reported Since 2011, Most In 2018: New Database, BloombergQuint, 23 May 2018; Aadhaar-linked payments double to 13.7 m in March, The Economic Times, 24 April 2018; MMPS, Mission Mode Project website, accessed on 21 January 2019

Impact of digital transformation on various stakeholders and sectors

Digital ambitions of the government and private sectors are bound to influence both direct and indirect stakeholders of the digital economy. When companies and government are digitally successful and agile, various stakeholders of economy (people, business, government) tend to have a larger impact on a country's growth



People

Rising technological adoption have brought a paradigm shift in consumer behaviour and buying pattern. Some of the most evident changes can be observed in the fields of commerce, communication, and media.

200

Average time spent per day by mobile internet users on online activities (as of 2017)

In the coming years, digital would become an integral part, as people look for more transparent, connected and personalised digital experience.

Business

Digitalisation has yielded operational efficiency, cost reduction and productivity improvement across the value chain of various industries. It provides a unique opportunity to businesses to reinvent themselves and grow at a much faster pace.

According to KPMG India CEO Outlook 2018,

9

CEOs in India see technology disruption as more of an opportunity than a threat

With the growing competition and rising consumer expectations, organisations have realised the importance of implementing digital strategy to survive in the rapidly changing global business environment.

Government

The government plays a dual role of a facilitator-cum-provider in the digital ecosystem.

As a facilitator, it is responsible for providing supportive digital infrastructure, formulating robust regulatory and legal frameworks, and creating a skilled and efficient digital workforce.

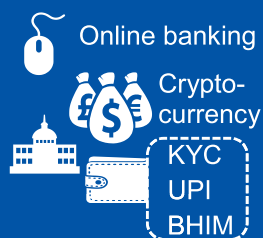
Furthermore, the government is leveraging various digital services to enhance its service delivery in the fields of healthcare, education, transportation, etc. and improving the way citizens interact with public services.

In FY19, the budget allocation for Digital India programme has been doubled to

INR 30.73 bn

Sources: Indians spend 70% of mobile internet time on social media, entertainment, The Times of India, 19 December 2017; KPMG India CEO Outlook 2018, technology disruption as more of an opportunity, KPMG, accessed on 21 January 2019; Govt doubles Digital India allocation to Rs. 3,073 crore; telecom sector disappointed, The Hindu BusinessLine, 1 February 2018

Financial services



Rise of online banking, m-wallets, and point of sale (PoS) devices has helped the traditional financial services industry to expand its services to rural India.

In near future, Block chain, AI, and Big Data are expected to be the key disruptors in the financial sector.

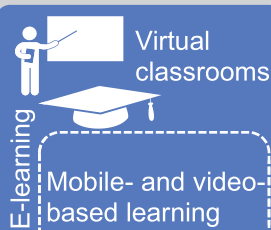
Growing internet penetration and rising disposable income have led to the advent of omni-channel retail model.

Companies are now looking to leverage new-age technologies such as predictive analytics and AI/AR/VR to provide a more seamless and personalised customer experience.



Consumer markets

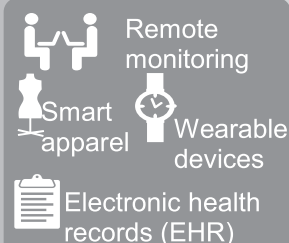
Education



India, as one of the youngest major economies of the world, offers numerous growth opportunities to 'EdTech' companies.

The country's online education market is likely to grow eight-fold during 2016–21, as it provides an interactive, personal, and competency-based learning experience across age groups.

As consumers become more health conscious and the competition to create better health monitoring systems intensifies, the healthcare industry is likely to see more technology-driven advancements in coming years.



Healthcare

Others



Other sectors such as media & entertainment, travel & leisure, automobile and even agriculture are experiencing rapid digital innovation. From experiencing queue-less instant movie/airline ticket process to accessing media on-the-go, digitisation has transformed our daily lives.

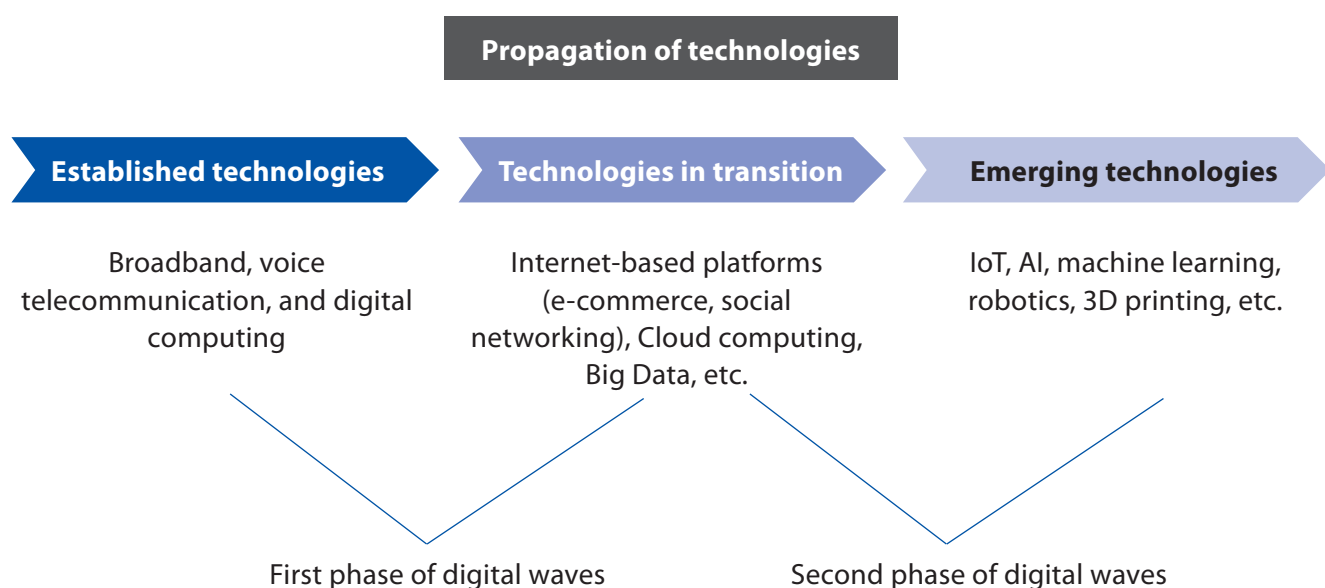
Digitalisation across sectors

Evolving technology landscape and its impact

Digital transformation is a continuous process, which is driven by a range of factors including technological advancements, consumer behaviour, market demand, and environmental factors. Different facets of technology often overlap with each other. Once a technology is widely accepted and well adopted by the consumers, it creates a platform for development and expansion of subsequent technologies. The social and economic impact of any technology depends on the speed and scale of adoption by businesses and citizens. While technologies such as internet, mobile, digital computing, and broadband brought about the first phase of India's digital transformation, the second phase will be driven by AI (Artificial Intelligence), ML (Machine Learning)/RPA (Robotic process automation), Robotics, etc.

The **first phase** reduced the business scalability constraints, allowing traditional sectors to grow at a rapid pace. Not only did it boost the manufacturing industry, it also expanded the services sector to include new sectors such as ICT. Technologies such as information systems, internet, and mobile have provided the speed and scale to deliver social and financial services to the masses in a faster and more convenient way, leading to a holistic development of society. Rise of internet led to the introduction of new services and applications (internet search engines, e-commerce, online banking, etc.), changing the consumption pattern of the consumers.

Meanwhile, new-age technologies such as AI, Big Data/analytics, robotics, and IoT, which form the **second phase** of digital transformation, would have significant effects on productivity, employment, social welfare and overall development of the nation. Although these technologies are at a nascent stage of development, they are likely to bring newly found efficiencies into the businesses, contributing to the economic and social development. These technologies are capable of creating an ecosystem that could adapt to the behaviour of users, anticipate their needs, provide solutions and implement them with minimal human intervention.



Impact of digital wave

Economic impact

Social impact

First phase of digital wave

- Growth in software and business process outsourcing (BPO) industry
- Rise in manufacturing output leading to higher revenues
- Supply chain optimisation leading to lower cost of production
- Improved market access through better communication channels
- Evolution of internet economy with emergence of new business models such as e-commerce, and online booking portals
- Rise of online B2B and B2C platforms allowing domestic businesses to address international markets

- Job creation in service sector (software, BPO, ICT, etc.) as well as in mass manufacturing industries
- Financial inclusion on the back of ICT-supported banking system
- Ease of access due to doorstep delivery of services
- Better access to public services and information
- Change in media consumption habits with increasing use of digital media

Second Phase of digital wave

- Use of Big Data/analytics for fraud detection, consumer behaviour analysis, promotion, and campaign placement, etc.
- Smart City management solutions for traffic management, utilities, security, waste management, etc. through IoT and AI
- Ease of data management, and higher transparency and security through Blockchain technology
- Reduction in the cost and time of manufacturing through 3D printing and robotics process automation

- Reskilling/mass movement of jobs across sectors, particularly the low-skilled repetitive jobs
- Higher risk of online fraud and data leak due to increasing data collection and weak cybersecurity measures.
- Rise in indirect employment/new jobs due to increase in internet platforms and digital economy.
- Rise in business opportunities with emergence of local content and data intelligence

Impact of digital transformation on economy

Digital connectivity, information access and advanced manufacturing techniques are reshaping traditional sectors, yielding operational efficiencies, lower transaction costs and improved productivity.⁷ Digital technologies enable firms to participate in global value chains and directly access customers in foreign markets. For consumers, the benefits are associated with access to a wider range of goods and services at competitive prices. The Government also plans to bring policies for quicker adoption of digital technologies such as 5G, artificial intelligence etc.⁸ The Government of India, on 1 May 2018, launched the draft version of the new telecommunications policy, named National Digital Communications Policy 2018. It plans to attract INR6,838 billion (USD100 billion) in foreign investments by 2022 and seeks to ensure that digital communications contributes 8 per cent to India's GDP by 2022.

Ongoing technological changes are creating significant impact across many sectors, driving the country's digital economy.

ICT — enabler of digital economy

IT-BPM industry has played an instrumental role in the growth of the services sector, which is the backbone of the Indian economy. Often mentioned as the 'Global Talent Powerhouse', the sector is the largest employer within the private sector, engaging 3.7 million people directly. IT-BPM industry is forecast to reach INR20,515 billion (USD300 billion) by 2020 from INR10,531 billion (USD154 billion) in 2017, at an impressive CAGR of 24.9 per cent⁹. This high growth would be supported by emerging technologies such as Cloud technology, AI, IoT, cognitive computing, and robotic process automation (RPA), which are helping firms across industries to drive profitability, thereby contributing to nation's economy.

In the last couple of years, Indian IT-BPM companies rejigged their business strategies to focus on high-value services, with key focus on digital offerings. Companies across the sector have taken a range of initiatives to develop their digital capabilities including

- Creation of dedicated Centre of Excellence and innovation labs to develop digital technology-based platforms and solutions;
- Reskilling and upskilling of employees to build the necessary talent pool to meet the rising demand;
- Investment in strategic partnerships and M&As (Merger and Acquisitions) to acquire niche digital capabilities.

As a result, digital now accounts for 30 to 40 per cent revenues of leading Indian IT companies and has been growing with an annualised CAGR of 20 per cent¹⁰. According to the report published by a leading global technology company in April 2018, the digital transformation could potentially contribute INR10,531 billion (USD154 billion) to India's GDP by 2021. This translates into an annual GDP growth rate addition of one per cent.¹¹

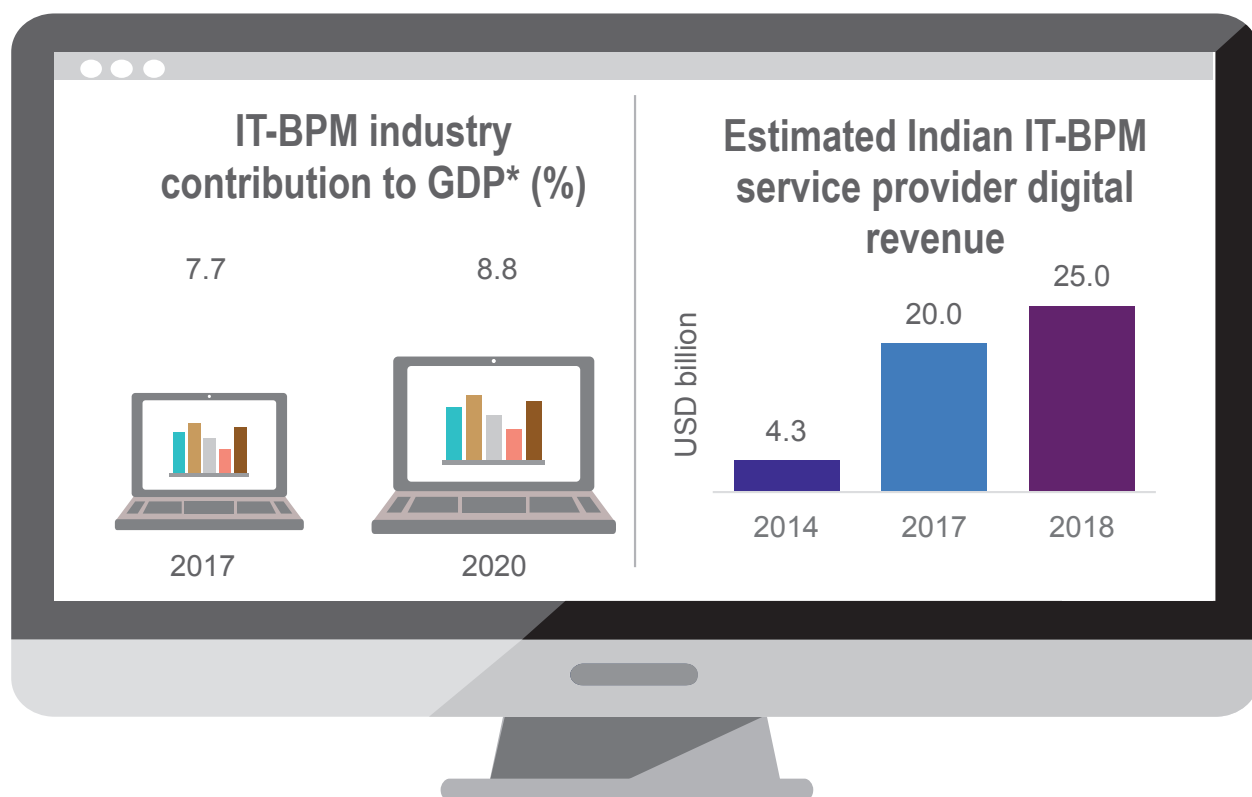
7. Broadband in India: Without the right speed, term is a misnomer; see how, Financial Express, 23 November 2017

8. National Digital Communications Policy 2018, DoT website, accessed on 24 January 2019

9. Fact Sheet of IT & BPM Industry, Ministry of Electronics & Information Technology, accessed on 24 January 2019

10. Indian IT industry is making convincing strides as their clients demand digital transformation, The Economic Times, 18 November 2018

11. Digital Transformation to Contribute US\$154 Billion to India GDP by 2021, Microsoft website, 11 April 2018



Sources: NASSCOM, EIU, Invest India, Ministry of Electronics & Information Technology

*2020 figure is estimated and calculated as per the projections of industry market size and overall country GDP estimates

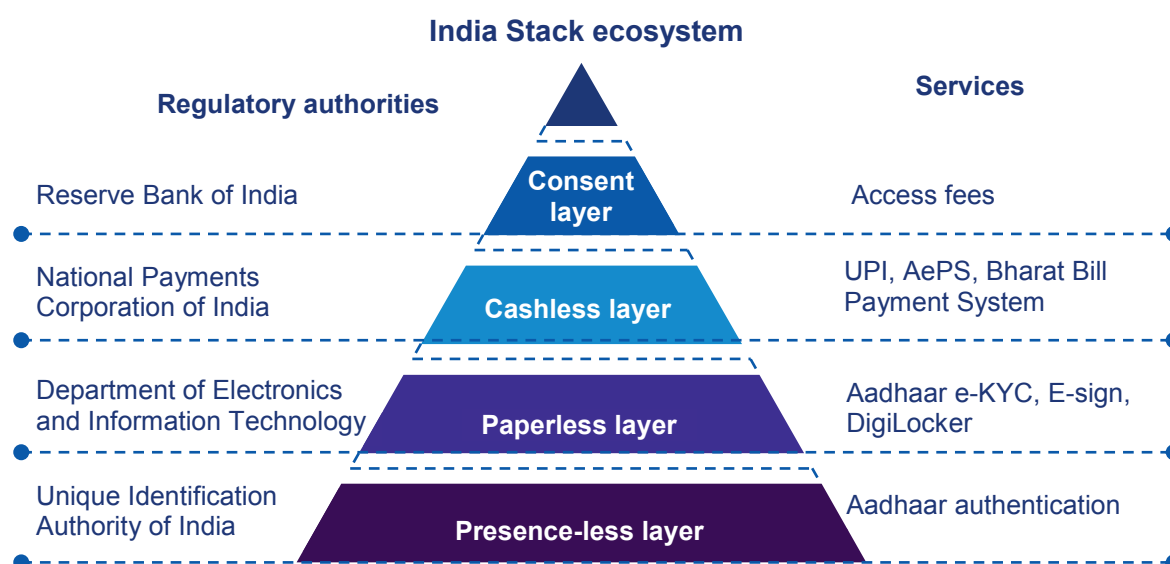
Impact of digitalisation on key sectors

In today's digital era, every sector is under immense pressure to reinvent itself in the wake of changing market dynamics and rising customer expectations. Digital innovation that begins in large and small business communities, in the context of efficiency and product throughput, has a tendency to trickle through the rest of the economy and sectors. Some of the most widely discussed sectors amid digital revolutions are banking and financial services, healthcare, education, manufacturing, retail and logistics, Agriculture and Power and utilities.

i. Banking and financial services

Banking and financial services sector is on the cusp of a digital transformation. Investment and new initiatives by the government to boost financial inclusion have opened up windows of opportunities in the financial service industry. The government launched Pradhan Mantri Jan Dhan Yojana (PMJDY) in 2014 to drive large-scale financial inclusion. By July 2018, nearly 320 million accounts were opened under the scheme¹². PMJDY is part of a larger framework called 'India Stack', which is a unified software platform developed by the government with an aim to facilitate digital transactions in a convenient and secure manner. The India Stack ecosystem has four layers:

12. Close to 32 crore bank accounts opened under Jan Dhan Yojana post 2014, Moneycontrol, 11 July 2018



Adoption of biometric approach and robust identity systems in India Stack ecosystem promotes financial inclusion, financial integrity and national development objectives in the long run. This instills confidence in consumers to use government financial schemes and improves effectiveness of social benefits delivery system. The Direct Benefit Transfer (DBT), implemented across 437 schemes, has helped in saving INR1,099 billion since December 2018¹³.

Opportunities and growth potential of technologies in financial services sector

Technology intervention	Opportunity	Growth potential
Digital payments	The advent of digital devices (such as mobile phones) and various transaction platforms (such as payment banks, Point-of-sale, digital wallets, peer-to-peer lending interfaces, and payment gateways) has greatly simplified digital payments, bringing down transaction costs for buyers and sellers.	According to a global investment banking firm, India's digital payment space is expected to register a five-fold growth and reach USD1 trillion by 2023 ¹⁴ .
Digital financial services	Financial services such as insurance, trading and wealth management are creating innovative products to provide convenient and cost-effective solutions to customers.	The Indian insurance industry is expected to grow to USD280 billion by FY20 ¹⁵ . With rising internet penetration and financial literacy, customers are getting comfortable with online transactions, driving the growth of online insurance market.

13. Home, DBT website, accessed on 25 January 2019

14. Indian digital payments to reach \$1 trillion by 2023: Credit Suisse, Outlook India website, 15 February 2018

15. Insurance industry to touch \$280 billion by FY20: Assocham, The Economic Times, 9 September 2018

Lending solutions	<p>A number of FinTech start-ups are harnessing digital platforms to assess the creditworthiness of the borrower by using data analytics.</p> <p>These platforms significantly reduce the overall loan processing time, thus giving easy, quick and personalised lending solutions to enterprises as well as individuals.</p>	A leading investment fund has stated that the online lending to small businesses in India is expected to reach INR6–7 trillion by 2023, a 10–15-fold growth from 2018 ¹⁶ .
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Private sector banks are also actively inculcating technology in their operational framework. By implementing online and mobile banking, banks have drastically reduced their service cost and saved valuable man-hours. A number of private banks have launched a range of digital initiatives to improve back-end data management and strengthen customer engagement. Some banks are using Big Data and AI platforms to bring efficiency in data management and fraud detection mechanism. A number of them have launched chatbots to improve customer support and employee engagement.



Use of blockchain in banking industry

A Pune-based technology company is developing a blockchain-powered platform to authenticate, verify and store electronic financial records. The platform will use machine learning-based fraud detection systems and real-time anti-money laundering checks. The company has partnered with BankChain, a consortium of leading banks from India and the Middle East, to work on a range of blockchain-based projects.



Leveraging data analytics to assess creditworthiness of customers

An Ahmedabad-based FinTech start-up has developed a solution based on Big Data/analytics to assess the creditworthiness of small businesses swiftly and accurately. It enables the company to disburse quick and hassle-free loans to MSMEs, which often face difficulty in securing loans from traditional sources due to lack of paperwork.

ii. Healthcare

Healthcare is one of the fastest growing sectors in India and is forecast to reach INR25,439 billion (USD372 billion) by 2022, at a CAGR of 22 per cent¹⁷. Despite its rapid economic growth, a number of healthcare services are limited to affluent section of society. India ranked 145 among 195 countries (in 2016) in terms of quality and accessibility of healthcare¹⁸. Technology could play a crucial role in rationalising the uneven doctor-patient ratio, improving quality standards as well as providing affordable healthcare services to

16. Omidyar sees opportunity in digital lending to SMEs, The Times of India, 24 November 2018

17. Indian healthcare market to hit \$372 billion by 2022, The Economic Times, 3 December 2017

18. Is there accessibility to affordable and quality healthcare in India?, The Economic Times, 29 June 2018

remote areas of the country. Digital revolution is already gaining prominence in India's healthcare industry, with efforts from both the public and private sectors.

Technology's impact on healthcare sector

Telemedicine

The current penetration of telemedicine is quite low in India, however, with rise in internet penetration, particularly in rural areas, it is likely to play a key role in bringing timely and affordable healthcare to the masses.



AI and cognitive technologies

Although AI is at a nascent stage in India, it has numerous applications in healthcare industry including AI-assisted robotic surgery, workflow automation, virtual nursing assistants, radiology image analysis etc.



Big Data/analytics

Analysis of large clinical and non-clinical data sets could be used to provide advanced patient care, reduce healthcare cost and delivery time with the help of predictive analytics and lessen medical errors.



IoT and wearables

IoT and wearable devices are providing an added value to healthcare services with a focus on diagnosis, treatment, patient monitoring and prevention. Large amounts of data collected by wearables are used by other technologies such as machine learning, predictive analytics, etc.



Additive manufacturing

Additive manufacturing or 3D printing could be used for creating tissues and organoids, surgical tools, patient-specific surgical models and custom-made prosthetics. The use of 3D printing is likely to improve with rise in industry awareness and fall in cost.



Key government initiatives launched to strengthen healthcare services in rural India includes

- Launched 'DigiGaon' to provide trainings and education on telemedicine to villagers
- Announced plans to promote digital payments at hospitals
- The expansion of National Optical Fibre Network would further reinforce rural connectivity, aiding in expansion of e-health¹⁹
- In the past few years, the women and child development ministry has distributed smartphones at 62,000 'anganwadi centre' in six states. The program helped in identifying 12,000 severely underweight children (specifically in 0-3 year age group) in these states through real-time tracking of meals and health data²⁰.

Other avenues where the government could partner with private sector to leverage digital technologies in healthcare industry include:

19. Government to expand DigiGaon project to 700 villages this year, The Economic Times, 20 May 2018

20. Smartphones help identify 12,000 severely malnourished kids at anganwadis, The Economic Times, 10 November 2017

Governance

- To manage performance of various health departments at zonal, state and national level
- To create reports and dashboard for tracking diseases, patient inflows, patient complaints and feedback, medical officials' attendance, etc.

Analysis and intelligence

- Using AI and ML on the extensive clinical data to identify people at risk of the disease, and get them on early intervention programmes
- Creating statistical models from the types of diseases, which could be linked to gene history of patient to create/predict the 'Genetic Report Card' for citizens

From launching mobile apps to setting up innovation centres, private sector is exploring the use of technology to improve accessibility and quality of healthcare service in India. Several private hospitals have already incorporated technology across various functions such as online appointment, electronic medical record (EMR) management, and digital payment. More premium private hospitals are using information technology to facilitate end-to-end healthcare management in their organisations. Healthcare institutes are also using advance analytics and AI to diagnose and predict critical ailments such as cancer. The rising number of digital health start-ups has influenced these innovations



Using AI to monitor the health and nutrition of children: The Centre for Study of Science, Technology and Policy (CSTEP) is developing an AI-based system for managing health and nutrition of women and children. Existing system deployed in various districts produces large amount of pertinent data that could help to detect early malnutrition and health risks of children and new mothers. The AI-based systems could examine through these large data sets and track the progress of an individual child in terms of their cognitive development and health. The programme predicts and ensures that new mothers and malnourished children from identified districts get required amount of proactive and targeted interventions, thereby improving the state of maternal and child healthcare in India



Leveraging technology in preventive healthcare: A leading global tech company has partnered with an Indian hospital chain to develop an India-specific heart risk score system to predict cardiac diseases. The system uses large-scale clinical data from hospitals across India, feeds that into the Cloud and uses AI and ML on the data to create predictive models to identify, prevent and manage heart diseases in patients. Such preventive healthcare models could significantly bring down the cost of healthcare in the country.

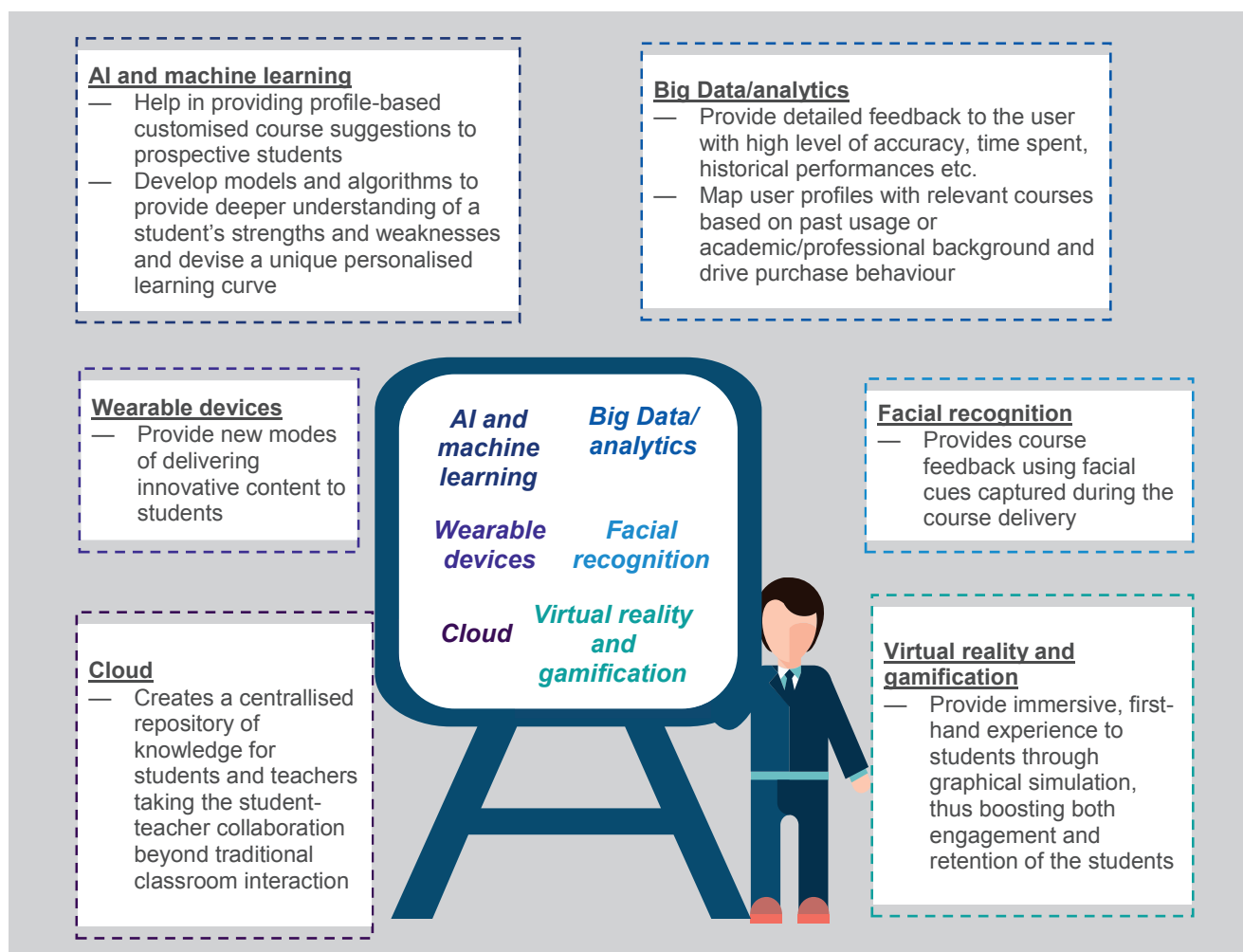
iii. Education

With more than 260 million students enrolled in more than 1.5 million schools and approximately 39,000 colleges catering to 27.5 million undergraduates and four million postgraduate students, India is one of the biggest education markets in the world. As of 2016, the education market in India stands at INR6.8 trillion (USD100 billion) and presents lucrative opportunities for digital transformation. The digitalisation of education is evident across the entire ecosystem, starting from primary education to corporate trainings.

Increasing internet penetration and proliferating mobile devices have led to adoption of online courses and learning material. The online education market in India was valued at INR16.9 billion (USD247 million) in 2016 with approximately 1.57 million paid users and is expected to reach INR134 billion (USD1.96 billion) with approximately 9.6 million paid users by 2021.²¹

Modern digital tools can help schools easily automate internal processes, streamline routine activities and enhance communication between students, teachers and parents. Going forward, technologies could make a fundamental difference by allowing educators to focus on students rather than paperwork.

Technology's landscape in education sector



The traditional education system is here to stay for the long haul but digitalisation can help the system to become more dynamic that can be molded as per student's capability and made available to socially disadvantaged students. Students can now get their lectures, seminars captured in the form of audios/videos and delivered to them in person.

A number of education technology or 'EdTech' start-ups have emerged in the last decade in India that brought a range of online learning platforms for the students. With interactive learning programmes and customised approaches, start-ups are catering the individual needs of students to produce better learning outcomes. A number of private schools are also experimenting with ways to integrate ICT into their education processes through smart classes, online learning management systems, digital content libraries, etc.

21. Online education in India: 2021, KPMG in India, May 2017



Leveraging technology to deliver low-cost offline solutions

High investment requirement, inadequate digital literacy, and unreliable internet connectivity are some of the common issues faced by schools in rural and remote areas of the country to implement digital learning systems. To tackle these issues, an NGO has developed an offline Learning Management System (LMS) which provides multimedia lessons in the local language to rural government schools completely free of cost. The society has collaborated with multiple institutions for content aggregation. Currently, implemented in over 800 government schools across Telangana and Andhra Pradesh, the project is a unique combination of technology, delivery channels, institutional collaborations, and training.²²



Fostering digital education in rural India

A Bengaluru-based NGO is connecting urban volunteers to village children through a Digital Classroom model, using remote connectivity. These digital classrooms are prepared with minimum investments and require only a few components such as a computer with a microphone, a wide-angle camera, a good quality speaker, and a broadband connectivity. Since 2012, the programme has delivered over 0.5 million hours of learning through digital classes across six states of India. The programme presents a scalable model for delivering quality education in rural areas across the country.

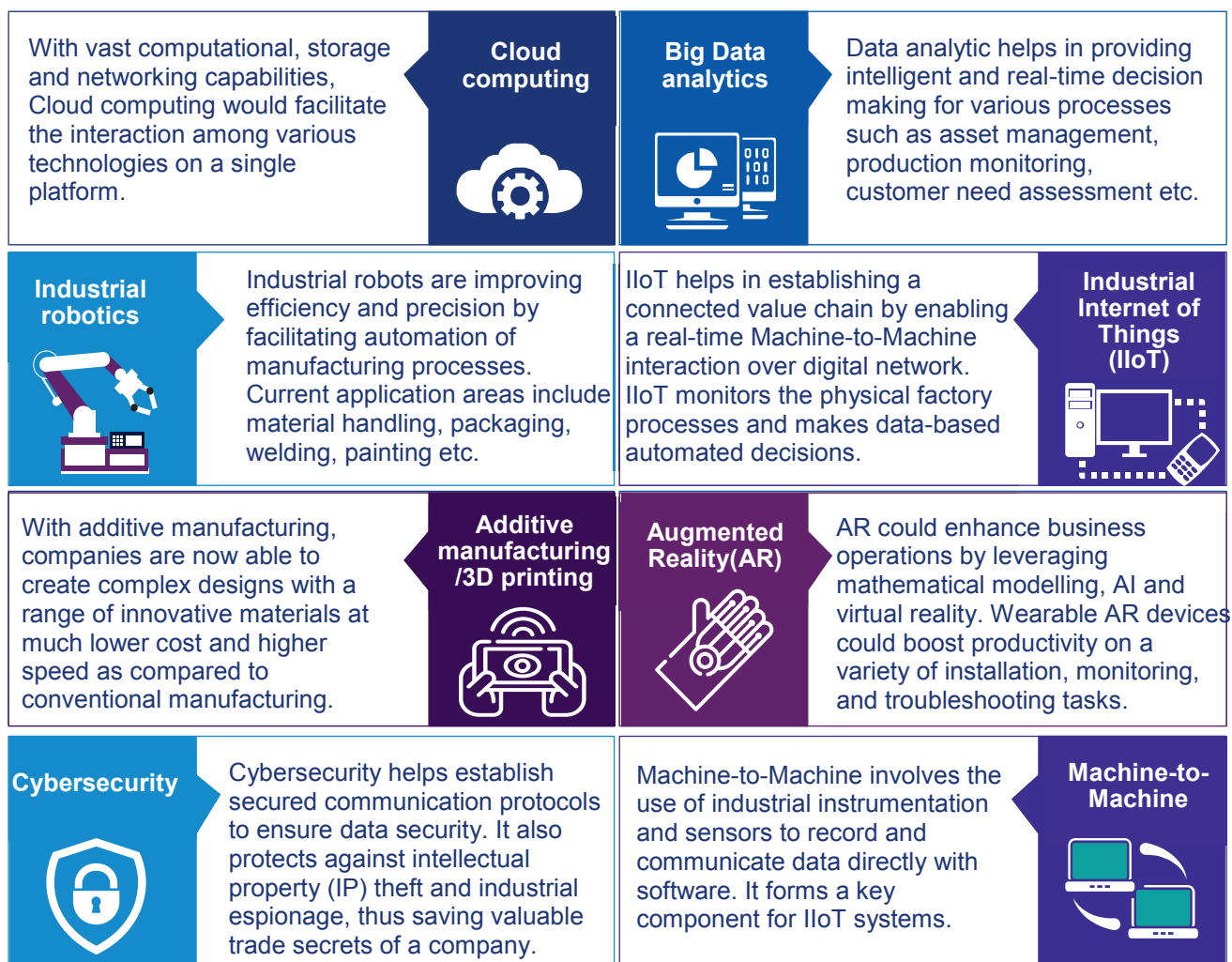
iv. Manufacturing

Over the past 250 years, the technology has aided in the development of manufacturing industry from simple steam-powered mechanisation in late 18th century to present-day high precision industrial robots. The introduction of information technology has unleashed a plethora of possibilities in the manufacturing industry. Currently, we are witnessing the fourth industrial revolution or digital, which refers to the digitalisation of the entire manufacturing value chain, starting from procuring raw materials to delivering end product to customers. Industry 4.0 is helping manufacturers in bringing together different silos of production system, allowing real-time data sharing and facilitating Machine-to-Machine and Human-to-Machine interactions.

Industry 4.0 uses emerging technologies such as Cloud computing, Big Data/analytics, additive manufacturing/3D printing, Augmented Reality (AR), Internet of Things (IoT), robotics, cybersecurity and Machine-to-Machine (M2M) communication to bring speed, scale and precision across the entire manufacturing value chain. While some of these digital technologies have already made their way into industrial applications (industrial robots and Cloud), some technologies such as 3D printing and AR are still at a nascent stage of development.

22. PRAVINYA LMS (PLMS), pravinya website, accessed on 14 February 2019

Key technology levers and their role in modern manufacturing



Manufacturing sector is an integral part of India's long-term growth strategy. To stay relevant and competitive, India will need to invest in emerging technologies to improve its domestic manufacturing capabilities. A significant portion of the Indian manufacturing sector is still in the post-electrification phase where the use of technology is limited to systems that function independently of each other. Furthermore, technologies (industry 4.0) can benefit tremendously for the Micro, Small and Medium Enterprises (MSME) to enhance their needs - speed, flexibility, quality, efficiency, and security. However, MSME sector lacks the financial support and skillset to implement digital initiatives. Government will have role to play in education and funding the initiatives to handhold Indian SME firms (handicraft, artisans) in their journey of automation.

Government initiatives towards digital manufacturing



National programme for the development of artificial intelligence (AI)

In the Interim Budget 2019, the government announced the launch of the national programme on AI. The programme includes setting up an AI portal, an AI hub and centres of excellence. The government has also identified nine priority areas, including manufacturing, that the AI programme will focus on.

National Manufacturing Policy, 2017

In July 2017, the government rolled out a new manufacturing policy with an aim to expand the **manufacturing share to 25 per cent of the GDP by 2025**. The policy laid focus on quicker adoption of Industry 4.0.



Mission on Cyber-Physical Systems (CPS)

As per the Union Budget 2018–19, the Department of Science and Technology plans to establish Centre of Excellence (CoE) to provide training in robotics, digital manufacturing, AI, IoT etc. The government has set aside INR1 billion for this project.

Sources: Industry 4.0: India Inc. gearing up for change, KPMG India, March 2018, Budget 2019: The Indian government is launching a national programme for development of artificial intelligence, Business Insider, 1 February 2019, Jaitley heralds cyber-physical systems mission to create new jobs, The Hindu, 1 February 2018

Industry initiatives towards digital manufacturing

Industry leaders are looking at transforming their vertical and horizontal value chains through factory automation. A number of these manufacturing companies are forging multinational partnerships and alliances in order to secure FDI, develop innovative solutions and benefit from digital technologies. Recently, an Indian automotive company collaborated with a leading U.S.-based IT giant to develop an AI platform for its vehicles. In another instance, an IT major recently announced to set up a 'Factory of Future' lab in Bengaluru. This lab would not only develop Industry 4.0 solutions, but also help the clients to adopt these technologies and overcome the legacy challenges with their implementation.²³



Bringing speed and flexibility in complex component manufacturing through 3D printing

During the construction of its new plant, a leading Indian steel company was facing delay in sourcing of a small but crucial component. The regular suppliers of the company gave an estimated delivery time of four to six months, which would have derailed the commissioning timeline of the entire project. In this crucial situation, the procurement team of the company reached out to a 3D printing company which delivered this component within a few days of placing the order.

The case presents a unique opportunity for the use of 3D printing in heavy equipment industry, which often requires complex and crucial components in small quantities.

23. Tech Mahindra opens Factory of the Future center at Bangalore, Tech Mahindra website, 7 March 2017



Improving speed of operations through industrial robots

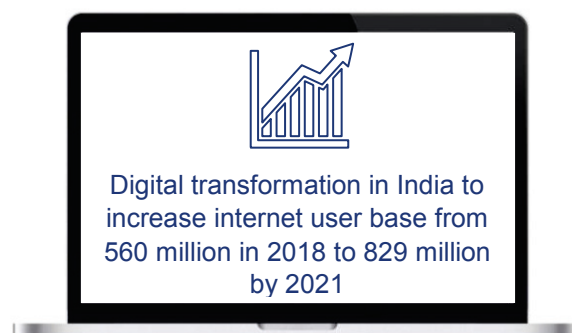
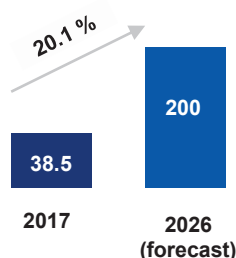
A Maharashtra-based auto component manufacturing company (SME) was facing difficulties in meeting the delivery timelines and product quality guidelines for its customers. To tackle this issue, the company decided to install a robotic automation solution in its facility. Post installation of the industrial robot, the company observed improvement in speed, quality and timely delivery of the products. The installation also saved nearly 40 per cent of the workstation space for the company.

v. Retail and logistics sector

The retail sector in India is gradually moving towards organised market with the emergence of single-brand retail and e-commerce companies. As per a report released by Crisil²⁴, the share of organised retail segment in India is expected to grow from seven per cent in 2017 to approximately 10 per cent in 2020. With a growing online retail segment in India, a robust logistics network is also required to control quality of product, inventory level, and other supply chain related costs. Logistics is thus a key enabler for growth of the e-commerce retail sector, connecting online retailers and their warehouses to customers.

Digital technologies are playing a critical role in helping e-retail brands to reach tier 2/3 market. Increasing penetration of internet, growth in the number of smartphone users, availability of affordable data plans and digital payments have led to a rise in the number of online shoppers.

Indian e-commerce market size (USD billion)



Adoption of digital technologies such as AI, ML, Augmented Reality/Virtual Reality (AR/VR) and IoT not only helps connect sellers and customers through mobile and web platforms, but also improve customer satisfaction through provision of personalised services and recommendations.

Applications of digital technologies in the retail sector

AR/VR	Voice technology	AI/ML	IoT
AR/VR technology could be used in the fashion segment for trying out multiple clothing outfits virtually, to better aid customer's buying decision.	Voice technology can help retailers to integrate data from voice assistance to their omni-channel offering.	AI-based solutions could be used to determine buying patterns of customers, enabling e-commerce companies to offer personalised product recommendations.	GPS-enabled shopping carts could be used to guide shoppers within the store. Furthermore, they could also allow the checkout via the shopping cart itself.

24. "Organised retail share in India to touch 10% by 2020: Crisil", Livemint, 15 January 2018

The lucrative growth in Indian e-commerce market has attracted many foreign investors. For instance, a global U.S.-based retail company invested nearly INR1,132 billion (USD16 billion) in an Indian e-commerce firm in August 2018. The government had also increased the limit of FDI in the e-commerce sector to 100 per cent in 2016, which could further boost foreign investment.



Reducing errors in product delivery through machine learning

A Bengaluru-based e-commerce firm developed a machine learning based model to determine the correct address for a particular purchase. Addresses in India consist of regional names which are converted to English language phonetically, which results in varied spelling patterns. This significantly impacts the last-mile logistics of the e-commerce company. The ML-based model helps in curbing this issue. The algorithm learns the names of different localities and sub-localities using both unsupervised and supervised learning methods. This allows the model to learn alternate spellings of a particular locality and helps reduce the error of delivering a product to an incorrect address.

The rise of organised and online retail has encouraged 'Kirana' stores to adopt technology solutions for serving the needs of new-age "digital customers". Today, a number of Kirana stores offer various digital payments options including digital wallets and QR code based UPI payments. A number of startups are also assisting Kirana stores by providing low-cost inventory management and marketing solutions such as customised SMS, itemised billing, and e-tailing via delivery.

Serving as a backbone to the Indian economy, the logistics sector has witnessed exponential growth in the last few decades on the back of rising domestic consumption and increasing international trade. However, the sector faces a plethora of issues such as lack of sound transport infrastructure, poor asset utilisation rate and high lead time in warehousing and distribution processes. As a result, the logistics spend, as percentage of GDP in India, ranges from 14 to 15 per cent, much higher than five to six per cent of other competing economies.²⁵

The Government of India aims to bring down the logistics cost to less than 10 per cent of the GDP by 2022.²⁶ To achieve this, the government has taken a number of initiatives to strengthen the technology framework of logistics industry.

- In 2014, the government has launched FASTag, a radio frequency identification (RFID) technology based automatic toll deduction system to reduce congestion at toll booths on national highways
- Implemented Logistics Databank System (LDB) at multiple sea ports to improve predictability and optimisation of cargo flows. LDB is a combination of IoT, Big Data and Cloud-based solution which provides single window interface to track the location of the container along its entire journey
- The Central Railway has developed an AI-powered robot which performs examination of under-gears of trains and send them to engineers for repairs and maintenance in real time.

The Indian logistics industry has made major strides in technology adoption in the past few years, especially after the e-commerce boom. Technology adoption has increased productivity in the supply chain, minimised expenditures and incidents of error. These advances benefit all areas of the logistics industry — trucking transportation, international transportation (ocean and air), shipment tracking, last-mile delivery etc.

25. How Technology Is Shaping India's Logistics Industry, CXO today website, 25 July 2017

26. India aiming to reduce logistics cost to less than 10% of GDP by 2022, Business Standard, 24 August 2018

Key technologies shaping future of logistics sector

IoT and telematics

A combination of IoT and telematics could be used to check the real time status of assets throughout the value chain, reducing the risks pertaining to breakdown. It would help in minimising process delays as well as fatal accidents.

AI and automation

By reducing manual intervention with the application of AI enabled automation, the companies could speed up processes such as material handling and warehousing, thus bringing down operational cost.

Cloud computing

Sharing information on Cloud-based platforms in real time could help service providers to coordinate the freight movements. This would reduce the idle time of the fleets and optimise asset utilisation rate.

With the use of data analytics, IoT, and Cloud platforms, a number of start-ups are providing smart logistics services by optimising their operations through right vehicle selection, real-time tracking, route/delivery planning, asset load optimisation, transit time prediction and reliable documentation and control.



Changing logistics industry through 'Smart trucking system'

A leading Gurgaon-based start-up is using Big Data, IoT and advanced analytics to solve critical issues of performance and reliability in the logistics industry. The company has fitted several sensors in its trucks which generate real-time data, which is processed and analysed to create traffic maps, prevent fuel pilferage, etc. The company has also developed a two-way IoT system that allows user to monitor and manage the correct temperature in temperature-sensitive shipments remotely.

vi. Power and utility

Real-time and mission critical operating environment has compelled power companies across the world to become the early adopters of digital technologies. Today, global power companies are creating digitally enabled customer centric business model by investing in asset lifecycle management, smart grid, and customer management solutions. On the contrary, Indian companies' are still working their way up in digital adoption curve. Most of the firms are still delivering products and services on legacy systems and struggling to modernise their current IT environment.

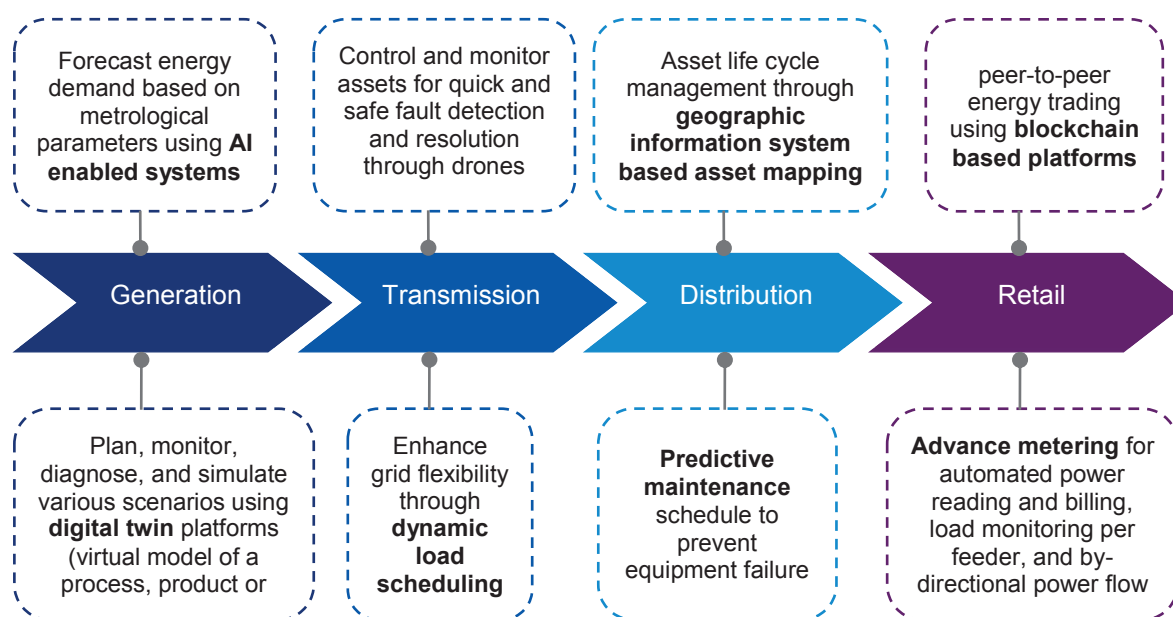
A recent World Bank Report, highlighted that glitches in Indian power sectors (high technical losses, power theft, inefficient metering, billing etc.) has led to losses to the tune of USD86.1 billion in FY16, equivalent to nearly four per cent of the country's GDP²⁷. To resolve these perennial issues associated with the sector and fulfill the growing power demand of a thriving economy, companies are increasingly incorporating digital in their business strategies

Digital solutions could help the power companies to deal with core operational issues such as high technical and commercial losses, high distribution transformer (DT) failure rate, and inefficiencies in power procurement.

27. Power sector distortions cost India billion, The World Bank, 18 December 2018

Furthermore, it could also aid companies to deal with forthcoming challenges such as effective integration of renewable energy (RE) with the grid and manage the unforeseen power demand due to rise in plug-in electric vehicles (EV). A simple IoT based asset management solution can bring down DT failure rate significantly, helping Indian utilities save around INR30 billion annually²⁸.

Applications of digital technologies in power sector



Both government and private sector realise the potential of digital technologies and are actively working to integrate them across the value chain, improving operational efficiencies and customer engagements. The government has established National Smart Grid Mission to lay the foundation for Smart Grid, which include smart metering, consumer indexing, asset mapping, and EV charging Infrastructure. However, government struggles to fully implement Smart Grid measures. For instance, as of March 2019, the government has been able to achieve only two to four per cent smart meters installation target in various meter categories (for >500 kWH and 200-500 kWH) across India²⁹.

Government has taken rigorous steps for including digital technologies in power sector, however, government could focus on below cases to maximize the benefits of digital in power sector.

- Converge and secure Information technologies (IT) and operational technologies (OT) systems
- Standardise and combine data structure to generate data driven insights across the value chain
- Deploy predictive load forecasting models to improve generation scheduling and load dispatch

Private companies are also actively upgrading their digital capabilities to meet the changing industry dynamics. A leading Indian private company has implemented Asset Performance Management (APM) solution across all its thermal power plants in India. The solution uses a suite of technologies such as cloud, digital twin, analytics and machine learning to reduce operating costs, improve maintenance scheduling and improve total cost of ownership.

28. The power of digital - An enabler and disrupter, KPMG in India, December 2018

29. Home, UDAY website, accessed on 12 March 2019

ing forward, the adoption of digital technologies in power sector would benefit not only companies but also customers, by facilitating decentralised power generation, consumption analytics, demand response, and energy management services; allowing consumers to optimise their electricity consumption and generate value by evolving into 'prosumers' (a power producer and consumer). The trend would shift the business model focus from producers to consumers in the coming years.



Streamlining electricity distribution through smart meters

In January 2019, a government owned company completed smart metering project in Delhi under which it replaced 50,000 conventional electricity meters with smart meters, making Delhi the first municipal body to implement 100 per cent smart metering solution. The adoption of smart meters has not only rationalised electricity consumption and enhanced consumer convenience but also led to annual savings of INR125 million³⁰.

vii. Agriculture

Agriculture is a primary source of livelihood for nearly half of country's population, however, the sector struggles to generate sustainable income for most of them³¹. The sector is plagued by plethora of challenges; right from pre-production to storage and distribution. According to the Agriculture Statistics at a Glance report 2016, India's agriculture yields of various crops are lowest among competing major economies such as China, Brazil and Russia³². Also, roughly INR957 billion worth of food produce in India gets wasted due to poor supply chain. All these inefficiencies make agriculture a high risk and low return business.

In order to revamp agriculture sector into an economically viable and ecologically sustainable practice, there is a dire need to move away from archaic practices and adopt technology assisted methods and systems, in line with global economies such as China and the U.S. These countries have demonstrated that an assortment of technologies such as precision farming, Big Data analytics, AI, satellite monitoring and geo-tagging, and farm management systems can be applied at various stages of agriculture to increase productivity and farm incomes.

Several organisations in India have already started investing in new agri-tech solutions. During 2014-18, there have been 41 deals worth INR6.5 billion in the Indian agri-tech space. Upsurge in the internet usage, increase in smartphone penetration, and various government initiatives in rural areas are also facilitating technology adoption in the farm sector.³³ These initiatives can be studied across the various stages of farming lifecycle.

- **Production:** Currently, most of the farmers in India choose their crops based on previous season trends rather than technical factors such as soil quality and nutrition level. Additionally, most of the farmers with smaller landholdings are overly dependent on monsoon for irrigation. All these factors along with conventional agricultural practices leads to lower farm productivity and higher farm input cost. AI and data analytics based platforms could assist the farmers in making suitable selection of crop, fertiliser, pesticide and irrigation method by analysing multiple factors such as soil nutrients level, moisture content, ground water levels, weather predictions etc. This, in turn, would help in producing higher crop yields with lower farm input.

30. 50,000 smart meters installed in NDMC area, BusinessLine, 9 January 2019

31. More than 55% of Indians make a living from farming. Here's how we can double their income, Weforum website, 4 October 2018

32. Agricultural output rose five fold in 60 years but farming sector is in distress, Hindustan Times, 12 August 2017

33. Agri-tech – enabling a new green revolution, Yourstory website, 5 September 2018

- As of March 2019, the government has issued more than nine million Soil Health Card to farmers. These cards provide crop-wise recommendations of nutrients and fertilisers required for the individual farms, enabling judicious use of farm input³⁴
 - In October 2018, the India Meteorological Department and a leading Indian engineering institute has jointly developed a country-wide soil moisture prediction model, which helps in better seed selection and irrigation plan³⁵
 - A number of start-ups are using Big Data analytics, AI, geo-tagging and satellite monitoring to provide real-time farm-related insights and recommendations to farmers to help them optimise their farm productivity.
- **Supply Chain and distribution:** In the current agriculture supply chain, middlemen gets a significant portion of farmers' income. The advent of e-market platforms has directly connected farmers to buyers, resulting in higher profit realisation for the former. It also provides better price transparency to both, buyers and farmers.
- In April 2016, the government launched National Agriculture Market (eNAM), an online trading portal, to connect existing 'mandis' across the country. The eNAM portal not only removes middlemen by directly connecting buyers and farmers but also provides a fair and transparent commodity pricing through a demand-supply based online auction system³⁶
 - Start-ups have moved a step further and are offering end-to-end digitalised supply chain that helps in reducing wastage in distribution. Apart from providing solutions, the start-ups are also providing trainings to farmers to effectively use these technologies. E-distribution, marketplace and other supply chain related start-ups accounted for more than 60 per cent of the agri-tech start-ups during 2013-17³⁷
 - To provide efficient and reliable cold storage solutions, companies have developed solar powered cold storage and energy storage solutions.

Rising number of agri-tech start-ups are opening new avenues of private sector investment in agriculture. Fresh investment in agriculture could have far-reaching economic and social impact on Indian economy.

Moving forward, the government role in facilitating technology adoption among farmers will be crucial. Tech adoption would result in higher yields and returns; in turn reducing the debt on farmers as well as the government. Likewise, the government need to create a framework where the benefits from the investments in food processing sector could reach to the bottom of the pyramid i.e. farmer.

34. Home, soilhealth.dac website, accessed on 7 March 2019

35. How wet is the ground after rain? for first time, India gets soil moisture, The Indian Express, 3 October 2018

36. Can eNAM flip Indian farmers' fate?, Business Today, 18 September 2018

37. Agritech in India, Nasscom, June 2018



Digital solution for marginal farmers

A Bengaluru based farm aggregator start-up is working on the agriculture problems arising from disaggregated landholdings and outdated farming techniques. The start-up brings together data from several small farms on a cloud platform and provide precise day-to-day recommendations to farmers based on its data science and analysis engines. It advises farmers on the right amount of crop input (seed, irrigation, fertilizers) to generate maximum yield. The company claims that its solutions provide 30 to 50 per cent increase in yields over conventional methods. The company works on a success-fee based model which reduces the farmers' risk as compared to other upfront investment initiatives.³⁸

38. Aibono wins Social Enterprise Award at the ET Startup Awards 2017, The Economic Times, 18 August 2018

Social impact of digital transformation

Digital revolution is well under way transforming jobs, skillset requirements, and overhauling industries. Globally, policy-makers, economists and industry leaders are trying to understand the societal impact of digital wave on issues such as inequality, health, resource efficiency, and jobs. Apart from building a sustainable digital infrastructure, Government of India is working towards the agenda of social inclusion in its digital policies/initiatives. In September 2018, the Union Cabinet of India approved the National Digital Communications Policy 2018 that laid down various objectives including creation of four million jobs in the digital communications space and organising training programmes to upskill one million people by 2022³⁹.

Adoption of widespread technologies varies in the country in terms of acceptance or adoption by different stakeholders, leading to varied impact. Technologies such as AI and ML are mostly being adopted by large technology enterprises and various emerging advanced tech start-ups, whereas matured technologies are being utilised by all stakeholders including people, businesses, and the government.

Labour force and job creation

In the past two decades, the Indian labour market has witnessed a structural shift, with a number of individuals moving from agricultural employment to other sectors. During 2001–11, labour force worth 79 million was added to the total workforce, of which two-third was absorbed by the non-agricultural sector⁴⁰. This was majorly influenced by the introduction of various dotcom companies in late 90s and early 2000. Since then, enterprises have built several digital services/solutions leading to the creation of various job opportunities that have a significant impact on the society as a whole.^{41,42} Even now, the advancement in technologies is creating new job roles. As per a study conducted by the World Economic Forum, an estimated 58 million new jobs will be created by 2022 due to adoption of new age technologies.

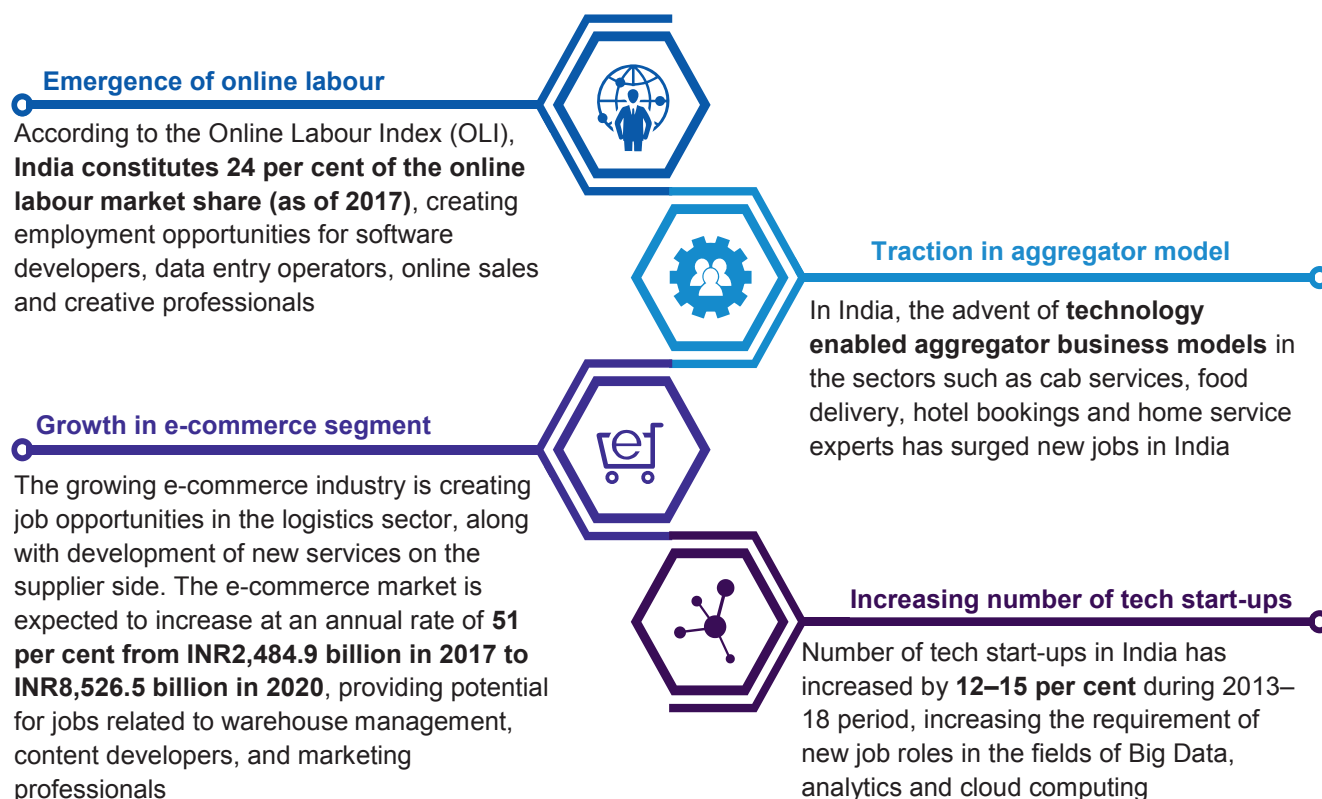
39. "National Digital Communications Policy 2018", Government of India, 26 September 2018

40. "Growth and Structure of Workforce in India: An Analysis of Census Data", published in 2016

41. "Emerging technologies and the future of work in India", International Labour Organisation, published on June 2018

42. "By 2050, India's working-age population will cross one billion. But where are the jobs?", Quartz India, published on 27 April 2016

Key reasons for creation of new job opportunities^{43,44,45,46}



Rising demand for delivery agents

Thanks to internet connectivity and smart phone usage, increasing number of companies are entering into e-commerce space. E-commerce companies in India are now strengthening the last human link of their supply chain. As competition intensifies amid growing volumes and expanding businesses, the demand of delivery agents has skyrocketed. Going forward, delivery agents will be of paramount importance for the success of O2O (online to offline) businesses, giving rise to new job profiles in India.

Furthermore, the implementation of advance digital technologies is also expected to replace low- and mid-skilled jobs with high-skilled jobs. In the U.S. and Europe, there has been a shift from labour intensive jobs, creating a polarisation and increasing importance of high-skilled jobs. In line with the global trend, new job roles pertaining to niche technologies such as data scientist, 3D printing, digital marketing, and blockchain designer have also gained traction in India. In the Indian automotive sector, enterprises are focusing on leveraging AI and ML to augment their data management and analytics capabilities leading to a growth in jobs related to these domains. In addition, there has been an increase in jobs in the field of cybersecurity, social media services, and mobile application development. These jobs require skillsets such as managing and interpreting Big Data/analytics, Cloud services, machine learning, etc.

Different sectors such as IT, manufacturing, healthcare and financial services are observing an increase in efficiency and productivity through the deployment of digital platforms and digitally enabled services.

43. E-commerce Industry in India, IBEF, accessed on 28 January 2019

44. The Online Labour Index, Oxford Internet Institute, accessed on 28 January 2019

45. Indian tech start-up ecosystem, Approaching Escape Velocity, Nasscom, published in 2018

46. India Largest Supplier Of Online Labour, Business world, 20 July 2017

For instance, the revenue for the IT sector has increased by nine per cent annually since 2012, due to the implementation of digital technologies such as machine learning to execute tasks including scheduling and planning.^{47,48} However, India faces the challenge of digital talent gap, which acts as a barrier for the companies in adopting digital technologies in business operations.

Addressing the digital talent gap

According to India Skills Report 2018, employability score in India was only 45.6 per cent during 2017–18⁴⁹, attributed to the digital talent gap in the country. India faces the challenge of talent gap as the number of working population is increasing relatively faster than the employability rate in the country.



According to a survey conducted by Observer Research Foundation and the World Economic Forum, focused on future of work in India, more companies have reported hiring additional workforce due to the introduction of new technologies (ML, Big Data and robotics), as compared to the companies that reduced the number of staff. **Around 21 per cent** of the companies surveyed have **created new job roles** in the last five years to handle digital technologies.

According to the World Bank, automation will most likely **replace 69 per cent** of the jobs in India. This has created the need for labour force to develop new skills and for businesses to undertake various initiatives to upskill their existing workforce.

Employability score — India



Key facts pertaining to skill gap in India (as of 2017)

Out of 1.5 million engineers graduating annually, only 52 per cent are employable

Around 360,000 MBA students graduate from 4,000 B-schools annually. 61% are unemployable due to skill gaps lesser work experience

According to the Digital Talent Gap report 2017, India has an average proportion of 76 per cent digital talent compared to the global average of 56 per cent. However, 64 per cent of the companies highlighted widening of digital talent gap in India, compared to 54 per cent globally.

The Government is focused on developing skill programmes to support the population in adapting digital technologies. Some of the government initiatives are **Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA)**, and **Skill India Programme**. **The government has also collaborated with private sector for vocational training initiatives.** In collaboration with Infosys and the World Economic Forum, the Minister of Skill Development and Entrepreneurship of India launched a Task Force for Closing the Skills Gap in India, focused on enhancing the education and training system of the country. The task force will be providing targets related to reskilling and upskilling of workforce to top 50–100 companies in the country.⁵⁰

47. "Indian IT goes slow on hiring, 20-25% likely reduction in jobs over 3 yrs", The Economic Times, published on 20 February 2017

48. "Jobs and Skills: The Imperative to reinvent and disrupt", Nasscom, published on 18 May 2017

49. "India Skills Report 2018", published in 2018

50. "Public-Private Task Force Launched to Close India's Skills Gap", World Economic Forum, published on 5 October 2018

Businesses are creating collaborative learning platforms across sectors and at organisation levels, aimed at providing e-learning and innovative training programmes.

- The IT sector has plans to train 1-1.5 million workforce in digital technologies in next 3-4 years. For instance, a large IT firm has developed a training that focuses on identification of skill gaps in middle management and assists in upgrading these skills⁵¹

Educational institutions are also transforming the traditional curriculum into skill enhancement courses related to decision-making and creative thinking. The institutes are collaborating with Government and corporates to provide students practical application of the new digital technologies.

Hence, the combined efforts of government, academia, and companies will be critical to bridge the digital talent gap and improve the productivity of the labour workforce in India.

Impact on social welfare (governance, corruption, and digital divide)

Digitally enabled governance infrastructure improves transparency, efficiency, and effectiveness of delivering services to the citizens. Apart from delivering government services, ICT infrastructure is necessary for businesses and start-ups to extend their services to more customers in order to bridge the significant gap, which exists between the rural and urban sections of India in terms of digital uptake.

Digital governance

Various departments in the government have adopted digital technologies, which are enabling them to implement numerous people-centric initiatives, such as the Direct Benefit Transfer (DBT) scheme. Ministry of Electronics and Information Technology (MeitY) in India has formulated a National e-Governance Plan to streamline the delivery of public services and enable easy access to those services.



Source: India's big leap into the digital future", eGov Magazine, 19 December 2018; "India Makes A Massive Leap In UN E-Government Survey 2018, Secures 96th Position", Inc42, 4 August 2018

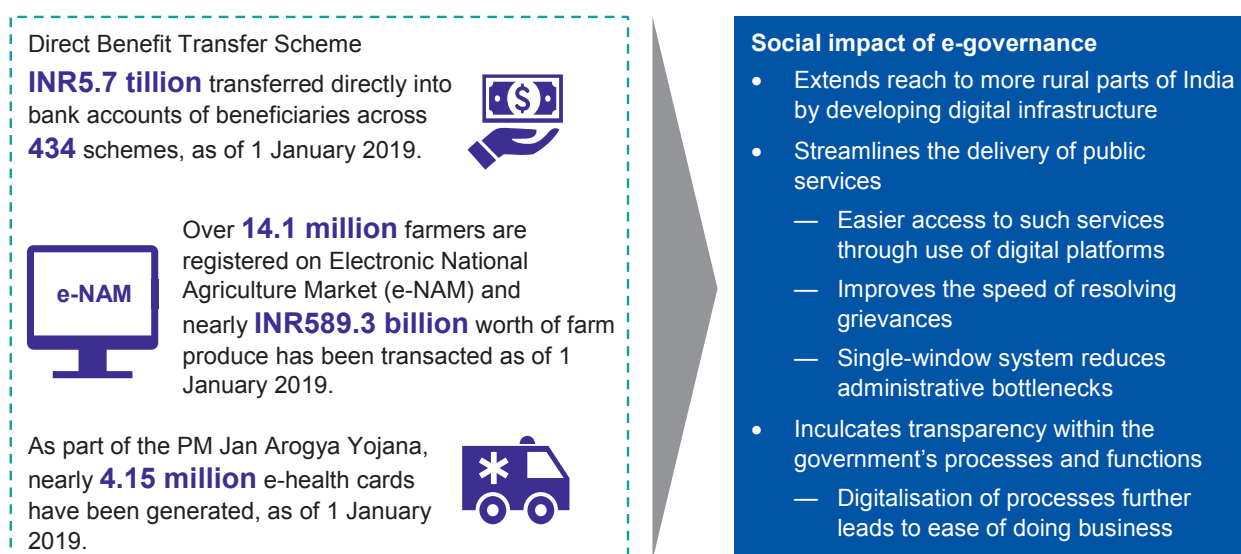
In order to achieve transparency and streamline the disbursement of public services delivered to the citizens, the government has provided each individual with a unique digital identity enabled through the Aadhaar card. This makes it the foundation layer of India's e-governance infrastructure (India Stack). The primary purpose of the India Stack is to enable the government and businesses to create Aadhaar-based applications/services. For instance, in the DBT scheme, financial benefits/subsidies are directly transferred to the bank account of the beneficiary, which is linked with the Aadhaar card. This initiative assists the government in eliminating intermediaries, and transferring the entire benefit to the beneficiary.

The plan of developing digitally enabled governance infrastructure in India is analogous to that of developing software stack, which refers to building of interdependent services on top of each other. Even 'India Stack'

51. "Why India's IT firms should huddle up for the future", TechCircle, published on 26 December 2018

comprises four technology layers and each of these layers represents different categories of government services. These services are disbursed to citizens through Application Programming Interface (APIs), which assist in developing applications across financial services, healthcare, education and other domains.

Development of digital infrastructure and platforms to deliver services has helped the government to improve upon various operational efficiencies, allowing them to reach more citizens and ease access to public services.

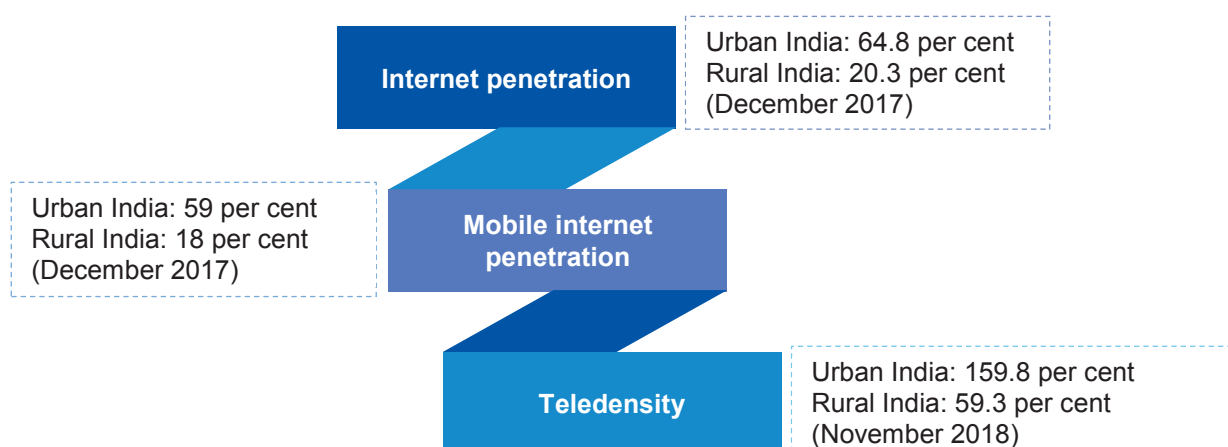


Source: Speed, Scale and Spectrum of Transforming India, Transforming India website, 08 January 2019

Digital Divide

Despite the aforementioned developments on the digital front, various challenges still exist. Not everyone has access to all technologies, which has led to creation of a significant Digital Divide in the country. There is a big difference between the internet penetration, including wired and wireless internet, between the urban and rural sections of the country. As per a report published by the Internet and Mobile Association of India (IAMAI), 'Internet in India 2017'⁵², the usage of internet is skewed towards the urban cities, with top nine cities (in terms of number of internet users) accounting for nearly 35 per cent of all the internet users. Some of the key factors responsible for the rural-urban Digital Divide in India are attributed to the differences in network infrastructure, digital skills, and affordability of internet services provided in urban and rural regions of the country.

Urban-rural digital penetration^{53,54}



52. "Internet in India- 2017", Internet and Mobile Association of India (IAMAI), 2017 Edition

53. "Highlights of Telecom Subscription Data", Telecom Regulatory Authority of India, 30 November 2018

54. "Mobile internet users in India to reach 478 million by June 2018: IMAI report", YourStory, 31 March 2018

However, India has come a long way in providing digital infrastructure to common men and has put thrust towards connectivity provision, data cost reduction, capacity augmentation and rural participation to diminish the digital gap. The Digital Divide now predominantly focuses on the educational, as well as the level of awareness in the country. For instance, while people in rural areas may have access to data and mobile, they still struggle to understand or use the various services available at their disposal by government and private players. This presents a huge opportunity for businesses, start-ups and the government to educate, create awareness and foster the development of digital infrastructure, enabling the hinterland gain better access and skills to employment, healthcare and education services.

The government has laid down various initiatives/policies, such as BharatNet and National Digital Communications Policy 2018, to ensure countrywide connectivity, build fibre optic infrastructure to provide high-speed internet in gram panchayats and other rural sections of the country. In addition, improving the internet connectivity infrastructure and provisioning low cost mobile data plans and smartphones will further bridge the rural-urban gap in terms of mobile internet penetration and smartphone users. The government also announced an investment of INR30.7 billion to foster the adoption of technologies such as AI, ML and IoT⁵⁵.

Emergence of new age technologies like AI and ML, despite having productivity and efficiency benefits, expected to create a Digital Divide among enterprises. This is because implementation of such technologies majorly depends upon the availability of necessary skills and affordability of the firm. Apart from the aforementioned factors, inability to align new age technology systems with the organisation's business model also acts as another barrier for adoption of such technologies. Adoption of niche technologies is still in a nascent phase in India, and the high cost of implementation prohibits decision makers to envisage the return on investment from these technologies.



As per a study conducted by The Fletcher School, 'The Digital Evolution Index 2017', India scores relatively low in terms of digital evolution as compared to countries globally. Inadequate infrastructure and the need for establishing stringent policies around data privacy and security are some of the factors that have widened the digital gap when compared with countries such as the U.S. or European economies.

However, the digital economy is evolving in the country with various technology giants and the emergence of many advanced tech start-ups that are exploring the potential of high customer demand in India.

Improvements in the digital communications infrastructure could have numerous benefits across various sectors such as logistics, retail, education and agriculture. For instance, the government has launched Electronic National Agriculture Market (e-NAM) initiative, which provides farmers an online platform to sell farm commodities. This enables farmers to earn the right price for their produce, eliminates the concept of intermediaries and ensures transparency in the system.

Favourable demographics in the country and implementation of digital infrastructure to improve governance and connectivity will most likely bridge the digital gap between different sections of society in India.

55. "Budget 2018: Govt. Still Strong On Digital India; Allocates \$480 Mn To Promote AI, ML, IoT", Inc42, 01 February 2018
Source: "The Digital Evolution Index 2017", The Fletcher School, 2017 Edition

Environment sustainability

Countries across the globe, including India, are undertaking various measures to tackle climate change and reduce their overall carbon footprint. To have a better environmental sustainability index, India entered into the Paris Agreement in order to establish objectives to reduce its carbon footprint by 2030⁵⁶. Implementation of digital technologies would help in reducing consumption of fuel, better disposal of waste and efficient utilisation of scarce resources. For instance, advanced automation systems could be implemented in the Indian cement industry that can augment computational fluid dynamics (CFD) analysis in combustion process. This could help in increasing energy efficiency and improving productivity of the entire cement production process. Government-led initiatives have provided a boost to various domestic sectors as well, for instance, 'Make in India' initiative is promoting the manufacturing sector in the country. Demand for quality and customised products has driven the manufacturing industry to adopt digital technologies. This would enable efficient utilisation of resources and effective electronic waste management.

Impact of key technologies on environment (manufacturing sector)⁵⁷

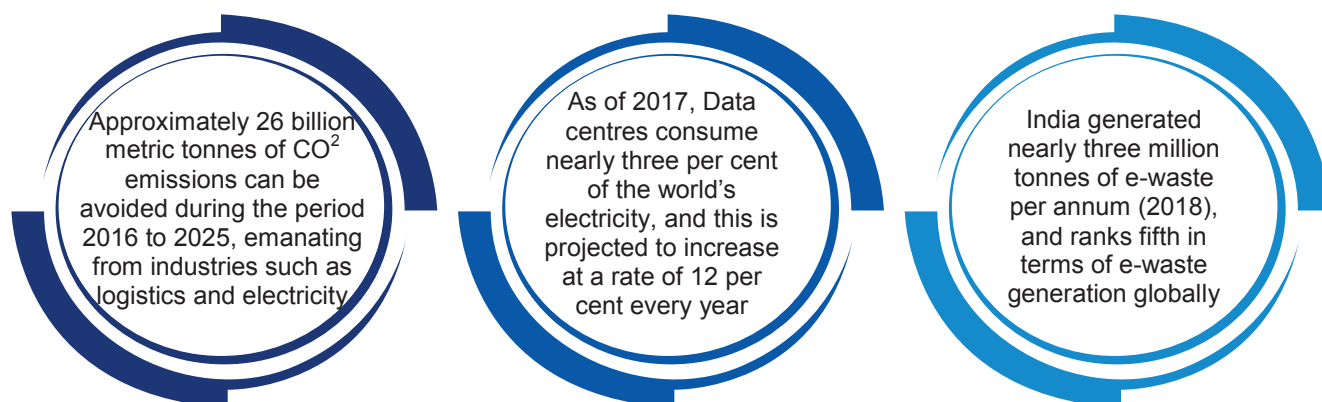
Focus technology areas	Application impact	Impact on flows of production activity	Environmental impact
Big Data analytics	Predictive maintenance, remote maintenance, thereby reducing downtime	Reduction in raw material flow for manufacturing and overall reduction in energy flow at factory	↑
Additive manufacturing	Assists in manufacturing tools, parts and finished products	Reduction in waste and raw material flow, however, increases energy consumption	↑
IoT and sensors	Provides access to data regarding raw material flow, energy flow, thereby promoting efficient utilisation	Optimises energy, material flow and consumption	↑
Digitisation	Obsolescence of existing machinery and equipment	Increase in mechanical waste generation	↓
Blockchain technology	Creating and maintaining records, and enforcing contracts	Leads to increase in energy utilisation (increase in energy flow)	↓

Although the processes become more efficient with use of digital technologies in the manufacturing sector, but this also leads to increased waste generation due to obsolescence of existing machinery and equipment. Increase in energy consumption and waste generation are the key factors that might pose a negative impact on environment. Furthermore, manufacturing semiconductor chips produce acid waste that could pose a significant health risk if not treated appropriately. Disposal of electronics such as computers and mobile phones release toxic components such as lead and zinc, which might seep through the soil and into the groundwater, leading to major health risks.

56. "India Set to Achieve 2 of 3 Paris Agreement Goals: Draft Government Report", The Wire, 12 November 2018


57. "Industry 4.0 and Sustainability Implications", MDPI, 17 October 2018

Key facts pertaining to digitalisation's impact on environment^{58,59,60,61}




In order to curb the above factors, large manufacturers are focusing on leveraging green technologies, such as electro winning for eliminating copper metal from waste discharge, within the premises of the manufacturing facility. Similarly, implementing data analytics technology in the logistics domain would help optimise the routes taken by the trucks, which in turn would reduce consumption of fuel and reduce the overall carbon footprint of the process.

Businesses are leveraging digital platforms for effectively utilising existing assets, as well as working towards capitalising on opportunities across the value chain to reduce their carbon footprint. Utilising digital technologies not only assists in enabling transparency within the operations of a firm, but also allows company stakeholders to understand the environmental impact.



A global retailer of sportswear implemented an environment scenario tool designed to quantify the impact of its business operations on the environment. With the help of the tool, the company could envisage the impact of energy, emissions and waste across its supply chain.

Global technology giants are focusing on utilising 100 per cent renewable energy for data centre operations. Furthermore, a global smartphone manufacturer reduced the amount of energy consumed by its products by nearly 57 per cent in order to reduce the carbon footprint.



Logistics, automotive and electricity are three major industries, which could significantly contribute towards lowering of greenhouse emissions, as per a study conducted by the World Economic Forum⁵⁸. The study further highlights that every ton of CO₂ emitted through use of digital technologies can save 10 tonnes of emissions. Numerous industries are adopting digital technologies such as IoT and Big Data analytics to foster effective utilisation of resources.

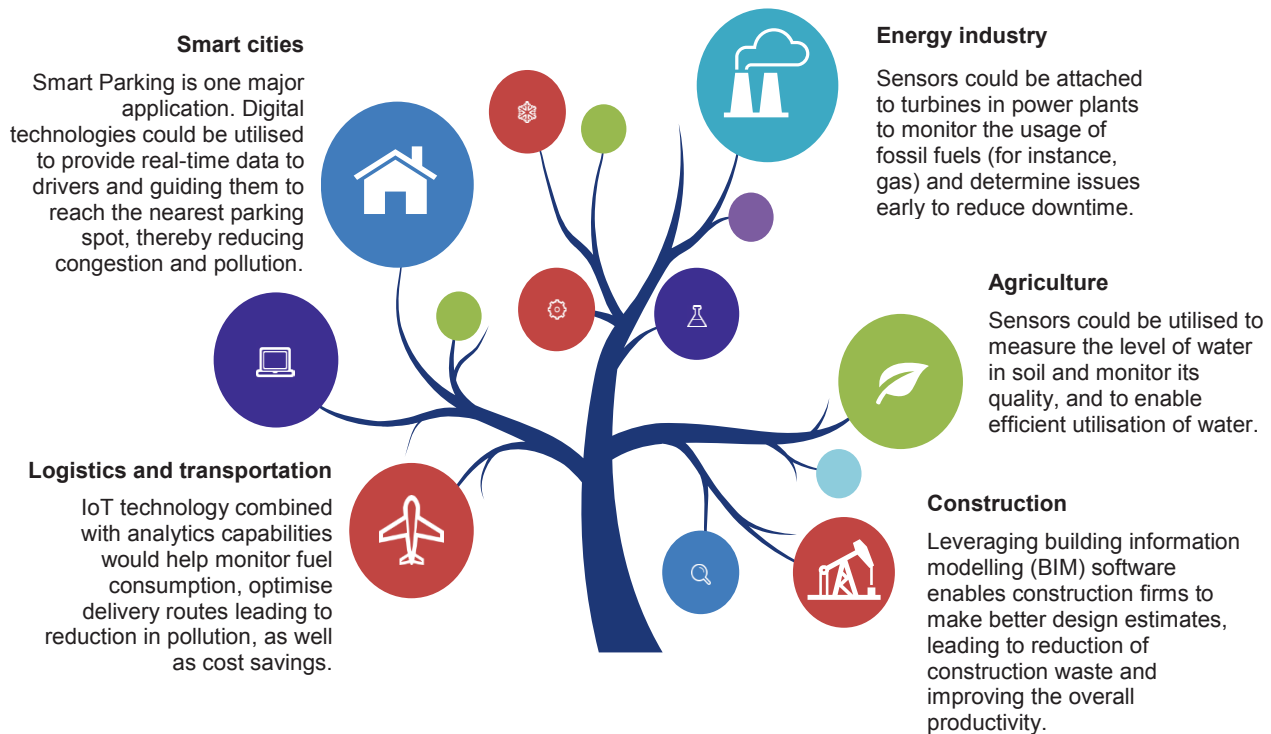
58. "How can digital enable the transition to a more sustainable world?", World Economic Forum, accessed 30 January 2019

59. "E-Waste Production To Touch 3 Million Tons By End Of 2018", Business World, 18 September 2018

60. "India among top five countries in e-waste generation", The New Indian Express, 04 June 2018

61. Why Energy Is A Big And Rapidly Growing Problem For Data Centers, Forbes, 15 December 2017

Environmental impact of digitalisation on key sectors



Development of guidelines to establish best practices for setting up operations would help in reducing environmental footprint. For instance, the European Commission established a code of conduct, which highlights best practices for designing, operating and maintaining the data centres in order to ensure efficient utilisation of resources. Implementation of digital technologies helps improve productivity by reducing the wastage of materials and resources at a construction site or a factory floor, thereby reducing the impact on environment.

Way forward

Government

Policies and frameworks: Formulate robust policies and framework to promote

- Data protection and privacy to mitigate cyberattacks and data leaks
- Labour and market laws for proliferation of new age technologies (IoT, AI)
- Data standardisation to effectively leverage vast amount of unstructured data
- 'Whole-of-Government' approach to build backend data architecture for effective utilisation of resources and public data
- Adopt solution based approach (Design Thinking) while developing and marketing digital products at national or regional level

Collaboration:

- Collaborate with industry bodies and private players to streamline the regulatory structure of hi-tech industry
- Build cross-institutional links and foster collaboration among private and public sector to facilitate the digital adoption
- Establish training center or center of excellence (COE), comprehensive apprenticeship and internship programmes in collaboration with technological institutes and IT firms that can help SME to learn and experience the benefits of technology.

Digital literacy and reskilling:

- Introduce skill training and digital literacy as part of learning curriculum in schools, colleges and universities across India
- Conduct digital literacy programmes for senior citizens and rural population to develop their digital quotient

Industry

Skill development:

- Reskill or upskill the existing workforce to meet the requirements of future jobs
- Develop a framework that could define participation of the private sector in national skill development programmes, which could provide clarity in terms of investments, content and job guarantees

Incubation: Provide incubation to tech start-ups/SMEs and support them in new technology development

Environment: Implement stringent policies and leverage digital technologies to prevent carbon footprint and e-waste generation

Academia

Collaboration: Academic institutes and not-for-profit educational organisations could collaborate with technology companies to develop low cost and scalable education (digital technologies) models

Capacity building: Invest in training and development of teachers, thus enabling them to effectively incorporate digital learning in classrooms

Service delivery: Provide digital content/services in various regional languages to engage wider audiences from all parts of the country

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About AIMA

The All India Management Association (AIMA) is the apex body for management in India with over 37000 members and close to 6000 corporate /institutional members through 68 Local Management Associations affiliated to it. AIMA was formed over 60 years ago and is a non-lobbying, not for profit organisation, working closely with industry, Government, academia and students, to further the cause of the management profession in India.

AIMA makes a salutary contribution to management learning and practice in the country by offering various services in the areas of testing, distance education, skill development & training, events & conferences, research, publications, executive education and management development programmes.

The association is represented on a number of policy making bodies of the Government of India and national associations including All India Council for Technical Education (AICTE), which is the apex regulatory body for professional education in the country under the Ministry of Human Resource Development; National Board of Accreditation (NBA); Association of Indian Management Schools, Hyderabad; National Productivity Council, New Delhi.

AIMA also brings to the Indian managers, the best management practices and techniques through numerous foreign collaborations with professional bodies and institutions. AIMA is a member of the Asian Association of Management Organisations (AAMO) and works closely with several international institutions like University of California – Berkeley, USA; The World Bank; St Gallen Foundation, Switzerland; The Imperial College, UK; Horasis: The Global Visions Community, Switzerland etc in organising international conferences and management development programmes.

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